Debt Markets and Investments

H. KENT BAKER
GREG FILBECK
ANDREW C. SPIELER
EDITORS

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> You write to communicate to the hearts and minds of others what's burning inside you, and we edit to let the fire show through the smoke.
>
> —Arthur Plotnik

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PART I

BACKGROUND

1

Debt Markets and Investments

An Overview

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Introduction

Bonds have a long and storied history. Dating back to the 1300s, Venetian citizens could buy government-issued bonds. The issues paid the owner (lender) an endless stream of equal payments or what is known as a *perpetuity*. Fixed income investments are probably the best-known type of bond. *Fixed income investments* generally pay a return based on a fixed schedule, but the amount of the payments can vary from period to period. Other types of fixed income investments include bond funds, some exchange-traded funds (ETFs), certificates of deposit (CDs), money market funds, fixed income derivatives, and securitized assets among others. Fixed-income securities can be contrasted with equity securities, often referred to as stocks and shares, which create no obligation to pay dividends or any other form of income. Unlike stockholders, holders of various debt instruments are creditors, not owners, with no direct control over the borrower's assets or investment decisions.

Morningstar (2012) classifies fixed income into six broad sectors: government, municipal, corporate, securitized, derivatives, and cash and equivalents.

- *Government*: This sector consists of all issues by governments including the Treasury and central banks as well as regional and local issues.
- *Municipal*: This sector comprises issues under the authority of state or local governments including both taxable and nontaxable entities. *General obligation bonds* are secured by the full faith and credit of the issuing municipality. By contrast,

revenue bonds are secured by the cash flows generated by the project for which they are issued to raise funds.

- *Corporate*: This sector includes public issues and private loans by corporations including both straight and convertible securities.
- *Securitized*: This sector includes all securities that have cash flows backed by a pool of underlying assets, which includes both mortgage-backed and asset-backed issues.
- *Derivatives*: This sector includes securities that have values based on an underlying process (normally interest rates) including forwards, futures, options, and swaps.
- *Cash and equivalents*: This sector includes fixed income securities with maturity lengths no longer than 12 months, including CDs, repurchase agreements, and money market holdings.

Within these markets, borrowers obtain funds by issuing various debt instruments. The instruments can be either *short term* (one year or less) or *long term* (greater than a year). For example, bonds are typically issued for a period of 10 to 30 years. In exchange for receiving funds, the issuer usually agrees to pay a fixed interest rate, also known as a *coupon rate*, based on a par (principal) value. *Par value*—also called *face value, nominal value, maturity value*, or *redemption value*—is the amount that the issuer is obligated to return when the security is redeemed. For example, a bond with a par value of $1,000 can be redeemed at maturity for $1,000. Interest or coupon payments are generally paid on a semiannual or annual basis. Par value often differs from the market price. If the market price is higher than the par value, the difference is called a *premium*; if the market price is lower, the difference is called a *discount*.

At issuance, the amount the issuing entity receives for each bond depends on the market's current assessment of the value of all future coupon payments and the par value. The rate at which the market discounts future cash flows is referred to as the bond's *yield to maturity* (YTM). If the YTM is equivalent to the coupon rate, the bond will sell for its par value initially. If the YTM exceeds the coupon rate, the bond will sell for a discount, which is less than its par value. Similarly, if the YTM is less than the coupon rate, the bond will sell for a premium, which is greater than its par value.

Unlike shareholders, bondholders rarely have voting rights so they must negotiate provisions with the bond issuer up front. These bond provisions are contained in an *indenture agreement*, which is a legal document issued to lenders describing key terms of the bond offering. The indenture agreement contains *positive* (or *affirmative*) and *negative* (or *restrictive*) covenants. Positive covenants include requirements the bond issuer must meet such as delivering audited financial statements and maintaining minimum liquidity ratios. Negative covenants include restrictions on the bond issuer such as limitations on additional borrowings. Covenants protect the interests of both issuer and bondholder. The issuing entity hires a *trustee* that serves as the fiduciary for enforcement of the provisions contained in the bond covenant agreement.

Although a bond's maturity is established at issue, provisions may exist that serve to alter its actual life. These provisions are called *embedded options*, which are special conditions attached to a security, and in particular, a bond, that give either the holder or the issuer the right to perform a specified action at some point in the future. Examples of embedded options include call, put, and conversion features.

A bond can be issued with a *call provision* that allows the issuer to redeem or pay off the bond before maturity. If redeemed, the issuer normally pays the par value plus a premium, which may be established based on a percentage of the bond's par value. Bond issuers are motivated to issue callable bonds because they offer flexibility in financing costs in the event that market interest rates decline. Such a market dynamic allows the bond issuer to pay off a more expensive bond and reissue a new bond at a lower interest (coupon) rate. However, an issuer is likely to pay a higher interest rate on bonds with a call provision because this provision benefits the issuer. A *puttable bond* is a bond with an embedded put option, which gives the holder the right, but not the obligation, to demand early repayment of the principal. The put option is exercisable on one or more specified dates. Another example of an embedded option is a *convertible bond*, which is a bond that the holder can exchange for another security, typically common stock.

Given that expenditures associated with a bond's redemption at maturity can be sizable, some bond issues include a *sinking fund provision*, which systematically retires portions of a bond issue on a staggered basis before maturity. A sinking fund provision offers additional assurance to bond holders because it lessens the burden on the issuer to raise the necessary capital to retire a matured bond issue all at once.

Not all bonds pay coupon payments (zero coupon bonds) or pay coupon payments immediately after issue (deferred bonds). For those bonds with a contractual obligation to pay coupon payments, if the issuer fails to make these payments it can force the issuer into bankruptcy as a result of the default.

Bond Risks and Products

Although bonds have a higher priority to earnings than preferred stock or common stock, bondholders still face various risks beyond bankruptcy. Some of these risks include interest rate risk, inflation risk, credit risk, liquidity risk, and reinvestment risk.

Bond values are determined by the present value of the expected coupon payments and par value. *Interest rate risk* is the risk that overall interest rates will change from the levels available when the security is sold, resulting in an opportunity cost. Interest rate risk becomes a substantial threat for bondholders because increases in interest rates, reflected in a bond's YTM, can markedly decrease a bond's value. Both micro- and macro-based factors can influence changes in the YTM. Micro-based factors are related to the creditworthiness of the bond issuer. Thus, increases in credit risk can cause the YTM to increase, which reduces the bond's value. Corporate bonds tend to be categorized as either investment grade or speculative. An *investment grade bond* is a bond with a credit rating of BBB– or higher by Standard & Poor's (S&P) or Baa3 or higher by Moody's. The rating agency generally judges these bonds as likely to meet their payment obligations. Speculative grade bonds are referred to as high yield or junk bonds because of their relatively high yields compared to investment grade bonds and their associated higher default risk compared to investment grade bonds. Bond rating agencies, such as S&P's or Moody's, rate bonds based on creditworthiness. Interest rate risk is often driven by *inflation risk*, also called *purchasing power risk*, which is the chance that the cash flows from an investment will not be as valuable in the future because of changes in purchasing power due to inflation.

Credit risk is the risk of an issuer not making timely interest or principal payments as promised. This risk includes the risk of defaults, downgrades, and widening credit spreads. A differential pecking order exists among bond issues. Secured bonds are backed by collateral. *Collateral* represents an asset that the issuer may sell to repay the holder in the event that the issuer fails to make agreed-upon payments. That is, the issuer ends up in default. *Subordinated bonds* or *debentures* are not secured by collateral, but rather by the general good faith and credit of the bond issuer. A direct relation exists between perceived riskiness and yield.

Liquidity risk is the risk associated with the ability to buy and sell bonds without substantially affecting the price paid or received. Because some bonds are thinly traded, the act of entering the market can induce large price changes as transactions occur. Bondholders often reinvest coupon payments or principal received and hence they face *reinvestment rate risk*, which is the inability to buy another security of similar return upon the expiration of the current security. Thus, when interest rates fall or when the issuer calls the bonds, the bondholder faces reinvestment risk.

Macro-based factors are more closely tied to the state of the overall economy, often driven by fears of inflation that directly influence market yields. Yield changes may not uniformly affect bonds of differential remaining maturity lengths. The relation between time until maturity and yield is reflected in the *term structure of interest rates*, and graphically depicted through a yield curve. The normal shape of the yield curve is upward sloping, implying that higher yields are usually associated with bonds with longer maturities. However, yield curves can also be inverted, flat, or humped.

Bonds can also be further distinguished based on product design. *Floating rate bonds*, for instance, do not have a fixed coupon rate, but instead pay a coupon rate that varies directly with some market-based benchmark. As previously mentioned, some entities issue bonds that are exchangeable into another instrument, generally into a fixed number of shares of stock, and are known as *convertible bonds*. Pricing relations for convertible bonds are more complex because an analyst would have to value the bond based on its fixed income characteristics and its value if converted to shares of common stock.

Securitized Products

Bond issues can be bundled into portfolios or securitized for the purpose of creating an investable instrument. Investors in these so-called *collateralized debt obligations* (CDOs) receive a pro-rata (or a more complex distribution) share of the cash flows generated by the pooled assets. The pooled assets are usually housed in a *special purpose vehicle* (SPV), which is structured to be bankruptcy remote (i.e., economically independent from the issuer). Although bonds are one type of fixed income instrument that can be securitized, other assets such as mortgages can similarly be bundled. *Mortgage-backed securities* (MBSs) are investments based on mortgage pools, but their expected life is less certain than CDOs. Unlike callable corporate bonds, whose lifespan is more predictable based on interest rate paths, the lifespan of MBSs can vary greatly because changing interest rates also alter the prepayment and refinancing behavior of homeowners.

About This Book

This section discusses the book's purpose, its distinguishing features, and intended audience.

Purpose of the Book

As the tenth book in the *Financial Markets and Investments Series,* this book provides an objective look into the dynamic world of markets, products, valuation, and analysis. It also provides an in-depth understanding about this subject from experts in the field, both practitioners and academics. Discussion of relevant research and current trends permeates the book. The coverage extends from discussing basic concepts and their applications to exploring increasingly intricate and real-world situations. This volume spans the gamut from theoretical to practical, while attempting to offer a useful balance of detailed and user-friendly coverage. Readers interested in a broad survey will benefit, as will those looking for more in-depth presentations of specific areas within this field of study. In summary, this book provides a fresh look at this intriguing and dynamic but often complex subject.

Distinguishing Features

The distinguishing features of *Debt Markets and Investments* are as follows.

- It provides an in-depth but readable introduction to this broad, complex, and competitive field. It skillfully blends the contributions of a global array of scholars and practitioners into a single review of some of the most important topics in this area. The varied backgrounds of the contributors assure different perspectives and a rich interplay of ideas. The book also reflects the latest trends and research in a global context and discusses controversial issues as well the future outlook for this field.
- While retaining the content and perspectives of the many contributors, the book follows an internally consistent approach in format and style. Similar to that of a choir consisting of many voices, this book has many contributing authors with their own separate voices. A goal of both a choir and this book is to have the many voices sing together harmoniously. Hence, the book is collectively much more than a compilation of chapters from an array of different authors.
- The book presents theory without unnecessary abstraction, quantitative techniques using basic bond mathematics, and conventions at a useful level of detail. It also incorporates how investment professionals analyze and manage fixed income portfolios.
- The book places a strong emphasis on empirical evidence involving debt securities and markets. When discussing the results of various studies, the objective is to distill them to their essential content and practical implications, so they are understandable to a wide range of readers.
- Each chapter contains discussion questions to help reinforce key concepts. Guideline answers to all the questions appear at the end of the book.

Intended Audience

Given its broad scope, this practical and comprehensive book should be of interest to investors, academics, researchers, practitioners, policymakers, students, libraries, and anyone curious about debt markets and investments. Investors can use this book to provide guidance in helping them navigate through the key areas involving investing in debt securities. For academics, the book provides the basis for gaining a better understanding about various aspects of debt markets and investments and as a springboard for future research. They can also use the book as a stand-alone or supplementary resource for advanced undergraduate or graduate courses in debt markets and securities. Additionally, researchers, practitioners, policymakers, students, and libraries should find this book suitable as a reference. Thus, *Debt Markets and Investments* should be essential reading for anyone who wants a better understanding of this important topic.

Structure of the Book

The 36 chapters of this book are grouped into eight sections. A brief summary of each part and chapter follows.

Part One: Background

Besides this chapter (Chapter 1), this section consists of three other chapters dealing with debt fundamentals and indices, interest rate risk, and other risks associated with debt securities.

Chapter 2 Debt Fundamentals and Indices (Ryan J. Dodge, Steven T. Petra, and Andrew C. Spieler)

This chapter serves as an introduction to debt obligations and securities and in particular bonds and related fixed income instruments. The chapter discusses the size of the bond market relative to other traditional asset classes as well as describing different types of debt instruments. The relatively large par value of bonds and structured payments affects the issuance, trading, and ratings processes. The unique structure and risk-return profile of fixed income instruments can be useful for investors to hold in their portfolios. Bonds are obligations of federal and local governments, corporations, and other issuers and are issued via auctions and public and private placements. The fundamental risk factors including interest rate risk, credit risk, and option risk are summarized. Finally, the chapter concludes with a discussion about the purpose and uses of bond indices with a focus on some challenges involved in their construction.

Chapter 3 Interest Rate Risk, Measurement, and Management (Tom Barkley)

Interest rates are part of the fabric of finance, used for assessing rates of return on investments, determining costs of capital to firms, compounding and discounting cash flows, and as underlying variables in many derivative instruments. As interest rates change, so do values of associated securities, resulting in substantial risk to investors in these financial products. Interest rate risk measurement is often defined in terms of the sensitivity of prices to changes in interest rates. Duration is a measure used for small changes in rates, and convexity provides a correction to duration when the rate changes are larger. Forecasting how short- and long-term rates move based on macroeconomic factors becomes important for businesses in any country, as these rate changes affect borrowing costs and investment opportunities. Financial institutions carry out interest rate risk management using instruments such as interest rate swaps, or through more advanced approaches such as asset-liability management and gap analysis.

Chapter 4 Other Risks Associated with Debt Securities (Randolph D. Nordby)

This chapter covers the additional risks in investing in debt securities that are not considered under interest rate risk. It emphasizes credit risk and provides a primer on understanding the S&P credit rating naming conventions. Investors are warned not to rely solely on credit rating agencies to conduct the required due diligence necessary to understand the credit risks associated with an individual security. Next, the chapter presents a method to supplement credit reporting agency reviews. This supplemental analysis involves applying the Cs of credit analysis and determining where the security resides in the overall corporate capital structure. The chapter also addresses inflation risk, liquidity risk, reinvestment risk, and environmental, social, and governance (ESG) risk. These additional risks provide a more comprehensive view of the risks facing fixed income investors.

Part Two: Market Sectors

This part of the book consists of seven chapters focusing on different debt market sectors. These sectors include government debt, municipal bonds, and corporate bonds. Other chapters examine securitized debt markets, derivatives markets, short-term funding and financing alternatives, and private debt markets.

Chapter 5 Government Debt (Keith Pareti and Rob Kennedy)

This chapter focuses on the origin and functionality of U.S. government debt (Treasuries). The amount of this debt has been increasing for many decades, especially since the financial crisis of 2007–2008. The types of debt securities are discussed along with the auction process to obtain these investment vehicles. All investments involve risks and rating agencies attempt to rank and grade the risk associated with sovereign debt. Default rates, derivative contracts, and risk are important in making investment decisions with government debt. Investors could range from long-term investors, short-term speculators, and others. This chapter concludes with the outlook into the future and the historic high debt-to-gross-domestic product (GDP) ratio.

Chapter 6 Municipal Bonds (Xiaohu Deng, Christopher Goebert, Gershon Morgulis, and Isaac Yates)

This chapter discusses various types of municipal bonds, which represent an important part of the bond market. After providing a brief history of municipal bonds, the chapter then discusses two major types of municipal bonds: general obligation and revenue bonds. The next topics focus on tax exemption, credit considerations, and municipal bond structuring alternatives such as fixed, variable, and serial debt. Next, the chapter discusses the municipal bond value proposition resulting from comparatively low rates of default coupled with relatively high investment returns on a taxable equivalent basis. The chapter also highlights several "hot button" issues facing the municipal bond market such as pension bonds, private-public partnerships, and types of bond sales.

Chapter 7 Corporate Bond Markets (Kelly E. Carter)

This chapter covers the fundamentals of corporate bond markets. It begins by highlighting the size and importance of these markets, followed by a discussion of the major types of corporate bonds and the process of issuing bonds. Next, the chapter provides a discussion of important relations between a bond's price and market interest rates, including the key observation that bond prices move opposite market interest rates. The next topic focuses on duration and convexity, which are techniques to estimate the dollar and percent changes in bond prices for a given change in market interest rates, followed by a discussion of bond immunization, which is a technique used to protect the value of bond portfolios from adverse changes in market interest rates. The final topics covered concern yield curves, credit ratings, and the impact of the Dodd-Frank Wall Street Reform Act of 2010 on corporate bond markets.

Chapter 8 Securitized Debt Markets (Şenay Ağca and Saiyid S. Islam)

Securitized debt markets play a vital role in financial markets in risk-sharing and creating alternative financing sources, which provide benefits for both borrowers and lenders. This chapter describes the main characteristics of securitized debt and securitized debt instruments. Major securitized debt instruments are MBSs including residential mortgage-backed securities (RMBSs) and commercial mortgage-backed securities (CMBSs) as well as asset-backed commercial paper (ABCP) and CDOs. The chapter also covers characteristics of these securities, their associated benefits and uses, and the risk factors that determine the performance of securitized debt instruments. The evolution and size of these securitized markets is also discussed. Overall, the chapter indicates that securitized markets help originators in transferring risks and monetizing illiquid assets and aid investors by providing an efficient mechanism for portfolio diversification and ability to better adjust their investments to their risk preferences.

Chapter 9 Derivatives Markets (Halil Kiymaz and Koray D. Simsek)

Interest rate derivatives markets have enjoyed substantial growth since the late 1990s. This chapter discusses the development of these markets since 2000 and introduces the most popular interest rate derivative instruments. Although forward rate agreements (FRAs) and interest rate swaps are important examples of over-the-counter (OTC) products, futures on interest rates and bonds are innovations of organized exchanges. Both OTC interest rate options and exchange-traded options on interest rate futures are discussed to illustrate an overlapping area of both types of derivatives markets. Participants in debt markets are also exposed to both interest rate and credit risk. To mitigate the latter risk, the OTC fixed income derivatives markets provide credit default swaps (CDS). As credit derivatives are also a subset of fixed income derivatives, CDS are discussed further.

Chapter 10 Short-Term Funding and Financing Alternatives (Benjamin Aguilar, Ajit Jain, and Kevin Neaves)

This chapter discusses the different types of short-term funding and financing alternatives that are available in the commercial money and capital markets. First, it covers commercial paper market activity, issue maturity, and quality. Second, the chapter addresses common uses and terms for commercial and standby letters of credit as well as common issuing requirements and covenants, and discusses the parties, processes, and risks involved. Third, it covers bilateral and trilateral repurchase agreements. Fourth, the chapter discusses asset-based loans, including accounts receivable factoring and purchase order financing. Finally, it covers revolving credit facilities and their associated costs. In sum, short-term funding is important for borrowers seeking additional liquidity to finance working capital or other short-term investments. For each type of short-term funding alternative, the chapter examines the expected return and potential risks that the borrower and lender should evaluate before entering the financial transaction.

Chapter 11 Private Debt Markets (Douglas Cumming, Grant Fleming, and Zhangxin (Frank) Liu)

This chapter provides an overview of private debt and private debt markets. It explains the array of different types of private debt investments that are observed in practice, and the role equity incentives play in private debt deals. The chapter examines evidence from different countries around the world, including developed and developing markets. The chapter also describes the motives and contexts for using private debt, including but not limited to transactions involving private placements, syndicated loans, and direct lending. Private debt is not restricted to private companies but includes public ones as well. Further, the chapter characterizes private debt investors and their evolution over time. Additionally, it reviews evidence on the returns that private debt investors enjoy. The chapter concludes by identifying gaps in existing knowledge of private debt and offering suggestions for future research.

Part Three: Yield Curves, Swap Curves, and Interest Rate Models

This part of the book consists of two chapters focusing on yield and swap curves as well as interest rate models.

Chapter 12 Yield Curves, Swap Curves, and Term Structure of Interest Rates (Tom P. Davis and Dmitri Mossessian)

This chapter discusses multiple definitions of the yield curve and provides a conceptual understanding on the construction of yield curves for several markets. It reviews several definitions of the yield curve and examines the basic principles of the arbitrage-free pricing as they apply to yield curve construction. The chapter also reviews cases in which the no-arbitrage assumption is dropped from the yield curve, and then moves to specifics of the arbitrage-free curve construction for bond and swap markets. The concepts of equilibrium and market curves are introduced. The details of construction of both types of the curve are illustrated with examples from the U.S. Treasury market and the U.S. interest rate swap market. The chapter concludes by examining the major changes to the swap curve construction process caused by the financial crisis of 2007–2008 that made a profound impact on the interest rate swap markets.

Chapter 13 Models of the Yield Curve and Term Structure (Tom P. Davis and Dmitri Mossessian)

This chapter presents an overview of the modern state of term structure modeling techniques. It provides an analytical framework that is applicable to all short rate models and considers them from the point of view of the classic approach of pricing by replication. The market price of risk and its relation to the drift of a short rate model are important considerations in modeling the term structure. The notable short rate models used in the industry for relative value pricing are introduced with a brief description of the class of affine short rate models employed for forecasting the real-world dynamics of bond prices. The chapter also includes a description of the Heath-Jarrow-Morton derivative pricing framework and an analysis of the London Interbank Offered Rate (LIBOR) market model.

Part Four: Bond Products

This section consists of six chapters including a wide variety of bond and bond-related investments. These chapters cover international (sovereign) debt, float ng-rate notes, inflation-linked notes, and more esoteric bonds (social impact bonds, death bonds, catastrophe bonds, green bonds, and covered bonds).

Chapter 14 International Bonds (Soutonnoma Quedraogo, David Scofield, and Garrett C. Smith)

Perhaps surprisingly, the size of the global sovereign debt market is nearly as large as the entire international equity market. Sovereign bond markets also allow nations to balance trade and fiscal policy, but a well-functioning domestic bond market and access to international investors are more complex than merely issuing sovereign debt. A nation's credit rating affects both its economy in terms of domestic market stability and the economic stability of trade partners. Further, default and the restructuring of sovereign debt can trigger economic crisis and affect the cost of both debt and equity capital. The chapter also discusses the role of integration, effects of global macroeconomic risk factors, and diversification benefits.

Chapter 15 Floating Rate Notes (Aby Abraham, John Casares, and Jibran Ali Shah)

This chapter provides an overview of floating rate notes (FRNs). Since Citicorp issued the first FRN in 1974, FRNs have evolved into a much larger market with a variety of types including plain, capped, floored, collared, reverse, super, deleveraged, perpetual, and flip-flop. An FRN can have a maturity of up to 30 years and include periodic interest rate adjustments throughout its life. An FRN uses a reference rate, such as LIBOR, Treasury bill (T-bill) rate, prime rate, or domestic certificate of deposit rate plus a spread to determine its coupon rate. The chapter provides a discussion of such risk factors as interest rate risk, credit risk, call/reinvestment risk, liquidity risk, and market risk. Additionally, it covers FRN valuation using spread for life, effective margin, total adjusted margin, discount margin, and option-adjusted spread methods.

Chapter 16 Bonds with Embedded Options (Christopher Barnes, Gaurav Gupta, and Joseph F. Abinanti)

Bonds with embedded options are a subset of traditional fixed income instruments in which an option has the potential to influence the timing and amount of a security's cash flows and the security's valuation. The term *embedded* signifies that the option and the bond are inseparable. Unlike a warrant, which in general can be detached and traded independently of its underlying instrument, an embedded option cannot be split from the bond to create two distinct, investable assets—the bond and the option. The inseparability of the bond and option changes the risk-return profile for both issuers and investors alike, and therefore renders traditional bond metrics, such as YTM, ineffective. This chapter explores the most common bonds with embedded options, which are callable, puttable, and convertible bonds, in addition to discussing some nontraditional embedded option bond structures including contingent convertibles, extendable bonds, combinations, and knock-in and knock-out options.

Chapter 17 Bond Mutual Funds, Closed-End Bond Funds, and Exchange-Traded Funds (Halil Kiymaz and Koray D. Simsek)

This chapter provides an overview of bond mutual funds, closed-end bond funds (CEFs), and exchange-traded funds (ETFs). Since the turn of the century, the net assets under management (AUM) of investment firms have increased steadily. The composition of the net AUM is now skewed more toward ETFs. As more money flows to bond funds, bond CEFs, and ETFs, the issue for investment firms continues to be how to provide risk-adjusted returns to investors while minimizing expenses. The existing literature reports mixed evidence on the performance of bond mutual funds, bond CEFs, and ETFs. Most studies comparing performance against their benchmark index report widespread underperformance. However, actively managed global bond funds tend to provide higher risk-adjusted returns.

Chapter 18 Other Bond Products: Social Impact Bonds, Death Bonds, Catastrophe Bonds, Green Bonds, and Covered Bonds (Erik Devos, Robert Karpowicz, and Andrew C. Spieler)

Over time, the availability of investable bond products has expanded considerably including bonds focused on social improvements (social impact bonds), life settlement securitization (death bonds), natural disaster risk transfer (catastrophe bonds), environmental improvements (green bonds), and collateralized bonds (covered bonds).

Social impact bonds are geared toward positive social change to provide financing to programs that are otherwise ignored or underfunded. Death bonds are bonds backed by the cash flows from life insurance policies. Catastrophe bonds spread the risk of natural disasters or human catastrophes over a broader investor base. Green bonds are issued to raise funds to revitalize brownfield sites or underdeveloped areas and geared toward energy efficiency and pollution control, sustainable agriculture, and clean transportation. Covered bonds are issued against a pool of assets but remain on the issuer's balance sheet providing safety in the event of bankruptcy.

Chapter 19 Inflation-Linked Bonds (John Lettieri, Gerald O'Donnell, Seow Eng Ong, and Desmond Tsang)

This chapter focuses on the fundamentals of inflation-linked bonds including issuers, pricing, and measuring inflation expectations. It examines how such bonds reduce inflation risk and discusses the type of market environments that favor investments in inflation-linked bonds relative to nominal bonds. The relation between realized inflation and expected inflation is a driving factor for both interest rates and the performance of fixed income products. Adding inflation-linked bonds to existing portfolios can help to minimize the risk associated with future inflation. Although nominal bonds offer protection from current inflation expectations, inflation-linked bonds offer a guaranteed real return with protection from unexpected inflation. The relative performance of inflation-linked bonds versus nominal bonds is primarily dependent on changes in both inflation and the real interest rate.

Part Five: Securitized Products

This section, which consists of four chapters, discusses both the securitization process and securitized assets. Within the class of securitized assets, individual chapters are devoted to pooling of mortgages creating MBSs (residential and commercial), pooling of other interest-bearing loans such as auto leases and student loans creating asset-backed securities (ABSs), and pooling of bonds and loans to create CDOs.

Chapter 20 Securitization Process (Mark Ferguson, Joseph McBride, and Kevin Tripp)

This chapter discusses the process and participants in securitized markets. A securitized product will pool illiquid, idiosyncratic assets or contracts, turn the pool into claims (bonds) creating a new capital structure exhibiting differing risk-return attributes. The securitization process has become an essential tool that provides liquidity to firms and borrowers while allowing previously underserved investors to expand their participation in the breadth and depth of capital markets. The securitized market has increased in size and complexity since its origins in the housing market to include many other asset classes such as commercial real estate loans in commercial mortgage-backed securities, student loans, credit card debt, auto leases, equipment leases, and aircraft leases in ABSs.

Chapter 21 Mortgage-Backed Securities (Mingwei (Max) Liang and Milena Petrova)

MBSs have played an important role in the housing and financial markets, providing liquidity to mortgage originators, offering investment opportunities for investors, and helping to set minimum mortgage underwriting standards. This chapter provides an overview of MBSs as an investment tool by presenting an analysis of the MBS market, discussing the securitization process, describing the main MBS pool characteristics, and examining the different types of MBSs in terms of underlying loans (RMBSs and CMBSs), maturity, interest rate terms, pass-through of interest and principal (pass-through securities versus CMOs) and issuers (private-label versus agency MBSs). The chapter also highlights the major risks inherent to MBSs, particularly prepayment and credit risks.

Chapter 22 Asset-Backed Securities (Massimo Guidolin and Manuela Pedio)

This chapter investigates the mechanics of the origination process, cash flow structures and the main characteristics of ABSs. In particular, it provides an overview of why and how unencumbered assets, such as loans, may be pooled into special legal entities, such as trusts, that are isolated from potential bankruptcy proceedings that may involve the issuer of the assets. Special attention is given to the role played by the rating process in determining the value of ABSs and hence to credit enhancement mechanisms and the typical rules of allocation of default losses. The second part of the chapter offers a detailed analysis of the key features of the most important categories of ABSs: auto loans and leases, credit card receivables, student loans, and residential ABSs.

Chapter 23 Collateralized Debt Obligations, Collateralized Bond Obligations, and Collateralized Loan Obligations (Robert Eckrote, Christopher Milliken, Ehsan Nikbakht, and Andrew C. Spieler)

CDOs are structured products that are issued by a special purpose vehicle (SPV) with the objective of improving the issuer's balance sheet, increasing access to illiquid securities, and/or generating a higher yield than a traditional fixed income security. This chapter provides an overview of CDOs including a discussion of the history, structure, uses, and impact on investors and the broader financial system. CDOs can be further classified by the type of security held as collateral, such as collateralized bond obligations (CBOs), which generally hold high yield debt, and collateralized loan obligations (CLOs), which hold bank loan CDOs. These financial structured products gained notoriety for their role in the financial crisis of 2007–2008 and have since declined in popularity. Despite the negative perception that CDOs carry, securitization continues to play an important function in the financial system and offers benefits to issuers and consumers as long as both parties use the end product responsibly.

Part Six: Valuation and Analysis

This part contains four chapters beginning with a discussion of factors affecting bond prices that lead to their valuation and analysis. Two specialized valuation chapters focusing on ABSs and fixed income derivatives round out this section.

Chapter 24 Factors Affecting Bond Pricing and Valuation (Mark Wu, Xiang Gao, and Robert Wieczorek II)

The bond market is extremely important because it provides necessary financing support for both public and nonpublic sectors. The U.S. bond market is much larger than the equity market, and its sheer size makes understanding the factors that could influence bond pricing and bond valuation important. This chapter discusses the most critical economic elements that could influence bond prices, including the Treasury yield curve, credit risk, liquidity risk, equity volatility, corporate governance, accounting quality, product market competition, creditor rights, and financial innovation. The content presented in this chapter has profound implications for today's bond market and can help investors better understand bond valuation.

Chapter 25 Valuing and Analyzing Bonds with Embedded Options (Yiying Cheng)

This chapter introduces the analysis and valuation of bonds with embedded options. For callable bonds, it discusses their unique reinvestment risk and negative convexity. For both callable and puttable bonds, the chapter introduces two additional measures to gauge their risk: yield-to-call and yield-to-put. The chapter reviews the application of the spot rate curve in bond valuation and introduces the zero-volatility spread (Z-spread) to measure bond-specific risk more accurately. To model interest rate risk, the chapter builds a binomial interest rate model and calibrates it with on-the-run Treasury issues. The *option-adjusted spread* (OAS) is introduced to measure the bond-specific risk excluding the option effect. The difference between the Z-spread and OAS represents the option effect. Common measures of convertible bond risk and value are discussed including the possibility of valuating a convertible bond using option-pricing models and its drawbacks.

Chapter 26 Valuing and Analyzing Mortgage-Backed and Asset-Backed Securities (Matthew Dyer)

This chapter discusses how to value and analyze ABSs with an emphasis on MBSs. Valuation differs fundamentally from traditional fixed income securities due to the risks presented by fluctuations in the securities' monthly cash flows derived from unscheduled principal repayments. For an MBS, prepayments, which are largely a function of interest rates, housing turnover, refinancing sensitivity, burnout, and a host of borrower inefficiencies, can cause drastic fluctuations in the security's theoretical or intrinsic value. Once an estimate of forecasted prepayment rates and default rates, if applicable, has been calculated, monthly cash flows are determined and discounted at the appropriate discount rate. Spread measures such as the Z-spread and the OAS can be used to approximate the necessary discount rates applicable to monthly cash flows, the latter of which can be calculated using Monte Carlo simulation.

Chapter 27 Valuing and Analyzing Fixed Income Derivatives (Koray D. Simsek and Halil Kiymaz)

Derivatives valuation is based on the key principle of no-arbitrage pricing. This chapter presents valuation models for various types of fixed income derivatives, including

FRAs, interest rate swaps, Eurodollar and Treasury bond futures, bond options, caps and floors, swaptions, and options on interest rate futures. Following the financial crisis of 2007–2008, major changes occurred in the practice of fixed income derivatives valuation, particularly regarding the adoption of overnight indexed swaps (OIS) as a source of the risk-free rate. This chapter shows how OIS discounting is implemented in FRA pricing and swap valuation. Traditional approaches such as cost of carry valuation in futures pricing are illustrated. With respect to option valuation, this chapter explains the risk-neutral pricing approach as well as closed-form solutions such as the Black (1976) model. The chapter also provides numeric examples to illustrate the practical use of the presented models and formulas.

Part Seven: Special Topics

This part has six chapters including discussions on credit analysis and bond ratings, the bond auction process, and bond accounting. High yield bonds and distressed debt are covered in a two-chapter sequence focusing on higher risk segments of the bond market. Bond microstructure including trading trends and the role of liquidity complete this section.

Chapter 28 Credit Analysis and Ratings (Peter Dadalt, Michael Gueli, Rafay Khalid, and Ling Zhang)

Credit analysis is more than a quantitative exercise because qualitative factors can influence creditor decisions to lend funds. This chapter discusses the importance of balancing the strengths and weaknesses of the quantitative characteristics with an analysis of qualitative characteristics. The extension of credit from a lender to a business is a decision that should follow the careful analysis of factors recognized as industry structuring tools. The "five Cs of credit" provide a framework to begin a qualitative assessment of a company, for without context, financial analysis lacks meaningful interpretation. A subsequent discussion of business, industry, and economic analysis rounds out the qualitative considerations. The chapter also examines the critical role of credit rating agencies as gatekeepers. Finally, a review of financial statements, metrics, ratio analysis, and firm capital structure provides a broad view of the firm when conducting a financial analysis. The chapter presents a case study to illustrate key principles.

Chapter 29 Bond Auctions (Mark Wu, Patrick Herb, and Shishir Paudel)

Each week, billions of dollars (or local currency) of government debt securities are sold in auctions to market participants. Central governments want to use the auction mechanism that minimizes both borrowing costs and chances of market manipulation. A liquid secondary market is also pivotal to the success of the auctions. This chapter begins by providing the definitions, mechanism design, bidding process, and method ranking of government debt auctions with a focus on U.S. Treasury auctions. The next section discusses some important issues including the common value assumption, role of private information, and the winner's curse. Large and active markets coexist before and after the auctions, creating possibilities of a short squeeze. When comparing prices in the pre- or post-auction markets with auction prices, the literature documents positive bidder profits (underpricing) on average.

Chapter 30 Bond Accounting (Oluwaseyi Adebayo Awoga)

Bonds play an important role in capital markets and in shaping micro- and macroeconomic activities designed to meet a government's fiscal and monetary policy objectives. Yet many accounting and finance professionals and practitioners do not fully understand how to properly record and report bond transactions on financial statements. Therefore, this chapter discusses the accounting and disclosure requirements for bond instruments to help bridge this knowledge gap. The chapter begins by reviewing the relevant bond accounting literature, generally accepted accounting principles (GAAP), and basic terms such as amortization, effective interest rate, derivatives, and valuation. Finally, examples illustrate some bond accounting problems from both asset and liability perspectives.

Chapter 31 High Yield Bonds (Byron C. Barnes, Tony Calenda, and Elvis Rodriquez)

High yield bonds (HYBs) have become an integral part of the funding and investment landscape. HYBs are bonds rated below investment grade indicating a potentially greater default risk and concomitant return. Although often associated with leveraged buyouts (LBOs), corporations also use HYBs to finance general corporate needs. The key drivers of HYB issuance include general economic activity, the number and size of transactions requiring financing, interest rates, and the availability of substitute financial products such as leveraged loans. Leveraged loans are another source of financing for issuers with a similar profile as HYB issuers. A key difference between HYBs and leveraged loans is that the covenants associated with a leveraged loan are usually more lender friendly. Similar to investment grade bonds, investors can purchase insurance to hedge a long HYB position against a credit event by using a credit default swap.

Chapter 32 Distressed Debt (Seoyoung Kim)

This chapter discusses distressed debt, primarily from the vantage point of debtholders in financially distressed corporations. In doing so, it gives a description of this sub-asset class and the basic intuition along with stylized examples to explain the motivating factors behind the strategic behavior of other stakeholders that may devalue a distressed-debt investor's financial claim if left unattended. This chapter also discusses the considerations in distressed debt exchanges of public bond issuances or in the restructuring of private loan agreements, with the view to minimizing the likelihood of strategic default and other inefficient outcomes to investors of distressed debt. Overall, this chapter offers exposure to the basic features and terminology in distressed debt and debt restructuring.

Chapter 33 Microstructure of Fixed Income Trading (Matthew John Jerabeck, Marc Perkins, and David Petruzzellis)

Some fixed income securities trade infrequently with high transaction costs. Although equity securities trade mostly on centralized exchanges or platforms, many bonds are inaccessible without an intermediary. Broker-dealers help create a channel between these otherwise illiquid and fractured markets, enabling the flow of information and capital between participants. These agents provide a critical service to developing markets, but they are increasingly threatened by modernization. Two forces are shifting the landscape of fixed income trading: (1) regulation is increasing the cost of business and (2) automation is squeezing profit margins. Although these changes may improve market efficiency in the long-term, they may come at the cost of short-term volatility and price shocks. This chapter describes the microstructure of fixed income trading, focusing on the mechanisms through which prices and liquidity are discovered in the Treasury, corporate, and municipal bond markets.

Part Eight: Strategies, Portfolio Management, and Future Outlook

This part contains three chapters that focus on investing strategies and portfolio management practices for bonds as well as current trends and a future outlook for bonds.

Chapter 34 Debt Investment Strategies (Steve Cosares, Taylor Riggs, and Andrew C. Spieler)

The diverse investment opportunities available in the debt market enable both individual and institutional investors to develop effective passive and active strategies for financial planning and portfolio management. Such strategies suggest a set of purchases, redemptions, and liquidations to meet investor objectives that consider such factors as market risk, expected investment returns, cash flows, liquidity, and investor convenience. Investment strategies can inoculate the portfolio against potential adverse market events such as wide fluctuations in interest rates or can be executed in anticipation of an event affecting future market conditions such as an announcement by the Federal Reserve or the default of a municipality. This chapter presents different scenarios in which an investor would employ some appropriate strategies involving bonds or other debt-based securities.

Chapter 35 Debt Portfolio Management (Zachary Jersky and He Li)

Debt portfolio management has received increasing attention over time as both academics and practitioners have become aware of its unique challenges. This chapter discusses the common risk factors faced by debt portfolio managers and introduces a set of portfolio management strategies that are targeted at addressing major debt portfolio risks in order to achieve common portfolio management goals. These strategies differ in both style and objective. Passive strategies only require investor effort and decision-making at the initial formation of the portfolio, whereas active strategies require frequent restructuring and rebalancing of the portfolio. Some strategies aim at funding liabilities, while others attempt to seek total return. The chapter also provides a discussion of the application of modern portfolio theory within the context of debt portfolio management.

Chapter 36 Debt Trends and Future Outlook (Dianna Preece)

The United States had a combined $47 trillion of public and private sector debt outstanding in the third quarter of 2016. This staggering figure is larger than many countries' gross domestic products (GDPs) combined. Borrowers include the U.S. government, businesses, and households. The debt is held by both domestic and foreign investors. The amount of debt affects virtually everything from a country's ability to grow to an individual's ability to get married or buy a home when saddled with crushing student loans. In early 2018, the most notable trends in debt markets include increased borrowing across all sectors and rising interest rates that will affect the ability of some borrowers to repay their debts. These trends are not just domestic, but global, as the U.S. Federal Reserve begins to roll back a decade-long period of quantitative easing and other central banks are likely to soon follow. This chapter considers trends in debt markets and their implications for the future.

Summary and Conclusions

The long history and continued relevancy of debt securities make them an important part of the structure of many portfolios. This book informs academics, investment managers, financial professionals, and individual investors among others about the latest developments in debt markets. Contributions by both scholars and practitioners provide an in-depth treatment of the role of debt securities including an investigation of the background of debt securities and their risks. Additionally, the book discusses securitized products, bond valuation and analysis, as well as special topics and current trends. Debt securities offer an opportunity for diversification in portfolios and are a staple of many portfolios focused on income generation.

An objective of the book is to emphasize that debt investments are much broader than just the traditional notion of bonds as an asset class. In fact, some perceive bonds as static and relatively safe investments, suitable for income generation. This perception is based on a limited and naive view of this market. Instead, bonds not only serve as a financing source for corporations and governments but also as an investment. A major theme of the book is the dynamic nature of debt markets to adjust to advances in technology and automation. Furthermore, substantial differences exist in both debt markets and debt investments. Debt markets vary across several dimensions based on issuer type, investor demand, trading venue, liquidity, regulation, and other factors. Similarly, from an investment standpoint, debt securities range from relatively low-risk government securities to increasingly complex and riskier securitized instruments.

Another objective of this book is to cover the spectrum of investing and financing aspects of fixed income instruments. Accordingly, it provides coverage of less researched but nonetheless important and emerging topics including the role of short-term financing, bond auctions, and current accounting standards for bonds and associated derivatives. Aside from the qualitative discussion of debt investments, the valuation of nontraditional instruments such as FRNs, inflation-linked bonds, and MBSs is discussed. Understanding these valuation methodologies should benefit readers as new and inevitably more innovative and complex debt investments are developed.

A discussion of debt investments would be incomplete without understanding the process of interest rate formation and its interplay with the yield curve. The role of interest rate–based derivatives that rely on the yield curve and nonstandard bonds is critically important in the current marketplace. Finally, the eventual changes to LIBOR as well as replacing LIBOR as the risk-free rate proxy with the OIS are of fundamental importance to understanding and valuing fixed income instruments in an assuredly more complex and integrated world.

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Debt Fundamentals and Indices

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Introduction

Debt refers to any security in which the current value is derived from an obligation or claim on a future stream of cash flows. This future stream of cash usually results from an initial exchange of capital from a lender to a borrower. Debt is interchangeable with the term *fixed income*, as a lender agrees to receive a specific, oftentimes periodic, cash return from the borrower (fixed income) in exchange for an upfront sum of capital. The most common debt security is a bond, which the Security Exchange Commission (SEC) defines as a "debt obligation similar to an IOU" (Securities and Exchange Commission 2014). When a bond is issued, the lender and borrower make a contractual agreement with respect to the terms of repayment. These terms are outlined within the bond's *indenture*, which is a legally binding document between both the borrowing and lending party. Aside from bonds, many other agreements are considered debt including direct bank loans, collateralized or asset-backed securities, repurchase agreements, lines of credit, and even a traditional home mortgage. Any scenario where one party has a future monetary obligation to another party, based on an initial borrowing, is likely to be considered debt.

Debt as a Traditional Asset Class

The largest securities markets by trading volume in the world are debt or fixed income and equity securities. Combined with cash and cash equivalents, these three categories are widely deemed "traditional asset classes" by the investment community. The most common investment allocation involves an apportionment between equities, fixed income, and cash securities in a portfolio. Still, the average retail investor is likely to know more about high profile stocks as opposed to the largest bond issues. This situation is not surprising because bonds are generally viewed as appropriate for older, conservative individual investors and institutions. Bonds also have limited upside as the best case is the return of principal and interest. Generally, bonds do not have the same return potential as, for instance, a technology stock. In general, equity securities tend to be the more commonly discussed of the two asset classes.

Yet, bonds are the most heavily traded asset class in the United States when measured by daily trading volume (in terms of total market value traded). According to Securities Industry and Financial Markets Association (SIFMA), the U.S. bond market averaged nearly $771 billion in daily trading in 2016. By comparison, the U.S. equity markets traded just $273 billion, on average, each day. The global bond market is about three times the size of the equity market in terms of total traded value (Securities Industry and Financial Markets Association 2016).

Although this chapter focuses on public debt markets and their issuers, an increasingly growing market in private debt finance exists. Private debt is considered an alternative asset class given the specialization and nontraditional structure of the agreements. Rather than public bond offerings in which securities are offered to the market publicly, private debt relies on specific lending arrangements between borrowers and underwriters. The securities and instruments issued are largely nonmarketable, and thus are usually less liquid than common, publicly traded securities. The terms of private debt arrangements for the most part remain nonpublic. This situation creates uneven markets and deal terms. Some examples of private debt include private placement bonds and syndicated loans, as well as direct bank lending. In each, loans are issued by either private or public companies to public or private investors.

According to Preqin (2017) estimates, $595 billion in private debt assets was under management by institutional and private investors in 2017, which is a fraction of the global public bond market. Although a growing industry of great interest to many investor groups, the majority of this chapter focuses on publicly traded bonds and other marketable fixed income instruments (Private Debt Investor 2014).

Debt Issuance and Trading

Public bonds are generally issued through syndicated offering and auctions. Syndicated bond offerings are analogous to an equity security's initial public offering (IPO). This method is used by nearly every type of issuer including corporations, governments excluding the U.S. Treasury, and municipalities. In a syndicated bond offering, borrowers wanting to raise capital from the debt markets enlist the services of an investment bank to market the issue. These banks generally have experience in the issuer's industry and a strong understanding of its pricing dynamics and pressures. The bank plans the issue and ultimately prices the offering, based on the offering's characteristics, issuer's credit rating, and prevailing market interest rates. Sometimes these underwriters assume the initial risk of the bond issue for the borrowers with the understanding they can make a market among their book of clients, often through a group of investment banks called a *syndicate* that buys the bulk of the issues before distribution to clients (Morningstar 2015; McCrum, Hale, and Allen 2017).

Alternatively, bonds may be brought to market through an auction. This method is exclusively used by governments in which auctions are specified in advance and normally run by the banking arm of a government. In the United States, bonds are auctioned directly by the Department of the Treasury. For these offers, investors can submit either noncompetitive bids or competitive bids. In a *noncompetitive bid*, an investor receives the bonds at the prevailing market price in the auction and is certain to have the entire order filled, barring any cap restrictions on allocations. A *competitive bid* specifies a desired price for the bond in advance, risking that the order might not be filled depending on the auction's outcome (Driessen 2016).

Many borrowers issue different varieties of bonds in an offering. For example, bonds can offer different coupon rates and maturities, among other characteristics. The *coupon rate* is the periodic interest paid on the bond's principal, and the *maturity* is the time until repayment. Bond issues with staggered maturity dates and/or coupon rates are called *serial bonds*. These bonds stagger maturities of an issue so that repayment of total issued principal occurs over many periods, rather than the issuer receiving a "lump sum" return of principal on a future date, called a *balloon payment*. Serial bonds reduce the issuer's risk of default, as principal payments can be spread out and managed over a period rather than concentrated around a single maturity date.

These institutional factors enable a single issuer to have many differing bond issues outstanding, in comparison to a standardized, single equity listing. For example, as of October 2017, FactSet (2017) lists 74 separate CUSIP-labeled debt securities previously issued by and outstanding from Apple Inc., relative to just one CUSIP for common stock (ticker symbol AAPL) that trades on the NASDAQ. This situation can create a liquidity problem for specific bond issues, particularly from smaller issuers.

Once an investor holds a bond following the initial auction, a bond issue becomes a secondary market security. Because of the sheer volume of tradable bond issues, buying and selling usually does not occur in a mechanized trading market such as the New York Stock Exchange (NYSE). Instead, bond dealers make over-the-counter (OTC) markets in which dealers use their client book to match buyers and sellers of specific bond issues relevant to each party's needs. This feature of the bond market is unique, whereas equity securities have the benefit of uniformity. Barring the use of multiple class structures of stock typically reserved for insiders or founders, only one version of equity securities usually trades in public markets.

Rankings Based on Credit Quality

Most debt issues are assigned ratings by the major rating agencies based on a quantitative and qualitative assessment of the borrower's ability and willingness to repay its loans. These ratings include qualities such as the issuer's operating model stability, current and future cash flow expectations, and relative balance sheet strength to determine a bond's credit risk. Three of the largest houses for ratings are Moody's, Standard & Poor's, and Fitch. As an example, Moody's (2017) ratings range from *Aaa* (Triple A) to *C*. *A*-rated bonds (*Aaa, Aa*, and *A*) are bonds of the best quality; these are followed by *B*-rated bonds (*Baa, Ba*, and *B*), with *C*-rated bonds the worst (*Caa, Ca*, and *C*). Moody's judges the best rated, Aaa-rated, bond as a "[bond] of the highest quality, with minimal risks." Non-government, Aaa issuers are extremely rare. In 2016, just two United States companies maintained Aaa status: Microsoft and Johnson & Johnson (Shen 2016). By contrast, a C-rated bond, according to Moody's, is the "lowest-rated class of bonds . . . typically in default, with little prospect for recovery of principal and interest" (Moody's 2017).

Beyond their individual ratings, bonds are also usually segmented into two groups: investment grade and non-investment-grade, also known as *junk bonds*. In Moody's rankings, bonds rated between Aaa to Baa (Triple B) are the deemed investment grade. A rating below Baa is considered non-investment-grade or a junk bond. Junk bonds may also be referred to as *speculative grade* or *high yield* bonds. Junk bonds are credit instruments in which meaningful risk exists such that the borrower will fail to meet the terms of its borrowing obligation. Generally, these bonds trade at a discount to investment grade bonds, thereby compensating investors for the additional credit risk and potential partial or complete loss of principal. Thus, non-investment-grade bonds offer a higher potential yield or return on their initial investment (Moody's 2017).

Within the scope of asset management, credit ratings can have a large impact on how managers position their portfolios. Many managers set limits for their portfolios. For instance, a conservative investor may only consider investment grade bonds. By comparison, some bond funds by nature can be more speculative—often referred to as *distressed bond funds* and focus on finding value in junk bonds.

Unique Risk-Return Profile of Bonds

Overall, bonds are considered a safer investment than equities from a traditional risk standpoint. Conceptually, this situation makes sense because most issuers in good health fulfill their payment obligations to lenders and return principal and interest under the original loan agreements. Any lender failing to meet its obligations is considered to be in *default*. Explicitly, a default occurs when an issuer enters bankruptcy, fails to make an interest payment, or completes a distressed exchange by renegotiating terms with the bond holders. Defaults are generally rare outside of recessions.

For example, in 2011, the percentage of total defaults of corporate issuers in the U.S. bond market was just 1.31 percent. Even in recessions, most issuers avoid default. In 2009, following the financial crisis of 2007–2008, default rates climbed to 10.1 percent, but still, 9 in 10 bond issuers remained in solid credit standing (Altman and Kuehne 2012).

Investment grade bonds are almost always repaid. According to *Standard & Poor's* (2013) analysis of more than 16,000 global issuers between 1981 and 2012, the median annual default rate of BBB bonds (the lowest of S&P's investment grade level rating, equivalent to Moody's Baa) was just 0.18 percent. In a similar experiment, Moody's determined that the average BBB issuance over a 10-year time horizon would default 4.64 percent of the time based on data between 1970 and 2005 (Johnson 2013).

Benefits and Risks of Fixed Income Securities

The defined repayment terms of bonds make valuation easier compared to equity securities. Similar to equities, different events may disrupt the borrower's financial position and affect the return of capital and interest to their bond holders. These risks must be factored into a bond's price. Still, a bond is generally priced as though issuers are expected to pay future cash flows, discounted for its explicit risks and thus its likelihood of default. Conversely, equities are more difficult to value because an equity security's repayment terms and value are open-ended and undefined. Equities are priced as the going concern market value of a company's assets (tangible and intangible), less its liabilities. This price is the intrinsic value and is inherently harder to derive for equities than for bonds. Thus, knowledgeable investors may have considerably different opinions on a stock's value and how it relates to its current market price.

Given its repayment structure, a typical bond's relative value and price fluctuates far less than a typical equity security, largely because the future value of a company's assets is far harder to value than the future value of a bond's cash flows. Accordingly, the average bond's price has lower volatility than the average equity. Therefore, as an asset class, market participants view bonds as a safer investment from a classical financial view. Riley, Wright, and Chan (2000) find that U.S. equities were more volatile than bonds by about a three-to-one ratio between 1950 and 1999.

For that same reason, the average bond has a lower relative expected return than an equity security. Equity investors need to be compensated for the additional risk they assume as proportionate residual claimants rather than simply receiving a stream of interest and principal payments. Higher risk is generally compensated in the form of higher expected returns, whether in terms of absolute price, share repurchases, corporate dividends, or other shareholder returns. According to data provided by Damodaran (2017), the geometric average annual return of the S&P 500 index between 1967 and 2016 was 10.09 percent, compared to 6.66 percent for 10-year U.S. Treasury bonds.

In a traditional asset allocation decision between fixed income securities and equities, a riskier portfolio contains a higher proportion of equities to bonds. The reverse would hold true for a more conservative portfolio. Generally, a portfolio holding a higher percentage of its net assets in equities instead of bonds has higher upside potential in terms of capital appreciation but bears more downside risk.

Benefits to Owning Bonds

Beyond its unique risk-return profile, other fundamental reasons are available to invest in fixed income. One reason is that bonds can provide a stable source of income to an investor. An investor can use bonds to match a portfolio's specific liquidity needs. Examples include a personal trust with distribution requirements to beneficiaries, or required monthly payments to retirees for a pension fund. In each case, the portfolio needs income at regular intervals. Managers can stack debt securities to generate stable and predictable cash flow streams for the portfolio in each case. Thus, rather than simply holding funds in cash, the manager can keep funds invested and earning a return—all while still maintaining required liquidity and distribution needs.

Another rationale for owning fixed income is capital preservation. Issuers usually honor their promise to pay back interest and principal. Thus, bonds, especially investment grade bonds, normally generate an annual return with a small likelihood of loss of principal when holding the bonds to maturity. For the retired or elderly who often have limited current earnings potential, stability in value is an essential characteristic of bonds. These investors typically look for less risk and are more concerned about capital preservation to manage their daily financial needs.

As investors age, they often invest a higher percentage of their net worth into fixed income securities. In fact, most retirement and 401(k) plans offer specialized mutual funds that increase the bond allocation as investors age. As an example, Vanguard's Retirement 2050 fund, which assumes a target retirement year of 2050, held 90 percent of investor assets in stocks in October 2017. By comparison, its 2020 fund, which assumes retirement in 2020, held just 55 percent in stocks and 45 percent in bonds. The differing mix of equities and bonds reflects the time to retirement and the relative safety and preservation of capital needs of older versus younger investors. These target date funds generally draw a *glide path*, which is a chart of the changing allocation between equities and bonds as the retirement date draws closer. Glide paths may vary considerably between fund managers (Miller, Rosenburgh, and Spieler 2011).

Lastly, owning fixed income securities offers a diversification benefit. In many extreme bear markets or recessions, equity correlations run to "one," signifying that when the market goes down, investors do not discriminate in their selling and most stocks experience steep declines. During these major recessionary periods in the stock market, bonds historically have outperformed equities. For example, the S&P 500 index lost 36.6 percent of its market value in 2008, while the U.S. 10-year Treasury gained 20.1 percent (Damodaran 2017). This example illustrates that market participants generally view bonds as a diversification complement to equities, specifically on the downside, ahead of potential bear stock markets.

Financing Capital Needs With Debt

Of the many different types of bond issuers, the most common borrowers are federal governments, state and local governments (i.e., municipalities), government agencies, and corporations. Each issuer has different characteristics that affect pricing, tax treatment, and general bond terms (e.g., coupon, tenor, and optionality). However, the primary purpose for issuing bonds of raising capital remains the same.

Government Bond Issuance

For sovereigns, bonds are a way to raise capital to fund government spending (fiscal policy) or to drive changes in the money supply (monetary policy). Governments raise most of their revenues directly from taxes on its constituency both individuals and corporations. However, governments can also borrow using bonds to raise additional capital to spend beyond their tax base. Specifically, in periods of low economic activity, governments typically lower taxes and increase spending. This situation is referred to as "loose" or expansionary fiscal policy, and the government incurs fiscal deficit, which occurs when a government's total expenditures exceed the revenue that it generates, excluding money from borrowings. Governments use the capital to drive investment and spending to boost economic growth. (Cameron Hume 2017).

Aside from fiscal policy, some developed countries use federal issuance or purchase of bonds to manipulate money supply. In the United States, the Federal Reserve conducts these purchases and sales. In times of poor economic activity in the United States, the Federal Reserve buys bonds, in an attempt to increase the money supply and drive down interest rates, to stimulate capital spending and provide an economic boost. In periods of strong economic growth, the Federal Reserve issues bonds, reducing the money supply and increasing interest rates, in an attempt to curb inflation (Cameron Hume 2017).

In the United States, bonds may be issued at all levels of government: federal, state, and local. The U.S. Treasury makes federal government issues in terms of Treasury bills, notes, and bonds. A *Treasury bill*, also called a T-bill, is a short-term debt obligation backed by the U.S. Department of the Treasury with a maturity of less than one year. A *Treasury note* is a marketable U.S. government debt security with a fixed interest rate and a maturity between one and 10 years. A *Treasury bond* is a marketable, fixed-interest U.S. government debt security with a maturity of more than 10 years. These issues are generally denominated in principal portions of $1,000 (Bodie, Kane, and Marcus 2017).

Federal Government Bonds

The primary risk to owning a federal government bond is the potential failure of that government to honor its agreed-upon payment stream. In developed countries with strong governments and currencies such as the United States and the United Kingdom that issue bonds regularly, this risk is virtually zero. These nations can simply print more money or refinance their debt to ensure repayment. In less developed nations, the default risk of a government is higher, and an investor would be ex-ante compensated for that risk by owning a bond with a higher yield or market interest rate. In the United States, United Kingdom, or Germany, government bonds, also called *sovereign debt*, are used as a measure of a "risk-free" interest rate. For these bonds, default risk is essentially zero, given it is backed by the government. This situation makes for a useful tool when measuring riskier bonds (i.e., those with higher potential default).

Treasury Inflation-Protected Securities

In the United States, the U.S. Department of the Treasury also may issue bonds that protect against investors against inflation, known as Treasury inflation-protected securities (TIPS). TIPS are also referred to as "real return" or "inflation neutral" bonds. The mechanics of these securities are somewhat complex. With TIPS, the principal increases with inflation and decreases with deflation as measured by the Consumer Price Index (CPI). When TIPS mature, investors received the adjusted principal or original principal, whichever is greater. Over the bond's life, adjustments allow investors to earn an interest rate on the bond equal to the country's real interest rate. Thus, the bond is insulated from increases or decreases in inflation. These bonds can be particularly useful in long-term insurance or pension portfolios, which likely have payment obligations tied closely to the rate of inflation. For instance, in a pension fund, TIPS can be used to mimic the future value of wages earned (Treasury Direct 2013; Fong and Guin 2016).

Municipal Bonds

At the local and state level, debt issuances are called municipal bonds, public finance, or "munis." In the United States, the primary difference between munis and Treasuries is their tax treatment. Municipal bond interest in the United States is generally exempt from federal, state, and local taxes (Johnson 2013).

Municipals are segmented into two types: general obligation (GO) and revenue bonds. GO bonds are responsibilities of the local or state government and are backed by business, property, and other taxes under its jurisdiction. *Revenue bonds* are bonds whose cash flows are directly tied to specific revenue-generating operations such as a toll road on a major highway (Bodie et al. 2017).

Agencies

Similar to federal or municipality issuance, federal agencies may issue debt to fund capital needs. In the United States, the most common are mortgage-related agencies, such as the Federal National Mortgage Association (FNMA or "Fannie Mae") or the Federal Home Loan Mortgage Corporation (FHLMC or "Freddie Mac"). Although not technically insured by the government, these agencies can be assisted by the U.S. government in poor economic times, which was the case in 2008 during the U.S. housing crisis (Congress of the United States Congressional Budget Office 2010).

Corporate Bonds

Corporate issuers use bonds to raise capital without diluting existing equity shareholders despite reducing net income by the net-of-tax interest expense. A defining characteristic of corporate debt is that investors do not hold ownership over the company or its assets, provided a company remains current on its interest payments. For that tradeoff, debt holders receive a higher "priority of claims" compared to stockholders. This higher priority means that debt holders must receive interest payments ahead of any distributions to stockholders. However, this situation does not always occur in practice. For this reason, debt generally has a lower cost of capital from the issuer's perspective than equity because it should provide a lower return to debt holders than stockholders in the same company. When a company seeks to fund a capital project with debt instead of equity, often the project appears more attractive given the lower relative cost of capital due to the debt issuance. However, using a single source of financing to evaluate a project is theoretically incorrect. Instead, decision-makers should use a firm's weighted average cost of capital (WACC) adjusted for a project's riskiness.

Debt can also be attractive to corporations given the tax deductibility of interest payments in most countries. Most rules of law allow corporations to deduct interest payments on their taxable income thereby reducing their tax bill. All else equal, this characteristic lowers the cost of debt relative to equity, which has no tax-deductible benefits. In recent years, a trend has emerged in which some governments with mature economies have taken steps to limit the deductibility of corporate interest expense. In the 2017, the Tax Cuts and Jobs Act, officially titled Law H.R.-1, signed into law by President Donald Trump in December 2017, reduced net business deductible interest expense only up to 30 percent of a corporation's adjusted taxable income (KPMG 2017). Authorities enacted a similar bill in the United Kingdom in 2017 titled the UK Finance Bill 2017, which also limits the nominal value of corporate interest that can be deducted from taxable income (PriceWaterhouseCoopers 2017).

Other Forms of Debt and Issuance

Investors can own bonds beyond directly buying issues from a primary offering or trading on the secondary market. A common way for structuring fixed income products is through *securitization*, a technique used to "package" similar types of bonds or cash flow assets into one investable pool. The benefits of securitization include liquidity (i.e., buying and selling a "pool" of bonds or loans is easier) and diversification (i.e., investors are not overly exposed to a singular loan or security). The most common securitized products are asset-backed securities (ABSs) and mortgage-backed securities (MBSs), which bundle their titular loans together into one investable package for the lender (Securities Industry and Financial Markets Association 2013).

Investors can also buy bonds through funds managed by investment companies. The most common types are open-end (i.e., mutual funds) and closed-end funds. These funds usually specify certain investment goals and strategies. The major difference between open-end and closed-end funds is the ability to process redemptions of capital. Owners of an open-end mutual fund who want to liquidate their positions can do so by redeeming their investment at the approximate net asset value (NAV) of their stake, which means bonds or shares of bonds are sold and investors receive their capital. Conversely, in a closed-end fund, capital is not redeemable. To exit their position, investors must "trade," similar to a stock, their investment in the fund at the prevailing market rate (Securities and Exchange Commission 2013).

Fundamentals of Fixed Income Contracts

Different bonds from a single issuer can have varying characteristics. The *maturity* of a bond is determined at issuance and identifies the time until principal is repaid. Bonds can be categorized into mutually exclusive maturity buckets: short, medium (also termed intermediate), or long term. *Short bonds* generally refer to any bond up to five years in maturity; *intermediate bonds* generally between five and 10 years; and *long bonds* generally longer than 10 years (Bodie et al. 2017).

A bond's *par value* is the face value or principal of the bond, and it represents the amount due at the bond's maturity. Most bonds are issued and purchased in increments of $100, usually $1,000. Notably, a bond's market price can trade above or below par value, for reasons discussed later in the chapter. When a bond's price is below its par value, the bond trades at a *discount*; conversely when the bond trades above par, it trades at a *premium* (Fabozzi 2007).

The *coupon rate* of a bond is the designated rate of periodic interest owed on the bond's principal by the borrower (Merrill Edge 2018). The frequency of the coupon payment is determined when the bond is issued and can be paid in any form of periodicity. In the United States, the most commonly used period calls for semiannual payments. Coupon rates are denoted as "fixed" or "floating." A *fixed coupon rate* is set at the bond's issuance and requires the same payments over the bond's life. By comparison, a *floating rate coupon* is paid over the bond's life on a set periodicity, but a reference or benchmark interest rate dictates the actual cash coupon. Most floating rate bonds use standard rates such as the comparable U.S. Treasury or the London Interbank Offered Rate (LIBOR). Modified coupon agreements exist including a *step-up* note in which the coupon rate experiences predefined increases over the bond's life. Some bond issues separate principal and coupon payments. Bonds that only return the principal payment are known as *zero-coupon bonds*. When issued by the U.S. Department of the Treasury, these bonds are denoted as Separate Trading of Registered Interest and Principal of Securities (STRIPS) (Fabozzi 2007; Tuckman and Serrat 2012).

Another feature of bonds is their ability to be issued with embedded options: a call, put, or convertible option. A *call option* gives the issuer the right, but not the obligation, to buy back a bond issue at a certain price. This option benefits the issuer when interest rates fall. The option allows the borrower to "call" back the bonds that may be trading at a higher value, due to lower interest rates, for a predetermined price. Under certain circumstances, the issuer can potentially re-issue bonds at the new, lower interest rates. To compensate for this benefit to the issuer, the lender receives a "call premium" based on the option's value at the time of the bond's issuance. Investors usually receive a higher interest rate on callable bonds to compensate them for higher call and reinvestment rate risk.

In contrast, a put option benefits the investor. As interest rates rise, a bondholder can "put" or sell the issue back to the lender for a predetermined, higher price. The issuer receives a "put premium" for this risk in the initial valuation of the bond, either by an increase in the bond's initial price or a lower bond coupon (Fabozzi 2007).

Lastly, a convertible option benefits the lender. This option affords the security's holder the right to exchange the bond for a specific number of shares of the company. For this reason, these bonds are almost exclusively issued by corporations. Convertible bonds and specifically the option are harder to value because such valuation depends not only on the bond's yield and credit quality but also on the underlying equity value of the corporation (Dialynas and Ritchie 2005).

Bond Pricing by Discounting Associated Risks

Pricing a traditional bond is a function of valuing (i.e., discounting) future cash flows to present value terms. The nominal difference between the present value and future value of a cash flow is the *time value of money*. Assuming normal market conditions with positive interest rates, the present value of a cash flow is always less than its future nominal promised payment.

When pricing a bond, the idea is intuitive: the price an investor should pay should be equal to the present value of the bond's future cash flows. What is more challenging is determining the rate that should be used to discount those future cash flows back to present values. Investors generally start their discounting analysis using a standard yield curve. In general terms, a *yield curve* is a plot of yields for equivalent bonds of varying maturities. Time to maturity is placed on the x-axis, and yield to maturity (YTM) is graphed on the y-axis. In the United States, the most commonly examined yield curve is the estimated spot-rate curve. This spot-rate curve attempts to find the theoretical current yield for zero-coupon Treasury bonds over varying maturities, usually from six months to 30 years. Because zero-coupon bonds are rarely issued with maturities greater than one year, investors often use a process known as "bootstrapping" to infer the theoretical yields from observable coupon-bond issues (Johnson 2013). Using this yield curve, investors can begin to determine a proper discount rate with which to find the present value of each cash flow of a risky bond, making adjustments to the discount rate for additional risks such as credit or liquidity (Adams and Smith 2014; Bodie et al. 2017).

Interest Rate Risk

The most important risk to consider in valuing fixed income securities is interest rate risk. Since future cash flows must be discounted by some function of the market interest rates plus additional risks such as credit and liquidity, bond prices directly move inversely to changes in the nominal rate of interest (Fabozzi 2007). Time to maturity is the primary determinant of interest rate risk. All else equal, longer-dated bonds have more interest rate risk than shorter-dated bonds. Changes to current interest rates disproportionately affect the current value of a bond's later-dated cash flows.

Measuring Interest Rate Risk with Duration

Maturity is not a perfect measurement of interest rate risk. Varying coupons, option agreements, and other bond characteristics can create different intermediate cash flows before a bond's principal payment. These shorter-dated cash flows lower the true interest rate risk to the bondholder as they are added to the payment stream. To encompass all cash flows of a bond in determining its length, investors use a measure called duration. *Duration* is the time-weighted average of the present value of the security's cash flows. Duration time-weights the value of every cash flow to a bondholder, thus creating a true "effective maturity" for the bond (Bodie et al. 2017).

Mathematically, duration is derived by finding the first derivative (the slope) of the relation between bond price and interest rate. By definition, duration measures a change in a bond's price for a given change in interest rates. Duration entered the financial vernacular in 1938 when Frederick Macaulay began adjusting the way he measured his portfolio's maturity, and thus is often called *Macaulay's duration* (Johnson 2013). A variation of Macaulay's duration is termed *modified duration*, which is Macaulay's duration divided by one plus the bond's YTM, adjusted by the frequency of coupon payments each year. Modified duration is used to determine price sensitivity for a small change in current interest rates (Giddy 1996).

Given that the relation between a bond's price and interest rates is curved and not linear, more context is required. To model for the curved relation between price and interest rates, managers introduce a measure called convexity. *Convexity* is the second derivative along a bond's price-yield curve, measuring the level of changes in duration at varying interest rate levels. All else equal, an investor would prefer a bond with higher convexity because these bonds have greater price upside when interest rates fall, and receive more downside protection if interest rates rise (Giddy 2000).

Active managers investing in bonds must have a point of view on interest rates and their direction for portfolio management. For example, if managers believe interest rates are likely to rise, they should limit the interest rate sensitivity of their portfolio by lowering duration. They achieve this objective either by selling high duration bonds in the portfolio, buying additional low duration bonds or using derivatives (Bodie et al. 2017).

Additional Risks of Fixed Income

Although interest rates are the key risk factor in fixed income, other risks affect bond pricing. One is termed *credit risk* often referred to as *default risk*. Yet, the two terms are not interchangeable. Non-default risks occur such as downgrades that affect bond prices. The Federal Reserve defines *credit risk* as "the potential that a borrower or counterparty will fail to perform on an obligation" (Board of Governors of the Federal Reserve System 2017). Credit risk is particularly important in emerging market government bonds or consumer and corporate loans, where the risk of not being paid back is higher than bonds issued from economies with strong governments. As previously discussed, ratings agencies rank and score bonds based on their assessment of credit risk.

Another risk that factors into fixed income pricing is liquidity risk. *Liquidity risk* is the risk of finding a counterparty to buy the security at a fair market price (BlackRock 2018). The sheer volume of differentiated fixed income securities makes liquidity risk higher than equity positions. All else equal, an issuance with lower liquidity should require a higher YTM. Securitization and other pooled investments such as mutual funds and exchange-traded funds (ETFs) have helped to add liquidity and reduce this risk for many retail investors.

Another risk of fixed income is *inflation* (BlackRock 2018). In theory, inflation is implicitly covered by interest rate risk given that nominal interest rates are a function of real interest rates adjusted for inflation. Higher inflation reduces the future value of cash flows paid on fixed income ignoring TIPS. Thus, as inflation risk increases, interest rates and subsequently bond yields rise, reducing the value of bonds. Although no one standardized measure is available, the most common indicators of inflation are the Consumer Price Index (CPI) and Producer Price Index (PPI), both of which measure the relative value of a defined basket of goods over time (Simko 2013).

A final risk to owning fixed income is *option risk*. Options on bonds can give added value to either the issuer (call option) or the investor (put option and convertible option). In these cases, the counterparty should be compensated for assuming additional risk. For example, consider two otherwise identical bonds with the lone difference being that only one is issued with a call option. The call option bond should be issued at a higher yield (lower price) to the lender because it benefits the issuer in the event interest rates decline. In a similar example, a bond with a put or convertible option should be issued at a lower yield (higher price) to the lender because it benefits the lender in the event interest rates rise or the corresponding stock price increases.

Fixed Income Indices and Construction Issues

According to the European Commission (2013, p.1), an *index* is a "statistical measure, typically of a price or quantity, calculated from a representative set of underlying data." Indices aim to provide a standardized measure of performance from a representative pool of investments or the market (Markit Group 2016). The stated goals of the Bloomberg Barclays Fixed Income (2017) indices, a widely referenced (legacy) publication in bond markets since 1973, is that the indices should provide baseline portfolio performance targets, market-level measurement of security and asset class specific risk and return, and reference measures for index-linked products.

One of the most common bond indices used is the Bloomberg Barclays Global Aggregate Index. According to Bloomberg Barclays Fixed Income (2017), the goal of the index is to provide a reliable measure of the "global, investment grade fixed income markets." This index encompasses fixed income instruments from 71 different countries, with the United States as the largest country of issuance at nearly 39 percent of the total index market capitalization (cap) as of January 2018. The index consists of about 54 percent sovereign treasuries, 12 percent of other government related debt, 19 percent corporates, and about 15 percent securitized loan offerings (Barclays Live 2018).

Constructing indices such as the Bloomberg Barclays Global Aggregate is much more challenging than constructing an equity index. Index providers are tasked with selecting an appropriate basket of securities from the market segment they aim to represent, which attempts to mimic the performance and risk of the investable universe of that segment. In bond indexing, the three critical measures by which the index should match the market are: (1) composition (i.e., characteristics such as credit, option risks, and proper sector weightings); (2) duration (i.e., interest rate risk); and maturity (i.e., overall length) (Riley et al. 2000). Matching these characteristics is inherently difficult for an index maker due to three major reasons: (1) the larger number of bond issues relative to equity securities in a given market; (2) the lack of liquidity; and (3) the high turnover and constant change in interest rate risk as each bond approaches maturity. The key point here is that the sheer size of the bond market paired with the heterogeneity of its constituents makes creating a "standardized" measure difficult. This task also creates a challenge for passive managers who are looking to replicate an index's risk and return with minimal additional transaction costs (Fong and Guin 2016).

Financial markets have considerably more individual and stand-alone bond securities than equity securities. For an equity index, the fewer total number of stocks makes selecting a representative basket for that index's theoretical investable universe easier. Additionally, the high liquidity of equity markets creates little uncertainty in what is the daily closing price. For bonds, however, security selection becomes far more difficult. Considerations must be made for differing risk and return characteristics of separate bond issues. For instance, consider index issues from U.S. technology companies. For a globally important company such as Apple Inc., including every bond Apple has outstanding is unnecessary to capture the risk-return profile that Apple's bonds add to the investable universe. But which bonds should be selected? For index creators, selection and inclusion of certain bonds and their risk characteristics often becomes more art than science as the decision-making process for inclusion is much more complex (Riley et al. 2000).

Once an index creator chooses a bond for inclusion in the index, other issues arise, including its liquidity and pricing transparency. Some bonds may go many days without recording a trade, even if their relative value may have changed due to interest rate movement or other factors. This situation can create a synchronicity problem for the index, as bond values are appraised based on pricing movement in other securities. If similar security pricing does not exist, it can oftentimes be estimated through pricing models relying on the movement of certain variables in the market. This situation can lead to stale and controversial pricing. In select cases, discrepancies in the index value relative to the real market value can be large based on estimates made by the index's creator (Fong and Guin 2016).

The last major challenge involving bond indices is the fast pace of change for security characteristics, in particular their risk-return profile, as time passes. Consistently changing exposures to interest rate and credit risk in the underlying securities can alter the risk-return profile of the entire index. This situation primarily occurs due to the passage of time: as a bond's maturity date move closer, duration is biased lower and interest rate risk is reduced. However, changes can also occur as issues are repaid, options are exercised, or revisions are made to the credit rating of the bond. To maintain the index's stated goals and risk-return profile, its manager usually needs to add and remove securities frequently. Index evaluation and rebalancing for bond indices are generally done on a monthly basis, whereas most equity indices rebalance quarterly or annually (Fong and Guin 2016). Such changes create substantial turnover and can cause undesirable shifts in characteristics such as credit and liquidity from period to period.

Both active and passive managers use indices for slightly different purposes. In active management, the performance fee many managers receive results from a portion of their outperformance relative to a defined benchmark index. In other agreements in which a fee is paid on the total value of the portfolio's assets, outperforming an index helps to justify a manager's fee to investors and to provide a benchmark for comparability between managers. Conversely, in passive management, an investor attempts to match the benchmark's performance and risk characteristics in a cost-efficient manner. In passive bond management, a trade-off exists in how closely the portfolio matches the index relative to the total transaction costs to manage it. Most managers use either stratified sampling or other strategies to match the index profile. Regardless, in either case, both sets of managers need to carefully select an index that best represents their portfolio's investment universe characteristics, including but not limited to country, currency, security type, market sector, relevant options, and risk profile.

Summary and Conclusions

This chapter serves as a broad introduction to debt, which is the world's largest asset class. In fact, the publicly traded bond market is more than three times that of the global equities market. As a security, debt is unique in that it represents an obligation or a right to a series of future cash flows both from interest and principal payments. Bonds issued by developed and stable governments as well as investment grade corporations rarely default. Bonds have a lower risk-return profile when measured against comparable equities. This payoff and cash flow structure make fixed income bonds ideal for conservative investors with high cash flow needs.

Nevertheless, owning a bond is not risk-free. Investors must consider such risks as interest rate risk (measured by duration), inflation (measured by the CPI), credit risk (measured by credit ratings), and liquidity. Prudent managers should position their portfolios to properly adjust for or benefit from these risks. This chapter also discussed public bonds, which may be issued by governments, government agencies, and corporations, as a way of raising capital. Finally, indices are important for measuring bond portfolio performance. However, many challenges exist in their formation due to the size of the market, lack of liquidity in a large amount of issues, and high turnover in individual securities.

Discussion Questions

1. Identify two methods of bond issuance.
2. Compare and contrast the risk and return characteristics of bonds relative to equity securities.
3. List three reasons investors hold bonds in their portfolios.
4. Identify the credit rating range for investment-grade bonds under the Moody's ratings system.
5. List and discuss two challenges in constructing bond indices.

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3

Interest Rate Risk, Measurement, and Management

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Introduction

Interest rates have been used in business transactions for the past 5,000 years (Homer and Sylla 2005) and are the basis for calculating the value of bank loans, Treasury securities, corporate bonds, mortgage-backed securities, interest rate swaps, options, and investment projects. Small changes in interest rates can have large effects on the prices of securities, borrowing costs for companies, and investment opportunities. Thus, borrowers, lenders, and investors seek to protect themselves from downside risk and capitalize on upside potential. As a consequence, some people even seek to manipulate interest rates to increase firm profits, as was the case during the collusion scandal in the setting of daily rates for the London Interbank Offered Rate (LIBOR) that reporters for the *Wall Street Journal* investigated as early as 2008 (Enrich and Fukase 2013; WSJ Graphics 2015). About $360 trillion (notional amount) in Eurodollar futures and related derivatives are estimated to be tied to LIBOR, and typical contracts involve a notional value of at least $1 million (Foxman 2012).

Interest rate risk is the possibility of a change in an investment's value due to a change in the level of interest rates. Interest rate risk affects: (1) the market value of fixed-income securities such as bonds or mortgage-backed securities; (2) the management of assets and liabilities by depository institutions, commercial banks, pension funds, and insurance companies; and (3) project finance undertaken by nonfinancial firms. Further, interest rate risk can be separated into *price risk* and *reinvestment risk*, in which the former considers the change in value of an asset's price, and the latter takes into account the value of income generated by the asset when reinvested. For fixed-income securities such as non-amortizing option-free bonds, the price of the security declines if interest rates rise; however, an increase in interest rates leads to an increase in value from reinvested coupon payments. Thus, these two types of interest rate risk often result in opposite effects on the total return from an investment.

This chapter on interest rate risk considers how these risks are measured and then managed to reduce the probability of a resulting loss. The remainder of the chapter is organized as follows. The next section describes duration and convexity, and their uses in measuring sensitivity of prices to interest rate changes. The third section discusses the forecasting of short-and long-term rates and models used to describe yield curve changes. The fourth section provides an overview of several financial instruments used to manage interest rate risk, such as futures, options, swaps, caps, floors, and collars. The fifth section elaborates on this discussion by describing more advanced techniques in risk management and how financial institutions use them in practice. The final section provides a summary and conclusions.

Duration and Convexity

Before looking specifically at duration and convexity, how they are calculated, and what they mean in practical terms, a return to the description of price risk and reinvestment risk is helpful. Reinvestment risk only applies when a security pays income before maturity, or some specified investment horizon, and that income can be reinvested. Thus, zero-coupon bonds do not have reinvestment risk associated with them. In contrast, price risk is associated with capital gains and losses, namely changes in a security's price, and this risk affects all types of investments. A simple example of a plain-vanilla, non-amortizing, option-free bond illustrates these risks and the factors that affect them the most.

Price Risk and Reinvestment Risk

Assume that a bond has a semiannual coupon rate of 8 percent, a face value of \$1,000, a 10-year maturity, and a current yield-to-maturity (YTM) of 6 percent. Equations 3.1 and 3.2 are both standard equations for pricing an annual coupon bond (Fabozzi 2013),

$$P = \frac{C}{(1+y)^1} + \frac{C}{(1+y)^2} + \cdots + \frac{C}{(1+y)^N} + \frac{M}{(1+y)^N} \tag{3.1}$$

$$P = \sum_{t=1}^{N} \frac{C}{(1+y)^t} + \frac{M}{(1+y)^N} = \frac{C}{y}\left[1 - \frac{1}{(1+y)^N}\right] + \frac{M}{(1+y)^N} \tag{3.2}$$

where P is the price of the bond; C represents the coupon payment; M denotes the principal value paid at maturity; N is the number of years until maturity; and y is the YTM. Equation 3.1 expresses a bond's price as a stream of discounted cash flows; Equation 3.2 expresses it as the present value of an annuity plus the present value of the principal payment. If the bond pays coupons with a frequency of k payments per year and valuation is between the coupon payment dates where a is the fraction of a period until the next coupon payment, then Equation 3.2 is generalized to Equation 3.3:

$$P=\left(1+\left(\frac{y}{k}\right)\right)^{1-a}\left\{\frac{\left(\frac{C}{k}\right)}{\left(\frac{y}{k}\right)}\left[1-\frac{1}{\left(1+\left(\frac{y}{k}\right)\right)^{Nk}}\right]+\frac{M}{\left(1+\left(\frac{y}{k}\right)\right)^{Nk}}\right\} \quad (3.3)$$

Inserting values and calculating gives a price of $1,148.77 for the semiannual bond.

Suppose an investor buys the bond for this price, plans to sell it after three years, but interest rates immediately rise from 6 to 7 percent after the purchase. The investor expects the required YTM on 7-year bonds to be 7 percent at the end of the investment horizon. To calculate the total return for this bond investment, Fabozzi (2013) outlines five steps to follow. Relevant calculations are summarized in Table 3.1.

- *Step 1. Find the total coupon payments plus the interest-on-interest at the investment horizon.* This amount is the future value at the investment horizon of all the cash flows

Table 3.1 **Total Return on a Bond Investment**

Step	*Calculation*
1. Total coupon payments plus interest-on-interest at the investment horizon	Total coupon interest plus interest-on-interest $= \$40\left[\frac{(1.035)^6-1}{0.035}\right]=\$40\times 6.5502=\$262.01$
2. Projected sale price at the investment horizon	Projected sale price $=\frac{\$40}{0.035}\left[1-\frac{1}{(1.035)^{14}}\right]+\frac{\$1{,}000}{(1.035)^{14}}=\$1{,}054.60$
3. Total future dollars at the investment horizon	Sum of calculations (1) and (2) $=\$262.01+\$1{,}054.60=\$1{,}316.61$
4. Periodic total return	Semiannual total return $=\sqrt[\text{No. of periods}]{\frac{\text{Total future dollars}}{\text{Initial investment}}}-1=\sqrt[6]{\frac{\$1{,}316.61}{\$1{,}148.77}}-1=0.0230$
5. Annualized total return	Annualized total return = No. of periods per year × Periodic total return $=2\times 0.0230=0.0460$

The table shows the necessary calculations for the total return on a bond investment. The bond considered has a semiannual coupon rate of 8 percent, a face value of $1,000, a 10-year maturity, and a current YTM of 6 percent. The initial price of the bond is $1,148.77. An investor purchases the bond for this price, plans to sell it after three years, but interest rates immediately rise from 6 to 7 percent after the purchase. The investor expects the required YTM on 7-year bonds to be 7 percent at the end of the investment horizon.

to be received. For the six coupon payments, assuming a semiannual reinvestment rate of 3.5 percent, the total coupon interest plus interest-on-interest will be \$262.01 at the investment horizon.

- *Step 2. Determine the projected sale price at the investment horizon.* Assuming the required yield on the bonds is 7 percent, the sale price of the bond will be \$1,054.60.
- *Step 3. Sum the total future dollars at the investment horizon.* The total amount received from selling the bond and from reinvesting intermediate coupon payments is \$1,316.61.
- *Step 4. Calculate the periodic total return.* For the semiannual bond, find the Nth root of the total future dollars divided by the initial investment, where N is the number of periods in the investment horizon; then, the semiannual total return is simply 1 subtracted from the previous result. In this example, the semiannual total return is 2.30 percent.
- *Step 5. Multiply the periodic total return by the number of periods in a year.* For the semiannual bond, the annualized total return is 4.60 percent.

Note that this annualized return on the bond investment is less than the expected YTM of 6 percent when the bond was purchased. This results because the immediate increase in interest rates caused a \$77.71 drop in the bond's price. Even though the reinvestment rate became higher, the investment horizon was too short to generate a sufficient return from the coupon payments plus interest-on-interest to offset the loss. Now consider the bond over an 8-year investment horizon. Performing the same step-by-step analysis as outlined in this section, the increase in interest rates still results in an immediate decline in the bond price by \$77.71, but the longer investment horizon means that reinvested cash flows more than offset the initial loss. This example illustrates how price risk and reinvestment risk can produce opposite effects on the total return from a bond when the investment horizon changes. Similar analysis highlights some other key factors that affect both types of interest rate risk for plain-vanilla bonds, as shown in Table 3.2.

Macaulay Duration

Immediate changes in the value of a security or portfolio after a change in interest rates are often noticeable and substantial. Consequently, price risk garners more attention than reinvestment risk. In a National Bureau of Economic Research (NBER) study on bond yields, Macaulay (1938) introduces the concept of *duration*, using this measure instead of maturity to proxy for the average length of time that a bond investment is outstanding. *Macaulay duration* is the weighted average of the times until fixed cash flows are received for a financial asset that pays such cash flows (e.g., a plain-vanilla bond). This type of duration is a time measure, having years as units, and is applicable only to assets with fixed cash flows. Equation 3.4 shows Macaulay duration (D_{Mac}), where the variable descriptions are as previously defined:

$$D_{Mac} = \frac{1}{P}\left(\sum_{t=1}^{N}\frac{tC}{(1+y)^t} + \frac{NM}{(1+y)^N}\right) \tag{3.4}$$

Table 3.2 **Key Factors Affecting Price Risk and Reinvestment Risk**

Increase in Factor	*Effect on Price Risk*	*Effect on Reinvestment Risk*
Time until the investment horizon	No effect	Decrease in risk, as more coupons can be reinvested for a longer period of time
Time to maturity	Increase in risk, as price is more sensitive to longer maturities	No effect if the time to maturity is greater than the investment horizon; decrease in risk if the investment horizon equals the time to maturity
Coupon rate	Decrease in risk, as price is less sensitive to higher coupon rates	No effect on the percentage change in reinvested cash flows; increase in dollar value of reinvested cash flows
Initial level of the YTM	Decrease in risk the higher the initial level of YTM before an increase in interest rates	Decrease in risk the higher the initial level of YTM before an increase in interest rates
Frequency of coupon payments	Increase in risk, as price changes more the greater the frequency of payments	Decrease in risk, as reinvested cash flows increase in value, the greater the frequency of payments

The table summarizes the effects on price risk and reinvestment risk for a plain-vanilla bond of increases in five key factors: (1) time until the investment horizon, (2) time to maturity of the bond, (3) coupon rate, (4) initial level of the YTM, and (5) frequency of coupon payments.

By expressing P as given in Equation 3.1, the calculation of Macaulay duration can be simplified to be in terms of only the coupon payment (C), the principal value paid at maturity (M), the number of years until maturity (N), and the YTM (y). This form is shown in Equation 3.5:

$$D_{Mac} = \frac{(1+y)}{y} - \left(\frac{M(1+y)+N(C-My)}{C[(1+y)^N - 1]+My} \right) \tag{3.5}$$

For a bond that pays coupons with a frequency of k payments per year and valuation is between coupon payment dates, then Equation 3.5 is generalized to Equation 3.6:

$$D_{Mac} = \left[\frac{(1+{}^{ay}\!/\!_k)}{({}^{y}\!/\!_k)} - \left(\frac{M(1+{}^{y}\!/\!_k)+Nk({}^{C}\!/\!_k - {}^{My}\!/\!_k)}{({}^{C}\!/\!_k)[(1+{}^{y}\!/\!_k)^{Nk} - 1]+{}^{My}\!/\!_k} \right) \right] / k \tag{3.6}$$

where a is the fraction of a period until the next coupon payment. For the bond with a semiannual coupon rate of 8 percent, a face value of $1,000, a 10-year maturity, and a current YTM of 6 percent, the Macaulay duration is about 7.29 years. Intuitively, this corresponds to having a zero-coupon bond with a maturity of 7.29 years and the same price as the semiannual coupon bond, as shown in Figure 3.1. Duration is analogous to the concept of a center of mass in mechanics such as the fulcrum of a lever. Note that the face value of the zero-coupon bond would not be \$1,000, but rather $1{,}148.77(1 + 0.03)^{7.29\times2} = \$1{,}767.67$.

The Macaulay duration measure can be applied to various financial instruments with fixed cash flows, including zero-coupon bonds (a single cash flow), fixed-coupon bonds, level perpetuities, and level annuities. Properties worthy of note are given below:

- For a zero-coupon bond, the bond's duration equals its time to maturity.
- For a coupon bond, if maturity is held constant, the bond's duration is greater when the coupon rate is lower.
- For a coupon bond, if the coupon rate is held constant, the bond's duration generally increases with its time to maturity. It always increases with maturity for bonds selling at par or at a premium, but it may decrease slightly for bonds selling at a discount.
- For a coupon bond, holding other factors constant, the bond's duration is greater when its YTM is lower (i.e., a lower interest rate environment).

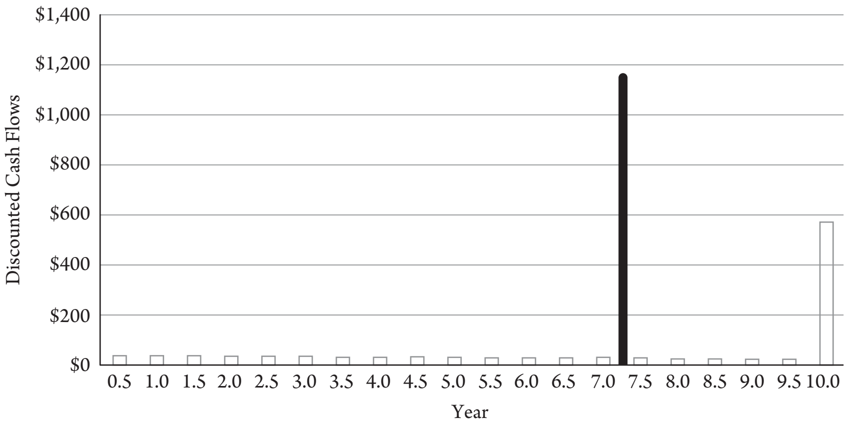

Figure 3.1 Macaulay Duration: A Representation of Cash Flows

This figure provides a representation of discounted values of coupon payments and principal for a bond with a semiannual coupon rate of 8 percent, a face value of \$1,000, a 10-year maturity, a current YTM of 6 percent, and a price of \$1,148.77. These cash flows could be replaced by a single cash flow from a zero-coupon bond with a maturity of 7.29 years (the Macaulay duration of the coupon bond) with the same price as the coupon bond. The time-weighted average of cash flow payments would be the same for both bonds. The Macaulay duration is calculated as:

$$D_{Mac} = \left[\frac{\left(1 + {}^{1\times0.06}\!/_2\right)}{\left({}^{0.06}\!/_2\right)} - \left(\frac{1{,}000\left(1 + {}^{0.06}\!/_2\right) + 10\times2\times\left({}^{80}\!/_2 - {}^{1{,}000\times0.06}\!/_2\right)}{\left({}^{80}\!/_2\right)\left[\left(1 + {}^{0.06}\!/_2\right)^{10\times2} - 1\right] + {}^{1{,}000\times0.06}\!/_2} \right) \right] / 2 = 7.29$$

- For a coupon bond selling at par, the duration is illustrated in Equation 3.7:

$$D_{Mac} = \left(\frac{1+y}{y}\right)\left[1 - \frac{1}{(1+y)^N}\right] \tag{3.7}$$

- For a perpetuity with constant payments, the duration is shown in Equation 3.8:

$$D_{Mac} = \left(\frac{1+y}{y}\right) \tag{3.8}$$

- For an annuity with constant payments, the duration is shown in Equation 3.9:

$$D_{Mac} = \left(\frac{1+y}{y}\right) - \frac{N}{(1+y)^N - 1} \tag{3.9}$$

Equations 3.7, 3.8, and 3.9 are special cases of Equation 3.6 with $a = 0$, $k = 1$, and (1) $y = C/M$ in Equation 3.7, (2) $N \to \infty$ in Equation 3.8, and (3) $M = 0$ in Equation 3.9. Figure 3.2 displays some of these properties graphically.

Macaulay duration assumes that the term structure of interest rates is flat, and that yields for all maturities change by the same amount when a shift in interest rates occurs. A refinement of Macaulay duration that takes into account the term structure of interest rates when it is not flat is known as *Fisher-Weil duration* (Fisher and Weil 1971). This measure of duration uses the zero-coupon yield for each respective maturity to calculate the present values of the relevant cash flows.

Modified Duration

Samuelson (1945) and Redington (1952) independently developed an alternative definition for duration, through the examination of the interest rate sensitivity of financial institutions. Considering the asset's price as a function of its yield, duration also measures the price sensitivity to yield. *Modified duration* is a mathematical derivative and can be defined as the negative of the percentage rate of change in price with respect to yield. An expression for modified duration (D_{Mod}) is given in Equation 3.10:

$$D_{Mod} = -\frac{1}{P}\frac{\partial P}{\partial y} \tag{3.10}$$

Modified duration can be used with interest rate-sensitive financial instruments that do not have fixed cash flows. Thus, it applies to a wider range of instruments than Macaulay duration, and it is used more commonly than Macaulay duration.

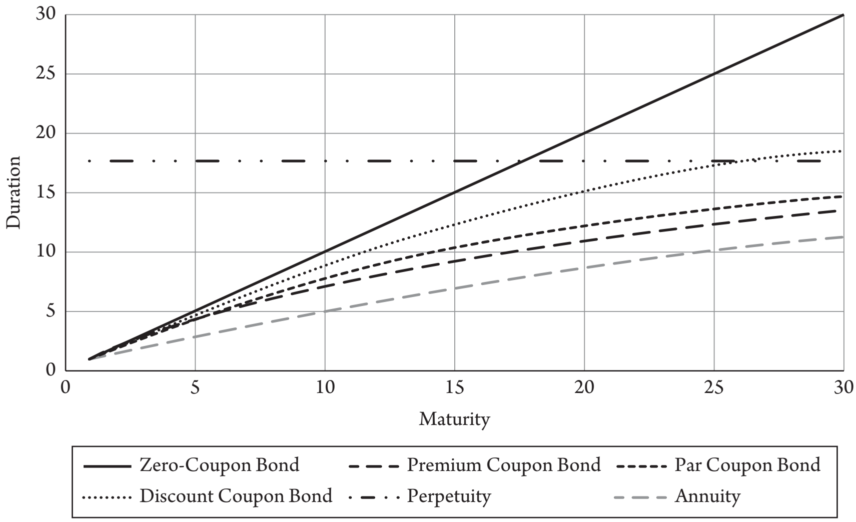

Figure 3.2 Macaulay Duration versus Maturity
This figure illustrates how Macaulay duration varies against maturity for six different financial instruments. The YTM for all six instruments is 6 percent. The premium coupon bond has a coupon rate of 10 percent and the discount coupon bond has a coupon rate of 2 percent.

When yields are expressed with continuous compounding, both forms of duration are equal (i.e., $D_{Mod} = D_{Mac}$). However, the relation changes slightly when compounding takes place with a frequency of k times per year, as given in Equation 3.11:

$$D_{Mod} = \frac{D_{Mac}}{(1+(y/k))} \tag{3.11}$$

For the bond with a semiannual coupon rate of 8 percent, a face value of $1,000, a 10-year maturity, and a current YTM of 6 percent, the modified duration is approximately 7.07. Strictly speaking, this variable does not have any units. Technically, modified duration is a semi-elasticity (i.e., the percent change in price for a unit change in yield) rather than an elasticity.

Analysts and others use modified duration to calculate the approximate change in the price of a security or portfolio when a small parallel shift in a flat yield curve occurs. Returning to the bond example, consider the change in price when interest rates immediately rise from 6 to 7 percent after the investor's purchase. The initial price of the bond was $1,148.77, but the price immediately after the rate increase becomes $1,071.06, resulting in a drop of $77.71. Taking the modified duration to be 7.07 and the change in interest rates to be a 1 percent increase, the approximate change in the price of the semiannual bond should be –7.07 percent. This approach would suggest the new bond price should be $1,067.55 ($1,148.77 × (1 – 0.0707)). This value is lower than the correct value of $1,071.06 because the relation between the bond price and its yield is nonlinear, as shown in Figure 3.3. For this reason, convexity adjustments are made to the changes in bond prices to improve the accuracy of newly estimated prices.

Dollar Duration

The *dollar duration* of a financial instrument is the negative value of the derivative of price with respect to yield. Typically, this price sensitivity with respect to yields is measured in absolute terms. It is the product of modified duration and the price of the financial instrument. Dollar duration ($D_\$$) can be expressed as in Equation 3.12:

$$D_\$ = -\frac{\partial P}{\partial y} = P \times D_{Mod} / 100 \tag{3.12}$$

The units for dollar duration are dollars per percentage point change in yield. Similar measures are defined where the units are dollars per basis point change in yield, where a *basis point* (bp) is one hundredth of a percentage point. These measures are interchangeably referred to as the *dollar value of an 01* (*DV01*) or the *price value of a basis point* (*PVBP*) or the *basis point value* (*BPV*), and can be expressed as in Equation 3.13:

$$DV01 = PVBP = BPV = -\frac{\partial P}{\partial y} = P \times D_{Mod} / 10{,}000 \tag{3.13}$$

All of these price sensitivities indicate *dollar price volatility*, rather than *percentage price volatility*. To illustrate how the dollar value of a 01 is calculated, consider once again the 8 percent semiannual coupon bond, having a 10-year maturity and a current YTM of 6 percent. The DV01 is \$0.81/bp, meaning that for a 0.01 percent change in the yield a corresponding \$0.81 change should be expected in the bond's price. Calculating the bond's correct price when the yield increases to 6.01 percent results in a price of \$1,147.96, which is a decrease of \$0.81 from the original price of \$1,148.77. Similarly, when the yield decreases to 5.99 percent, the bond price is \$1,149.59, which is an increase of \$0.82 from the original price. The small difference is due to rounding.

Convexity

As evidenced in Figure 3.3 and the numerical example for modified duration, the approximate change in price for a financial instrument such as a bond, calculated using modified duration, leads to increasingly larger errors the greater the change in the yield. The duration approximation is only reasonable for small yield changes because the price of a bond as a function of yield is nonlinear. In other words, the duration itself changes as the yield changes because the dollar duration corresponds to the slope of the tangent line at any given point on the price-yield curve. The price approximation can be improved by considering this nonlinearity, which is known as convexity.

Mathematically, if price is viewed as a function of yield, then the first term in a Taylor series expansion of the price function corresponds to the dollar duration. To

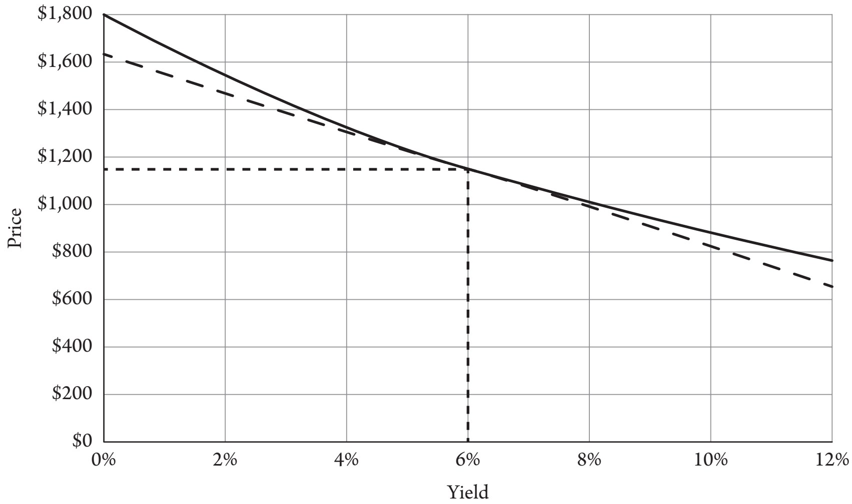

Figure 3.3 Modified Duration Approximation

This figure shows how, for a representative bond, the change in price calculated by using a modified duration approximation leads to increasing errors the larger the change in the yield. The figure depicts the price-yield curve (solid line) for a semiannual coupon bond that has a coupon rate of 8 percent, a maturity of 10 years, a YTM of 6 percent, and a price of $1,148.77. The tangent line at 6 percent (dashed line) represents estimated prices using the modified duration approximation to price changes. The approximation underestimates the change in price when the yield decreases and it overestimates the change in price when the yield increases.

improve on this approximation, the second term of the Taylor series expansion can be added as shown in Equation 3.14, where the error term is of the order of magnitude of $(dy)^3$:

$$dP = \frac{\partial P}{\partial y} dy + \frac{1}{2}\frac{d^2 P}{dy^2}(dy)^2 + O((dy)^3) \tag{3.14}$$

Dividing by P results in the percentage price change shown in Equation 3.15:

$$\frac{dP}{P} = \frac{1}{P}\frac{\partial P}{\partial y} dy + \frac{1}{2} \times \frac{1}{P}\frac{d^2 P}{dy^2}(dy)^2 + \frac{O((dy)^3)}{P} \tag{3.15}$$

The second term on the right-hand side of Equation 3.15 is used to correct for the convexity of the price-yield relation. Specifically, market participants refer to the second derivative of price with respect to yield as the *dollar convexity measure* as shown in Equation 3.16:

$$\text{Dollar convexity measure} = \frac{d^2 P}{dy^2} \tag{3.16}$$

Dividing the dollar convexity measure by price gives a measure of the percentage change in price due to convexity in Equation 3.17, and this measure is what is normally referred to as the *convexity measure*:

$$\text{Convexity measure} = \frac{1}{P}\frac{d^2P}{dy^2} \tag{3.17}$$

Calculating the second order derivative of price with respect to yield and dividing by price produces the expression for the convexity measure that is given in Equation 3.18:

$$\text{Convexity measure} = \frac{1}{P}\left(\sum_{t=1}^{N}\frac{t(t+1)C}{(1+y)^{t+2}} + \frac{N(N+1)M}{(1+y)^{N+2}}\right) \tag{3.18}$$

By expressing P as given in Equation 3.1, the calculation of the convexity measure can be simplified to be in terms of only the coupon payment (C), principal value paid at maturity (M), number of years until maturity (N), and YTM (y). This is shown in Equation 3.19, which is analogous to Equation 3.5 for Macaulay duration.

$$\text{Convexity measure} = \frac{2}{y^2} - \frac{1}{y^2(1+y)^2}\left(\frac{2My(1+y)^2 + 2NCy(1+y) + N(N+1)y^2(C-My)}{C[(1+y)^N - 1] + My}\right) \tag{3.19}$$

Just as Equation 3.5 was generalized to produce Equation 3.6 for a bond that pays coupons with a frequency of k payments per year and where valuation is between coupon payment dates, Equation 3.19 can also be generalized to Equation 3.20:

$$\text{Convexity measure} = \frac{1}{k^2}\left\{\frac{2(1+\frac{ay}{k})}{(\frac{y}{k})^2(1+\frac{y}{k})} + \frac{a(a-1)}{(1+\frac{y}{k})^2} - \left[\frac{1}{(\frac{y}{k})^2(1+\frac{y}{k})^2} \times \left(\frac{2M(\frac{y}{k})(1+\frac{y}{k})(1+\frac{ay}{k}) + 2Nk(\frac{C}{k})(\frac{y}{k})(1+\frac{y}{k}) + Nk(\frac{y}{k})^2(\frac{C}{k} - \frac{My}{k})[(Nk+1)+2(a-1)]}{(\frac{C}{k})\left[(1+\frac{y}{k})^{Nk} - 1\right] + \frac{My}{k}}\right)\right]\right\} \tag{3.20}$$

where a is the fraction of a period until the next coupon payment.

As an example of how modified duration and the convexity measure can be used to calculate the percentage price change in a financial instrument, consider once more the 10-year coupon bond, having a semiannual coupon rate of 8 percent and a YTM of 6 percent. The modified duration was previously shown to be 7.07, and the convexity measure is 63.92 (using Equation 3.19 with $a = 0$, $k = 2$). The percentage change in price due to modified duration is:

$$-(\text{modified duration})(dy) = -(7.07)(0.01) = -0.0707 = -7.07 \text{ percent.}$$

Similarly, the percentage change in price due to convexity is:

$$\tfrac{1}{2}(\text{convexity measure})(\text{dy})^2 = \tfrac{1}{2}(63.92)(0.01)^2 = 0.0032 = 0.32 \text{ percent.}$$

Thus, by summing these results, the estimated percentage price change due to duration and convexity is –6.75 percent. Since the original price of the bond was $1,148,77 and its price immediately after the 1 percent increase in interest rates was $1,071.06, the actual percentage price change is –6.76 percent, very close to the estimated percentage change, and more accurate than using duration alone.

Four important properties of convexity, applicable to all option-free bonds, are worth emphasizing. First, as YTM increases, convexity decreases. Second, keeping yield and maturity fixed, the greater the coupon, the lower is the convexity. Third, keeping yield and the coupon fixed, the shorter the maturity, the lower is the convexity. Fourth, keeping yield and modified duration fixed, the lower the coupon, the lower is the convexity. These properties are illustrated in Figure 3.4.

Key rate duration (*KRD*), also known as *partial DV01* or *partial duration*, extends the concept of total modified duration to looking at price sensitivity to shifts in only certain parts of the yield curve. Introduced by Ho (1992), the use of this measure allows investors to manage interest rate risk by focusing on changes in the shape of the yield curve in detail. For instance, a KRD can be defined with respect to zero-coupon bond rates with maturity "3M," "1Y," "2Y," "3Y," "5Y," "7Y," "10Y," "15Y," "20Y," "25Y," and "30Y," where *M* refers to months and *Y* refers to years. At each point on the yield curve, the price sensitivity is calculated for a financial instrument or portfolio for a 100-basis-point-change in the yield at that point, keeping the yields at all other maturity points the same. In this way, KRD measures the price sensitivity localized at a specific maturity point on the yield curve, with the yield change dropping linearly to zero for neighboring points. Although the yield curve is unlikely to exhibit such localized movements, the overall change in the yield curve can be modeled by summing these saw-tooth functions. The overall change in the yield of a portfolio (Δy_P) can be calculated by summing across the KRD changes associated with yield changes at each maturity (Δy_i), as shown in Equation 3.21:

$$\Delta y_P = \sum_{i=2}^{m} KRD_i \Delta y_i \tag{3.21}$$

Chambers and Carleton (1988) first suggested this idea of using multiple durations, called *duration vectors*, with a similar approach being described by Reitano (1989, 1990), before Ho (1992) introduced the more popular approach of KRD. As these durations are vital to understanding how changes in yields for different maturities affect prices, modeling the yield curve becomes a prerequisite to investment strategies and interest rate risk management. The next section focuses on forecasting these yields.

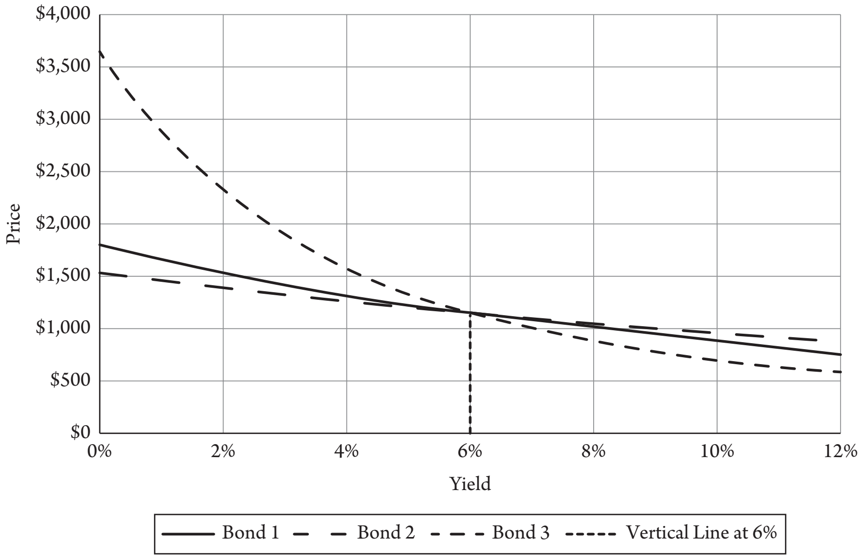

Figure 3.4 Properties of Convexity
This figure shows the price-yield curves for three different semiannual bonds. A comparison of the characteristics of the bonds illustrates properties of convexity. Bond 1 (solid line) has a coupon rate of 8 percent, maturity of 10 years, principal of $1,000.00, modified duration of 7.07, and convexity of 63.92. Bond 2 (long dashed line) has a coupon rate of 9 percent, maturity of 5.97 years, principal of $1,000.00, modified duration of 4.70, and convexity of 27.36. Bond 3 (short dashed line) has a coupon rate of 7 percent, maturity of 37.75 years, principal of $1,000.00, modified duration of 14.54, and convexity of 349.25. All three bonds have a yield of 6 percent and are priced at $1,148.77. Relative to Bond 1, Bonds 2 and 3 show that convexity is lower for bonds with greater coupons and shorter maturities.

Forecasting the Term Structure of Interest Rates

Numerous models attempt to describe the evolution of the term structure of interest rates. Many of these models focus on the evolution of the *short rate*, which is the annualized continuously-compounded interest rate that financial institutions apply when borrowing money for an infinitesimally short period of time beginning at time *t*. Although a specification of this instantaneous spot rate does not describe the entire yield curve, using no-arbitrage arguments, a model of the evolution of the short rate as a stochastic process can determine the price of zero-coupon bonds at particular maturities. The interest rates implied by these bonds form a zero curve, and so the short-rate model can specify bond prices in the future.

One-factor models have a single stochastic factor (the short rate), but these models are used to estimate all interest rates in the yield curve as they change over time. The Merton model (1973) explains the short rate in terms of a one-dimensional Brownian motion. Several models use stochastic calculus to consider infinitesimal changes in the short rate in terms of the infinitesimal passage of time and the differential of a standard Brownian motion under a risk-neutral probability measure. Although some of these models explicitly consider the mean reversion of interest rates (Vasicek 1977; Dothan 1978; Cox, Ingersoll, and Ross 1985; Hull and White 1990), others do not (Rendleman and Bartter 1980; Ho and Lee 1986). The Hull-White model (1990) can also be applied as a lognormal model, where infinitesimal changes in the logarithm of the short rate are considered instead. Similar models (Black, Derman, and Toy 1990; Black and Karasinski 1991; Kalotay, Williams, and Fabozzi 1993) are also lognormal.

Besides these one-factor models of the short rate, multi-factor models of the short rate exist. The Longstaff-Schwartz model (Longstaff and Schwartz 1992) uses two factors to estimate the short rate, while the Chen model (Chen 1996), also known as the "stochastic mean and stochastic volatility model," uses three factors. For the purposes of interest rate risk management, when creating realistic simulations of movements in these rates is necessary, the multi-factor models are sometimes favored over the one-factor models because they produce scenarios that are generally more "consistent with actual yield curve movements" (van Deventer 2011).

Perhaps the most encompassing and widely used approach for modeling the term structure is the framework put forward by Heath, Jarrow, and Morton (1992). This continuous-time, multi-factor framework describes the evolution of the instantaneous forward rate curve as opposed to simple forward rates. It is known as the Gaussian Heath-Jarrow-Morton (HJM) model of forward rates when the volatility and drift of the instantaneous forward rate are assumed to be deterministic. Recognizing that the drifts of the no-arbitrage evolution of certain variables can be expressed as functions of their volatilities and the correlations between them is essential to understanding this approach. Thus, no drift estimation is needed. Models developed along the lines of the HJM framework are different from the short-rate models in the sense that the former models capture the full dynamics of the entire forward rate curve, while the latter models only capture the dynamics of a point on the curve (the short rate). An example of an HJM-type model that employs a specific choice of volatility term to describe simple forward rates is the Brace, Gatarek, and Musiela (1997) model. Jeffrey (1995) derives another special case of the HJM model involving only one factor.

The models discussed in this section are used to analyze changes in the term structure of interest rates. Such analysis is important in forecasting bond prices as well as the values of portfolios of fixed-income securities. For many firms, however, interest rate risk management may be limited to hedging specific transactions. The next section considers the use of various financial instruments in such hedging practices.

Hedging Using Financial Instruments

Interest rates for securities can be either fixed or floating, and companies often borrow in one form but have an exposure in the other. To manage this exposure, firms have numerous financial instruments at their disposal, some of which lock in specific interest rates (forwards and futures contracts) while others allow for upside potential (options). Hedging is a special case of interest rate risk management, where the objective is to set the target duration of a portfolio (underlying asset and derivative) to zero. This section provides a brief description of some of the more common financial instruments, and how they are used to hedge. Fabozzi (2013) and Hull (2018) provide more comprehensive descriptions.

Interest Rate Futures and Forwards

Interest rate futures contracts are traded on exchanges such as the Chicago Mercantile Exchange (CME) and Intercontinental Exchange (ICE). Two main types of futures contracts are traded: (1) those based on securities and require their delivery (e.g., 10-year Treasury-note futures), and (2) those based on a floating rate and are cash-settled (e.g., Eurodollar futures). To the extent that bond prices adjust as Treasury yields move, bond portfolio managers can hedge their positions by shorting Treasury-note futures contracts when they have long positions in bonds. The contracts listed on the CME have notional values of $100,000 and maturities corresponding to the next three quarters in the March, June, September, and December cycle. Using Treasury-note futures locks in the value of a bond portfolio, which is a useful strategy when yields are expected to rise and hence bond prices fall.

Conversely, corporate financial managers may be interested in locking in a fixed borrowing cost when a loan is tied to a floating rate such as LIBOR. In this case, Eurodollar futures are more relevant, where the underlying asset is a Eurodollar interbank deposit with a principal value of $1 million and three months to maturity. The contracts listed on the CME Group website, per the contract specs, correspond to the "nearest 40 months (i.e., 10 years) in the March Quarterly cycle (Mar, Jun, Sep, Dec) plus the nearest 4 "serial" months not in the March Quarterly cycle" (CME Group 2018). If a financial manager has borrowed money at a spread above LIBOR, and is concerned that interest rates will increase in the near term, the manager may take a short position, in a Eurodollar futures contract to lock in a particular rate. Then, if interest rates do rise, the settlement index price of the contract falls, and the short position receives cash corresponding to the difference between the initial price and the settlement price multiplied by $25 per basis point change.

Forward contracts are traded over-the-counter (OTC) between two parties. Rather than having exchange-defined settlement dates and notional values, these contracts are tailored to the needs of the two parties and often have settlement dates and notional amounts that are specific to each contract. Unlike exchange-traded futures contracts that are marked-to-market on a daily basis and may be closed out before expiration, these forward contracts are typically settled only at maturity. As a result, counterparty credit risk exposure exists for the party that is owed money before the expiration of the contract.

Options

Interest rate options contracts can be written in which the underlying asset is a cash instrument or a futures contract. Although historically exchanges offered options on specific debt instruments (*options on physicals*), these are less common today and most options have futures contracts as their underlying asset. A futures option can be either a call or a put option. A *call option* gives the buyer the right to assume a long position in the underlying futures contract if the option is exercised ("buy" the futures contract), while the option seller would be obligated to take a short position. Similarly, a *put option* gives the buyer the right to enter into a short position in the underlying futures contract ("sell" the futures contract), while the option seller is obligated to take on a long position. These options contracts are useful for managers who want to hedge against adverse interest rate movements, but still retain the possibility of benefitting from favorable movements.

Swaps

A *swap* is a derivative contract in which two parties exchange multiple cash flows from two different financial instruments. In particular, an *interest rate swap* involves exchanging periodic interest payments, usually a fixed-rate payment for a floating-rate payment. The party that is the *fixed-rate payer* (or *floating-rate receiver*) is said to have a *long* position in the swap; similarly, the other party is the *floating-rate payer* (or *fixed-rate receiver*) and is said to have a *short* position in the swap. A financial manager who has borrowed money, and makes floating-rate payments on a loan, may be concerned about a future increase in market rates. The financial manager can enter into an interest rate swap to pay fixed and receive floating (a long position). If interest rates do rise, the manager receives payments from the swap to offset the increase in the loan payments, but locks in a fixed rate. Sometimes speculation on the direction of rate changes can lead to negative outcomes. For example, if the financial manager entered the swap and rates went down rather than up, the manager would be stuck with making higher fixed-rate payments than initially anticipated.

Similarly, a financial manager who has invested in a security that makes payments tied to a floating rate may be concerned that market rates will drop in the future. Entering into an interest rate swap to receive fixed and pay floating (a short position) allows the financial manager to continue to receive a higher rate if market rates do decline. The floating-rate swap payments offset the floating-rate receipts from the security, but the financial manager has locked in a higher fixed rate.

As interest rates change, the value of the swap also changes. The sensitivity of the swap value to changes in interest rates can be measured using dollar duration. An interest rate swap may be viewed as the exchange of cash flows between a fixed-rate bond and a floating-rate bond, where no exchange of principal occurs at the swap initiation or expiration as the principal on both bonds will be the same amount. The dollar duration of the swap is calculated as the dollar duration of the fixed-rate bond minus the dollar duration of the floating-rate bond, assuming that the party to the swap is receiving fixed payments and making floating payments. The latter is fairly small because the value of the floating-rate bond resets to par immediately after each cash flow exchange. Thus, the dollar duration of the swap is fairly close to the dollar duration of the fixed-rate bond.

Caps, Floors, and Collars

An *interest rate cap* is a derivative instrument in which the buyer receives a payment whenever a reference rate exceeds the pre-determined strike price. For example, purchasers of a cap may have entered into a contract in which they receive a payment every month that LIBOR is above 3 percent for the next five years. This arrangement is particularly useful for a financial manager who has borrowed money at some spread over LIBOR and makes floating-rate payments on the loan, especially if the manager is concerned about a future increase in market rates. Unlike a swap in which a fixed rate would be locked in, purchasing a cap means that the buyer continues to make floating-rate payments but a ceiling exists on how high these payments can go. In the example of the cap previously mentioned, 60 payments could potentially occur if LIBOR were to rise above 3 percent immediately after the purchase of the cap and remain at or above that level. The interest rate cap can be viewed as a series of separate European call options, known as *caplets*, which exist for as long as the cap is in existence such as 60 payments in the example described.

A similar definition exists for a derivative instrument where the buyer receives a payment when the reference rate drops below an agreed strike price. This instrument is known as an *interest rate floor*, and can be viewed as a series of European put options, known as *floorlets*, on the reference rate. For a financial manager who has loaned money at a floating rate and receives floating-rate payments, an interest rate floor can be a useful hedging instrument if the manager expects future market rates will decline. Purchasing a floor means that the buyer continues to receive floating-rate payments but a limit (i.e., a floor) exists on how low these payments can go.

An *interest rate collar* is the result of a simultaneous purchase of an interest rate cap and the sale of an interest rate floor, where both have the same notional amount and maturity. The strike rate on the cap is set to be above the strike rate on the floor. Thus, a borrower can still hedge against interest rate rises but can purchase this protection more cheaply as the sale of the floor offsets some of the purchase cost associated with the cap. The collar creates a range in which the borrower's effective interest rate fluctuates.

Although futures, forwards, options, swaps, caps, floors, and collars are valuable in managing interest rate risk associated with particular transactions, more general techniques are needed for the risk management of portfolios that contain a mixture of assets and liabilities with varying maturities. Although hedging the risks associated with each individual security in a portfolio might be possible, the transaction costs involved could be very high. The next section provides an examination of the various approaches that consider the magnitude and timing of portfolio cash flows.

Employing Interest Rate Risk Management Methods

Financial institutions of various sorts often need to balance assets and liabilities that have future associated cash flows. For example, banks and other depository institutions balance client deposits, which are typically liquid short-term liabilities, with loans made to borrowers, which are usually illiquid long-term assets. Pension funds balance contributions into the funds from those currently employed with payments out to those who have retired. Insurance companies balance premiums paid by policyholders with claims made by those who have suffered losses. A primary concern of those responsible for managing the cash inflows and outflows is to ensure that sufficient funds are always available to cover the expected cash outflows. Hence, the objective is not to maximize pension assets but rather to maximize the difference between the plan assets and liabilities (i.e., the surplus).

Portfolio Immunization

To keep assets and liabilities in balance, especially for portfolios that are composed primarily of fixed-income instruments, the financial manager must pay careful attention to risks associated with changes in interest rates. These changes affect both the value of the assets in the portfolio and the value of the claims against those assets (liabilities). According to Redington (1952, p. 289), the person usually credited as having introduced this risk-management strategy, the *immunization* of a portfolio can be defined as "the investment of the assets in such a way that the existing business is immune to a general change in the rate of interest." Two criteria are necessary to immunize a portfolio against changes in interest rates: (1) the duration of the cash flows produced by the assets must be matched with the duration of the cash flows required by the liabilities so that the two are equal; and (2) the present value of the assets must equal the present value of the liabilities. This portfolio immunization seeks to limit both price risk and reinvestment risk.

Although relatively straightforward in theory, the practice of immunizing a portfolio can be exceedingly complex. For example, financial managers may have difficulty forecasting the size of cash outflows and when they will occur. Additionally, the volatility of the term structure may be high, and embedded options in many of the assets traded today may create difficulties in estimating correct values for the duration of those assets. Even if the duration of the liabilities can be forecast correctly, challenges may be present in finding fairly liquid assets that generate an appropriate stream of cash flows to immunize the portfolio. Sophisticated financial managers and institutional investors employ costly hardware and software to compute a multitude of scenarios that could occur, calculating prices, durations, and convexities, and investing in derivatives for hedging purposes.

Consider a pension fund manager facing a single liability that comes due in several years. Even if the manager can find an asset that has exactly the same duration as the liability today, due to changes in market rates and the passage of time, duration mismatches will quickly arise and the manager will need to rebalance the portfolio of assets. The fund manager faces a trade-off: if the rebalancing is done too frequently, transaction costs become very expensive, but if it is not done often enough, the duration of the assets wanders from the duration of the liability so that the required return on the assets might not be achieved. This situation raises an important question related to immunization risk: As many possible asset portfolios exist that can be constructed to immunize the single liability, can one be found that minimizes the risk of not achieving the target yield? According to Bierwag, Kaufman, and Toevs (1983a, p. 21), "the risk of realizing a return less than the promised return because of incorrect identification of the actual stochastic process is referred to as 'stochastic process risk.' " Bierwag, Kaufman, and Toevs (1983b) and Fong and Vasicek (1984) offer strategies for minimizing losses from this type of risk.

Asset-Liability Management

Financial institutions operate with two objectives in mind: (1) to generate a fair rate of return on their investments, and (2) to keep a comfortable surplus of assets over and above liabilities. To achieve these objectives, the task of managing a financial institution's funds is called *asset-liability management* (ALM). Financial managers face a trade-off between taking on reasonable risks to obtain an adequate return on invested funds, and keeping the risk of a decline in the surplus under control.

Although ALM was originally developed to manage risks arising due to mismatches in the values of assets and liabilities, today the process finds itself at the intersection between risk management and strategic planning. Taking a long-term perspective, successful maximization of asset cash flows to meet complex liabilities leads to increased profitability. The modern approach to ALM takes into account the allocation and management of assets, equity, interest rates, and credit, including risk overlays and calibration of tools at a company level within these risk frameworks that lead to optimized outcomes in the local regulatory and capital environment.

Although ALM initially focused on interest rate risk management and liquidity risk management, the scope of the ALM function today has been expanded to include risks associated with a firm's capital markets (both equity and debt), foreign-exchange-rate risk, a firm's needs for short-term and long-term capital, credit risk, and profit planning and growth. Although this scope is extensive, it is still contained within an even broader framework called *enterprise risk management* (ERM) that also addresses other market risks, operational risk, accounting risk, and regulatory/legal risk. The scope of the ALM function includes a prudential component (i.e., managing all possible risks, rules, and regulations) and an optimization role (i.e., managing funding costs and balance sheet positions), within the limits of compliance. Companies manage their exposure to interest rate risk through stress testing the market value of assets and liabilities by considering the effects of possible interest rate shocks, calculating the value at risk (VaR) for the portfolio, and analyzing the mismatch of the interest sensitivity gap between assets and liabilities. *Value at risk* is a technique used to measure a portfolio's financial risk over a specified period of time.

Summary and Conclusions

In this chapter, interest rate risk was defined in terms of two main aspects: price risk and reinvestment risk. As the former has a more immediate impact on the value of a security or portfolio, measures of estimating price risk were described, particularly duration and convexity. Due to financial instruments with fixed cash flows having prices that are sensitive to changes in interest rates, forecasting prices places heavy reliance on forecasting yield curves. Firms that manage interest rate risk typically hedge transactions by using derivative instruments, such as futures contracts, options, swaps, caps, floors, and collars. As financial managers at banks, pension funds, insurance companies, and elsewhere seek to manage risks associated with multiple liabilities, more advanced techniques are employed. For instance, portfolio immunization can reduce or eliminate price risk and reinvestment risk, and, more holistically, asset-liability management provides a broader framework that also includes the management of other risks as well as profit planning and growth.

The financial crisis of 2007–2008 led to the Great Recession. Following this period in the United States and around the world, interest rates dropped to almost zero. The Federal Open Markets Committee (FOMC) sets the *federal funds rate*, the rate at which banks lend reserves to other banks on an overnight basis. According to Macrotrends (2017), the Fed funds rate never rose above 0.25 percent between December 4, 2008, and December 16, 2015. During this period of very low interest rates, fund managers saw little volatility in the term structure of interest rates, companies seized the opportunity to raise capital through new debt issues, households borrowed to purchase homes and cars, and overall the economy began to grow once again.

On December 16, 2015, Janet Yellen, chair of the Federal Reserve Board of Governors, announced that a modest increase of one quarter of a percentage point was appropriate (CNBC 2015), reflecting confidence in the economic recovery. Follow-on increases have brought about a new rising interest rate environment. This situation is bringing interest rate risk management once again to the fore in the private sector, and the government sector and regulators continue to review monetary policy in an effort to stimulate the economy while monitoring inflation. New opportunities exist for investors, but increased risks accompany them.

Discussion Questions

1. Define interest rate risk.
2. Explain how modified duration and convexity are used to approximate the change in the price of a bond for a given change in interest rates.
3. Identify the major financial instruments used in interest rate risk management.
4. Describe the characteristics associated with portfolio immunization, asset-liability management, and gap analysis.

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4

Other Risks Associated with Debt Securities

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Introduction

While return-hungry investors continue to seek abnormal returns by investing in the latest Internet stock or cryptocurrency, more conservative fixed income securities continue to play an important role in investor portfolios and in building a strategic asset allocation (SAA). Academic research supports the need for investors to diversify their investment portfolios (Brinson, Hood, and Beebower 1986; Xiong, Ibbotson, Idzorek, and Chen 2010). Going forward, both equities and fixed income are likely to continue as the two main building blocks in portfolio construction. Although generally less risky than equities, fixed income securities also involve risks. With the currently improving U.S. economy, at the time of this writing, many economists are forecasting multiple interest rate increases by the U.S. Federal Reserve System through 2019, bringing fixed income risk to the forefront of both investor thoughts and financial headlines.

Although as an asset class bonds are among the safest securities in an investor's portfolio, most fixed income investments involve risks. In fact, certain fixed income securities can be even more risky than many stocks. As discussed in Chapter 3, interest rate risk is the primary risk faced by fixed income investors. This chapter focuses on other risks associated with fixed income investing, especially involving corporate bonds. Additionally, investing in non-corporate bonds such as sovereign debt, municipal bonds, and securitized debt involves additional risks that are discussed in later chapters.

Diversification has its limitations as evidenced in the financial crisis of 2007–2008. In fact, investors experienced substantial losses not only in equities but also in other asset classes including fixed income. Unfortunately, the current investment environment continues to challenge investors with historically low but rising interest rates, increasing inflation, and political uncertainty. However, fixed income securities still should remain a cornerstone in investors' portfolios, especially as they age. Investors should understand the limitations of diversification and optimization of their portfolios through modern portfolio theory (MPT) but continue to diversify their portfolios (Resnik 2010).

Understanding why many investors buy bonds is important. They primarily purchase bonds to increase the yield of their portfolio and to reduce their portfolio's overall risk. Fixed income investors often buy bonds to earn a higher yield than is currently available from traditional bank savings accounts or certificates of deposit (CDs). However, most fixed income investors are also concerned with potential loss of principal. How do investors properly assess the safety (i.e., credit risk) of a bond to add to their portfolios? This chapter covers basic principles of credit analysis and explains the credit ratings issued by the three major credit reporting agencies for fixed income and how these agencies can help investors select the most appropriate fixed income securities to meet their unique needs. Additionally, investors with modest portfolios, for example, less than $5 million, should probably avoid individual bond investments to their high unit costs and transaction costs. Rather, it would be prudent to consider investing in bond mutual funds and exchange-traded funds (ETFs) that are discussed in later chapters to provide cheaper and greater diversification.

Investors have seen a dramatic increase in the accessibility of financial information available to them as technological advances have fueled the menu of options readily available. In fact, they now have free access to much financial data that were traditionally only available to top investment banks and sophisticated professional investors. This increased transparency is very important to fixed income securities as investors tend to find this market challenging to understand due to its historic lack of transparency. Although interest rates remain historically low since the start of the financial crisis of 2007–2008, investors have learned firsthand the difficulty of obtaining higher yields. By comparison, the 10-year U.S. Treasury bond is yielding about 2.8 percent, which is considerably lower than the double-digit equity index returns in 2017. To compensate for these low returns, fixed income investors continue to search for higher yields by often investing in more complex fixed income securities with both longer maturities and increased risk. Although fixed income may be viewed generally as low risk because of their seniority to equity claims, there is still certainly the potential for large losses particularly in the more complex and esoteric products.

Despite an increased array of financial data accessible to investors, this access is not useful if investors do not properly analyze and use the data to make informed financial decisions. Market interest rates are a function of many factors including the supply and demand of money in the economy, real rate of inflation, business cycle, and monetary and fiscal policies. Investors and their advisors may be becoming more aware of the potential dangers of interest rate risk in a rising interest rate environment, as demonstrated by the lower duration of professionally managed and advised bond portfolios at the time of this writing. Yet, only understanding interest rate risk does not properly profile the risk exposure for many fixed income investors.

Historically, fixed income investors have relied on credit reporting agencies to help quantify and summarize the amount of risk that bond investors are taking. The poor performance by the primary credit rating agencies—Standard & Poor's, Moody's, and Fitch—during the recent financial crisis in predicting the probability of default associated with certain bond types, especially mortgage-backed securities (MBSs) and collateralized debt obligations (CDOs), has become a serious concern for academics, investors, and U.S. regulatory agencies. Therefore, a basic understanding of credit risk and a firm's capacity to repay its debt is critical for fixed income investors.

This chapter focuses on credit risk, inflation risk, liquidity risk, reinvestment risk, and environmental, social, and governance (ESG) risk for fixed income securities. It also provides fixed income investors with a general overview for understanding S&P's credit rating methodology. Investors are cautioned against solely relying on credit reporting agencies for the due diligence of their fixed income securities.

Credit Risk and Analysis

Many methodologies are available for understanding credit risk when analyzing fixed income securities. These approaches focus primarily on the chance that the bond issuer may default on promises to pay interest and return principal (default risk) and the amount of principal that investors are likely to receive (recovery rate) if the bond issuer does default. According to Petitt, Pinto, and Pirie (2015), *default risk* is the risk that the issuer will not meet the terms of the bond indenture with respect to the payment of interest and/or principal.

Investing in fixed income differs greatly from investing in common stock, especially during bankruptcy. Generally, when companies enter bankruptcy, the value of the firm's common stock holdings become worthless, while fixed income investors often still have some residual value associated with their investment. When analyzing default risk, bond investors need to have a general overview of both the default risk and the likely recovery rate if the firm goes into bankruptcy. Equation 4.1 defines expected loss as:

$$\text{Expected loss} = \text{Default probability} \times \text{Loss severity given default} \tag{4.1}$$

Because most investors buy high quality bonds that have a very low likelihood of default, they tend to focus on understanding the default probability of a specific bond issue rather than estimating recovery rates. Bond investors also tend to rely on the main credit reporting agencies to quantify this default probability and to monitor the issuer's capacity to honor their debt obligations. As previously discussed, investors require higher expected returns to compensate for taking higher risk. Bonds that have a greater chance of defaulting or experiencing loss should trade at a higher yield premium than bonds with less credit risk all else equal. For example, a similar maturity Treasury bond should have a lower yield than a bond issued by a corporation that faces a positive probability of default.

Typically, credit-related bond risk includes spread risk and downgrade risk. The *credit spread* is the difference in yield between a U.S. Treasury bond and a debt security with the same maturity but lower quality. *Spread risk* is the probability that a bond's spread widens relative to a maturity-matched benchmark. Because an inverse relation exists between spread and bond prices, a wider spread implies a lower bond price whereas a tighter spread results in a higher bond price. Thus, market participants assign a yield premium to a risky bond over a similar maturity risk-free bond such as a U.S. Treasury bond and closely monitor these spreads. For example, a technology firm with a troubled history of paying its debt may trade at a spread premium of at least 300 basis points (bps) versus a similar maturity U.S. Treasury bond. A technology firm facing an increased probability of default is likely to experience a widening spread accompanied by a declining bond price.

Downgrade risk is the risk that a decrease in a bond's price as a result of a downgrade in its credit rating. A downgrade occurs because the chance of the issuer defaulting on its debt obligation has increased, causing yield spreads to widen and bond prices to fall. After the financial crisis of 2007–2008 and the poor performance of monitoring fixed income securities by the major credit reporting agencies, questions arose about whether credit rating agencies are reactive or proactive and if market participants can rely upon them to adequately monitor fixed income securities. As a result, many top institutional fixed income managers now supplement the major credit rating agencies' opinions with their own proprietary analysis. Individual investors should also have a basic understanding of the credit risk methodologies of the major credit reporting agencies and supplement with their own analysis.

Seniority Ranking and Capital Structure

Below is the priority of claims of various debt securities: (1) senior secured debt (first lien), (2) secured debt (second lien), (3) senior unsecured debt, (4) senior subordinated debt, (5) subordinated debt, and (6) junior subordinated debt. Understanding the fixed income securities position in the priority of claims is important for investors in calculating the recovery rate for a specific bond. The higher the security is in the priority of claims, the greater the recovery rate in bankruptcy. Secured debt is backed by some form of collateral, while unsecured debt is essentially a promise by the issuer that it will honor its debt agreement. Secured debt has the highest priority during a liquidation and is more likely to return the principal invested by bond holders. Recovery rates are directly related to the security's ranking, meaning that a fixed income security with a lower priority has a lower recovery rate. Bankruptcy is a costly and lengthy process that differs from country to country. The bankruptcy court may not honor the absolute priority of claims, resulting in increased risk and difficulty in predicting recovery rates.

Although priority of claims is important, fixed income investors should be aware that lower risk investment-grade bonds typically result in lower yields. The yield is the lowest for first lien positions and the highest for junior subordinated debt. Investors must balance their unique needs for the appropriate risk-adjusted returns relative to the investor's ability and willingness to bear risk.

Credit Ratings Scales and Estimates of Default Risk

When an issuer such as a government or a large corporation sells fixed income securities, one or more of the three major fixed income ratings agencies—Standard & Poor's, Moody's, and Fitch—rates the issue. Both individual and professional investors have long relied on the credit rating services for their assistance in measuring default risk and for continually monitoring the issuer's ability to meet their bond payment obligations in the future.

After the dismal performance and underestimation of default risk by credit rating services during the financial crisis of 2007–2008, many practitioners have taken a more active approach by supplementing credit reporting agencies' analyses with their own proprietary analyses. Although the three main credit rating agencies have similar credit processes and procedures, they have different scoring and naming conventions.

A bond's credit rating reflects the credit rating agency's opinion about the issuer's likelihood of defaulting on its obligations, but not recovery rates. These ratings are important to both fixed income investors and issuers. Due to state and federal regulatory rules, banks and insurance firms are often prohibited from purchasing bonds that are not investment-grade quality, while other investors want the confidence that the issuer will honor the bond's commitment by paying back both interest and principal. The credit rating is also important to the issuer because it provides the corporation with an indication of its cost to raise capital by issuing bonds. For lower rated bonds, investors require a higher interest rate to buy these bonds and thus firms pay a higher interest rate to raise desired capital. Additionally, the higher yield suggests that firms face more risk of being unable to meet their debt commitments, which increases the probability of defaulting.

Understanding the S&P Credit Ratings

Although the three major credit rating agencies are similar, some key differences exist among them. The focus here is on S&P's rating methodology (S&P Global Ratings Definitions 2017). An S&P Global Ratings issue credit rating is a forward-looking opinion, not a specific investment recommendation, about an issuer's creditworthiness with respect to a specific financial security, financial securities, or financial program including ratings on medium-term note programs and commercial paper programs. This rating considers many factors including the following: any credit enhancements, guarantor arrangements, creditor's ability and willingness to honor the obligation, and the security's position in the corporate structure of the issuer. Issued credit ratings are based, in varying degrees, on S&P Global Ratings' analysis and due diligence of many key factors, including:

- The likelihood of the issuer defaulting on its obligation, which includes both an issuer's willingness and the ability to honor its commitments and a firm's willingness to honor its debt, especially regarding global bonds;
- Any changes in a firm's ability to meet its obligations and relevant macro-environment changes; and
- The position of the security in the overall capital structure of the firm (i.e., the priority of claims) during bankruptcy and any rights the bond holders have to specific collateral and cash flows listed in the bond indenture.

S&P Issued Credit Ratings

Below is an explanation of the S&P issued credit ratings (S&P Global Ratings Definitions 2017):

- *AAA*. An obligation rated AAA has the highest rating assigned by S&P Global Ratings. The obligor's capacity to meet its financial commitments on the obligation is extremely strong. Since the financial crisis of 2007–2008, only a small number of U.S. corporations have held that rating, such as Microsoft and Johnson & Johnson.

- *AA*. An obligation rated AA differs from the highest-rated obligations only to a small degree. The obligor's capacity to meet its financial commitments on the obligation is very strong.
- *A*. An obligation rated A is somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than obligations in higher-rated categories. However, the obligor's capacity to meet its financial commitments on the obligation is still strong but could be at risk during a prolonged or extreme or credit event.
- *BBB*. An obligation rated BBB exhibits adequate protection parameters. Adverse economic conditions or changing circumstances are more likely to weaken the obligor's capacity to meet its financial commitments on the obligation.
- *BBB–*. This rating is the last tier for investment-grade investments. Many firms and investors are prohibited from purchasing below investment-grade bonds.
- *BB, B, CCC, CC,* and *C*. These ratings have substantial speculative characteristics. BB indicates the least degree of speculation and C the highest. These securities are susceptible to economic downturns and/or credit events.
- *BB*. An obligation rated BB is less vulnerable to nonpayment than other speculative issues. However, it faces major ongoing uncertainties or exposure to adverse business, financial, or economic conditions that could lead to the obligor's inadequate capacity to meet its financial commitments on the obligation.
- *B*. An obligation rated B is more vulnerable to nonpayment than obligations rated BB, but the obligor currently has the capacity to meet its financial commitments on the obligation.
- *CCC*. An obligation rated CCC is vulnerable to default and is extremely dependent upon favorable business, financial, and economic conditions. In the event of adverse business, financial, or economic conditions, the issuer is not as likely to have the capacity to meet its financial commitments on the obligation as a higher rated bond.
- *CC*. An obligation rated CC is currently highly vulnerable to nonpayment. This rating is used when a default has not yet occurred, but it is extremely likely.
- *C*. An obligation rated C is currently highly vulnerable to nonpayment, and the obligation is likely to have much lower recovery rates than an investment-grade bond during default.
- *D*. A bond rated D is in default. For nonhybrid capital instruments, The D rating category is used when payments on an obligation are not made on the date due, unless S&P Global Ratings believes that such payments will be made within five business days in the absence of a stated grace period or within the earlier of the stated grace period or 30 calendar days. S&P also classifies a security to be in default upon the filing of a bankruptcy petition.
- *NR*. Not all fixed income securities are rated such as small bond offerings. S&P classifies a security as NR to indicate that no rating has been requested, or that insufficient information is available on which to base a rating, or that S&P Global Ratings does not rate a particular obligation as a matter of policy.

S&P states that it may modify the ratings from AA to CCC by adding a plus (+) or minus (–) sign to show relative standing within the major rating categories.

As previously noted, bonds assigned a rating of above BBB– are categorized as investment-grade bonds, while bonds that are assigned a rating below BBB are referred to as non-investment-grade bonds or high-yield bonds, also sometimes referred to as *speculative bonds* or *junk bonds*. The credit ratings agencies assign a credit rating on the probability of the debt obligation going into default and help quantify the risk a fixed income investor is taking by purchasing this security. Fixed income portfolio managers often estimate the likelihood of an issue being upgraded or downgraded during the next year or so. This estimate is called a *ratings transition matrix* and may be provided by the credit reporting agency and/or may be updated by the financial firm's proprietary research.

An Analysis of Credit Quality

Many sources of free information on investments are available for investors such as Morningstar. Morningstar Investment Research Center offers public, corporate, and academic libraries real-time access to comprehensive data and independent analysis on thousands of investments, spanning mutual funds, stocks, exchange-traded funds (ETFs), and closed-end funds. Specifically, Morningstar provides fixed income investors with important information on fixed income investment style details, style history, credit quality, and bond statistics. For example, Table 4.1 illustrates information from Morningstar regarding Vanguard's Long-Term Investment-Grade Fund Investor Shares (Symbol: VWESX). The credit quality analysis shows that more than 97 percent of the mutual fund's fixed income holdings contain investment-grade bonds and the fund's largest concentration is in A-rated bonds. The fund is overweighed in A-rated bonds, 55 percent versus 27 percent and underweighted in BBB bonds and non-investment-grade bonds. The average credit quality is A rated, average effective duration is 13.62, and weighted average coupon is almost 5 percent. Thus, a 1 percentage point rise in interest rates would lead to an estimated 13.62 percent decline in the portfolio's value if the average effective duration of the bond holdings in the portfolio was 13.62. The data displayed in this Morningstar analysis is free to investors and is available at http://portfolios.morningstar.com/fund/summary?t=VWESX.

Reliance on Credit Ratings

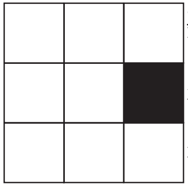
As investors learned during the financial crisis of 2007–2008, credit ratings provide a general guide for estimating the probability that a fixed income security defaults but should not rely only on this single source of analysis. Consider the comment from Peritus Asset Management (2012):

> Investors should understand what the ratings agencies themselves say about their ratings. Among their various disclosures, the ratings agencies caution that their ratings are opinions and are not to be relied upon alone to make an investment decision, do not forecast future market price movements, and are

Table 4.1 **Analyzing the Credit Quality of Vanguard Long-Term Investment-Grade Fund Investor**

Style Details VWESX

Fixed-Income Style



Fixed-Income Style History

Year	Style	% Bonds
2017		96.96
2016		97.07
2015		96.01
2014		96.05
2013		96.65

As of 12/31/2017

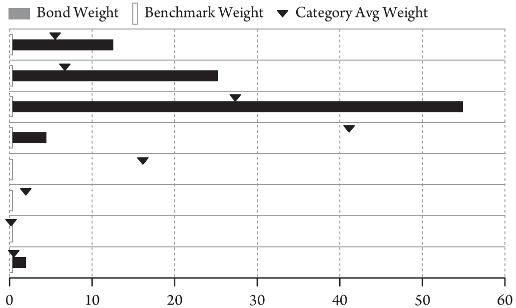
Bond Statistics

Detail	Value
Average Effective Duration	13.62
Average Effective Maturity (Years)*	22.20
Average credit Quality	A
Average Weighted Coupon*	4.95
Average Weighted Price*	118.59

As of 12/31/2017

Credit Quality

Type	% Bonds	Benchmark	Category Avg
AAA	12.76	—	5.64
AA	25.40	—	6.82
A	55.09	—	27.32
BBB	4.56	—	41.20
BB	0.03	—	16.26
B	0.03	—	2.02
Below B	0.00	—	0.25
Not rated	2.13	—	0.50



As of 12/31/2017
Credit Quality is calculated only using the long position holdings of the portfolio.

This table provides an overview of Vanguard's Long-Term Investment-Grade Fund Investor Shares including style details and history, bond statistics, and credit quality, which includes the fund's current allocation of credit quality breakdown, compared to its relevant benchmark and category average.

> not recommendations to buy, sell, or hold a security. So, if these opinions have no value in forecasting where the security price is going and are not investment recommendations, what good are they? We see the ratings agencies as reactive not proactive, yet many investors in fixed income rely almost entirely on these ratings in making investment decisions.

Since the recent financial crisis, academics, investors, and federal agencies have analyzed factors that exacerbated this crisis. According to DeHaan (2017), credit ratings on MBSs and CDOs substantially underestimated default risk before July 2007. Mass downgrades of these securities, starting in July 2007, triggered fire sales in debt markets and served as "the most immediate trigger to the [ensuing] financial crisis" (U.S. Senate 2011, p. 45). Further studies also indicate that these ratings failures were at least partially due to mistakes by credit rating agency personnel. According to a Moody's executive, "These errors [on MBSs and CDOs] make us look either incompetent at credit analysis, or like we sold our soul to the devil for revenue, or a little bit of both" (U.S. Senate 2011, p. 245). According to DeHaan, the Dodd-Frank Act and a host of Securities and Exchange Commission (SEC) regulations have been enacted since 2007 with the aim of preventing a recurrence of such widespread overly optimistic credit ratings. Little doubt exists that the performance and usage of ratings on MBSs and CDOs sharply declined during the financial crisis, but the fate of non-financial corporate credit ratings is less clear.

Risks of Relying on Credit Ratings Agencies

Investors who rely only on credit rating agencies face other risks. For example, credit ratings can change over time and credit reporting agencies often use "notching" to rate multiple issues from one issuer. This "notching" may not be timely or helpful for investors who may need to make decisions quickly. The financial crisis of 2007–2008 also produced concern that credit rating agencies are far from perfect, and that their models contain flaws. According to DeHaan (2017), corporate credit rating performance improved after the crisis, consistent with the rating agencies positively responding to criticism from regulatory agencies and sophisticated investors. Fixed income investors face additional risk if they fail to understand the ratings methodologies and assumptions. Finally, macro shocks caused by terrorism, military action, and political uncertainty are extremely disruptive and therefore notoriously difficult to model. In addition to the immediate direct costs related to terrorist activities, terrorism often imposes large indirect costs such as reduced demand for goods and services, supply chain interruptions, increased cost of doing business, and decreased foreign direct investment as a result of capital flight (Procasky and Utah 2016). These indirect costs from terrorism are extremely challenging to factor into credit models.

Four C's of Credit Analysis

Fixed income investors can supplement credit reporting agency ratings by using the four C's credit analysis framework.

Table 4.2 **Example of Credit Capacity**

	Current TIE Ratio	***3-Year Average TIE Ratio***
Company X	14x	12x
Company Y	9x	11x
Industry Average	11x	11x

Capacity

Capacity refers to the issuer's ability to meet the requirements of the bond's contract. Although a firm promises to pay the principal and interest in a timely manner, this promise may not be fulfilled. A firm may encounter a period in which it lacks sufficient cash flow to properly service its debt agreements. Credit analysts often use financial ratios to quantify a firm's capacity to meet their debt obligations. Good credit analysts avoid looking at financial ratios in isolation. A financial ratio is only a snapshot and provides limited information without examination in a broader more comprehensive context. For example, is a times interest earned (TIE) ratio (i.e., earnings before interest and taxes (EBIT) divided by interest expense) of 1, 5, or 10 good or bad? Instead, experienced fixed income analysts evaluate the firm's historical ratios to reveal trends and to compare with other similar firms in the industry. After placing a firm in a historical context and factoring in current conditions, they can make educated projections about the future.

Consider the following example shown in Table 4.2, which is only a partial analysis based on the current TIE for Company X. When comparing Company X to its competitor, Company Y, and the Industry Average, Company X has greater earnings capacity to pay its current debt. Note this trend has continued over the past three years. After comparing Company X to a major competitor and its industry, investors may be more confident in viewing Company X as having a higher ability to pay its debt, compared to Company Y and within its industry. Investors should also estimate the TIE ratio for the next several years to evaluate if this trend is likely to continue.

Collateral

Investors face challenges in valuing a firm's assets, and by extension the value of fixed income securities, just from financial statements. Since the mid-1990s, many firms, particularly Internet and social media firms, have experienced large increases in firm intangible assets such as intellectual capital, patents, and goodwill. These values, whether on (via acquisition) or off (via internal development) balance sheet, are extremely challenging to value as an outsider. Similarly, the average investor also has difficulty properly valuing physical assets such as a railway car or other specialized machinery that may be used as collateral on the loan. Therefore, they must rely on more sophisticated analysis techniques to value collateral. Relying on credit rating agencies to monitor the quality and value of collateral used for collateralized bonds is a recommended technique.

Covenants

A *covenant* is the legal framework and conditions found in the bond's indenture that defines the contract between the issuer of the fixed income security and investors. Two major types of covenants are affirmative (positive) and negative covenants. Affirmative covenants require a firm to perform or guarantee specific actions/conditions such as paying interest and returning principal. Negative covenants restrict firm activities such as taking on additional debt that is already backed by collateral or selling assets. For this area of analysis, most individual investors should rely on the major credit reporting agencies because covenants can be extremely complex. Xtract Research (2018) is a leading provider of covenant research throughout the world.

Character

Character refers to the management's history on repaying debt, previous management experience, and prior dealings with bond holders. Investors can conduct further due diligence in this area by accessing free available investor relations websites. For example, from the Coca-Cola website (http://www.coca-colacompany.com/our-company/leadership), investors can view the current senior leadership and review pertinent financial data about the firm including its annual report and includes key financial information from the 10-K. Under SEC regulation, top management/directors and key personal information such as compensation and board memberships must be disclosed. This information provides a starting point for investors to conduct their own analysis.

Inflation Risk

The extremely low inflationary environment since 2008 has reduced investor fears about this risk factor. However, its potential impact on bond returns and strategic asset allocation decisions is critical. According to the U.S. Inflation Calculator (2018), inflation averaged 2.1 percent during 2017. As of February 2018, inflation estimates are projected to be around 3 percent or higher in the near-term. Fixed income investors need to be concerned with unexpected inflation increases because they can be detrimental to fixed income holders, particularly with low bond yields. For example, if an investor buys a corporate bond that pays a 3 percent coupon, but inflation is 2 percent, then the real purchasing power for the investor has only increased by 1 percentage point. Since the bond issuer promises to pay a fixed interest rate, an investor is exposed to inflation risk. However, investors have expressed increased demand for inflation protected bonds issued by the U.S. government that can be used to hedge the inflation risk commonly associated with investing in government bonds. Inflation-linked debt, called Treasury Inflation-Protected Securities (TIPS), is discussed later in this book.

Inflation results from having too much money in the financial system without a concomitant increase in output. If inflation is 4 percent, then a basket of goods that costs $100 today would cost $104 next year. Many measures are available for measuring inflation such as the consumer price index (CPI), which measures changes in the price level of market basket of consumer goods and services purchased by households. However, economists disagree on whether inflation is good or bad for the economy and no consensus exists for the best way to accurately measure it. Too much or too little inflation can cause severe macroeconomic effects on the economy. For example, inflation during the 1920s in the Weimar Republic was disastrous, and even inflation in the United States in the 1970s was problematic.

Economist Arthur Okun developed the "misery index" in the 1960s to better account for the detrimental effects of inflation. He created this index by adding the unemployment rate to the inflation rate. Even when inflation turns negative (deflation), it can be detrimental for investors as consumer debts rise, and business tends to hold cash and curtail capital investment. Since 2013, the U.S. Federal Reserve System has focused on boosting the inflation rate to the 2 percent targeted rate.

A substantial body of knowledge helps to explain inflation expectations in fixed income pricing. For example, Kang and Pflueger (2015) find that inflation risk can explain as much variation in credit spreads as equity volatility and dividend yield. They also identify a possible new connection between inflation and credit risk in corporate bond yields. Specifically, the authors find that corporate bond spreads price two types of inflation risk: inflation volatility and inflation cyclicality. Surprisingly, they also find that fixed income investors factor in both increases in inflation and the possibility of debt deflation. This research could be helpful to central banks and policymakers as they attempt to manage the economy. Finally, Moerman and Van Dijk (2010) find that inflation risk can be much harder to hedge than exchange rate risk in global stock portfolios.

Liquidity Risk

Liquidity risk is the risk that an investor will be unable to buy or sell a security at the current market price. However, each issuer and, in fact, each bond issue face its own unique liquidity risk. For example, liquidity risk is very small for government debt and bond mutual funds or ETFs. These securities are virtually guaranteed an active market in which they can be sold, while some bonds require a deep discount to be sold. The most direct method for measuring liquidity risk is by using bid-ask spreads. Bonds that trade infrequently are likely to have a wider bid-ask spread to compensate dealers for increased liquidity risk.

Spreads tend to widen during periods of financial crisis for corporate bonds because investors often flock to treasuries and higher quality government debt during such periods. This "flight to quality" causes corporate bond prices to decline and widen the spread between corporates and government bonds with similar maturities. A security with a wide spread often means it has greater liquidity risk that increases the difficulty of investors buying or selling the security at a desired price. During times of extreme stress, such in the financial crisis of 2007–2008, liquidity declined sharply, which dramatically increased yield spreads, not just for low rated bonds but also for highly rated bonds. In fact, in some markets, trading was simply impossible at any price, and many markets became basically "frozen." Before the financial crisis, academics generally focused on better understanding the importance of credit risk and liquidity risk embedded in fixed income spreads on non-Treasury bonds. According to Longstaff, Mithal, and Neis (2004), the default component is the largest contributor to corporate spreads.

Acharya, Amihud, and Bharath (2013) find that the pricing of liquidity risk is dependent on the current state of the economy and liquidity risk becomes even more important during periods of high stress. As Longstaff et al. (2004) note, a high default premium was evident even in the highest quality investment-grade bonds given that default risk accounts for more than half of the total corporate spread. In fact, the authors estimate that the default component represents more than 51 percent of the spread relative to the Treasury curve for AAA-rated bonds and more than 83 percent for BB-rated bonds. They also suggest that the market price of credit risk may even be larger than implied by their models. In the aftermath of the financial crisis, more research is needed to properly quantify both default and liquidity risk.

Reinvestment Risk

With historically low interest rates since 2007, corporations have frequently turned to issuing long-term bonds to raise capital. To protect themselves from falling interest rates in the future, many corporations issue callable bonds. A *callable bond* is a bond that gives the issuer the right to buy back the bond before maturity and pay off the debt. For example, if a corporation issues a bond with a 6 percent coupon and interest rates fall sufficiently, the issuer may call the bond and pay off the bond before maturity. Although investors receive all their principal, and possibly a call premium, a call benefits the issuer but is detrimental to bond holders because they must reinvest the proceeds at the current (lower) rate. As a result, these investors receive less future income from such reinvestment.

Reinvestment risk is the possibility of reinvesting future cash flows from an investment in lower-yielding securities. For example, an investor buys a 10-year investment-grade bond that pays a 6 percent coupon rate for $100,000 and is callable in four years. The investor expects to receive semi-annual payments of $3,000 for at least four years but hopefully for the full 10-year period. In the fifth year, interest rates fall to around 3 percent, so the issuer "calls" the bond and returns the $100,000 to the investor and possibly a small premium for calling the bond and the investor's last interest payment of $3,000. The problem for the investor is that a similar 10-year investment-grade bond now pays only a 3 percent coupon rate. Therefore, if the investor buys $100,000 of this new bond, income is only $1,500 semi-annually, instead of the $3,000 previously received. Investors are exposed to greater reinvestment risk with amortizing bonds the pay back principal and interest periodically

Environmental, Social, and Governance Risk

Since the financial crisis of 2007–2008, a new trend has developed where investors have started to incorporate non-economic factors such as environmental, social, and governance (ESG) analysis. This trend is partially attributed to the perceived notion that financial reporting did not disclose all the substantial risks to investors. This movement started with stocks during the 1970s but did not generate much attention until the most recent financial crisis. This phenomenon has progressed beyond stocks and now is common in other asset classes such as real estate and fixed income. Although many analysts focus on credit risk as the primary driver of fixed income returns, a growing body of research demonstrates that ESG factors also can influence bond returns. In 2013, the United Nations supported "Principles for Responsible Investments" (PRI) and disclosed ESG factors that may affect the credit risk in fixed income securities (PRI 2013).

Table 4.3 shows some ESG issues affecting credit risk. For example, some environmental issues affecting credit risk are energy resources, pollution, and renewable natural resources. From a social perspective, health and safety, human rights, and diversity can also affect credit risk. Governance issues include transparency, compensation structures, and board diversity.

According to Hermes (Morningstar 2017), "Our unconditional analyses revealed that, on average, those issuers with the lowest ESG scores always exhibit the highest CDS spreads, whereas companies with higher ESG scores generally have lower CDS spreads. We conclude that while credit risk is still the most important driver of CDS spreads, good ESG practices also have a risk reduction effect on companies." Credit rating agencies are also taking notice of the increased demand for coverage of ESG risks. To accommodate an increasing interest by investors, Moody's has recently created a "Cross Sector Heat Map" that assesses overall sector credit risk and exposure to major categories of environmental risks including air pollution, soil/water pollution and land use restrictions, carbon regulations, water shortages, and natural and man-made disasters (Damutz 2016).

According to William Vaughan, Global Credit Research Analyst with London-based Brandywine Global (Seeking Alpha 2017), "The consideration of ESG factors is not a 'moral obligation' so much as a necessary step in comprehensive credit rating analysis." According to Christoph Klein of Deutsche Bank, "The benefits of considering environmental, social, and governance (ESG) factors have propelled the strategy into mainstream investing. Integrating ESG factors into fixed income analysis can reduce idiosyncratic and portfolio risk and improve portfolio performance by helping investors anticipate and avoid investments that may be prone to credit rating downgrades, widening credit spreads, and price volatility" (Klein 2015, p. 46).

Table 4.3 **Some Environmental, Social, and Governance Issues Affecting Credit Risk**

Environmental	*Social*	*Governance*
Energy resources	Health and safety	Transparency
Pollution	Human rights	Compensation structures
Renewable natural resources	Diversity	Board diversity

This table shows various environmental, social, and governance (ESG) factors that may affect credit risk.

Source: Principles for Responsible Investments (2013).

The Deepwater Horizon Accident

Could ESG factor analysis alerted investors to avoid investing in securities of British Petroleum (BP)? Some proponents of incorporating ESG factors in credit analysis seem to think so. For example, Klein (2015) finds that before the spill, BP's five-year credit default spreads (CDS) were trading at around 50 bps, which was average for an A-rated energy company. After the spill, BP's CDS were trading at more than 600 bps, a remarkable widening of CDS rarely seen outside of the financial crisis of 2007–2008. According to the Occupational Safety and Health Administration (OSHA), before the Deepwater spill, BP had been cited for 760 "egregious willful" safety violations in its refineries. Additionally, the company violated OSHA's "process safety management standard," which is precisely what that BP advisory panel had been charged after the Texas City explosion in 2005. In October 2009, OSHA fined BP an additional $87 million for refinery deficiencies.

Using Sustainalytics, a prominent global ESG data provider, Klein (2015) finds that in the years leading up to the accident, BP's performance in relevant metrics indicated major operational risks. If investors had factored in BP's poor ESG track record into their risk analysis, they may have avoided BP-related losses in their investment portfolios.

Summary and Conclusions

Although bonds are generally considered some of the safest securities in an investor's portfolio, most fixed income investments still involve risks, some of which are substantial. Interest rate risk is the primary risk for fixed income investors particularly for investment-grade issuers. This chapter focused on other risks associated with fixed income investing including credit risk, inflation risk, liquidity risk, reinvestment risk, and ESG risk.

Historically, fixed income investors relied on credit reporting agencies to help quantify the risk associated with various debt issues. However, during the financial crisis of 2007–2008, these agencies demonstrated poor performance in predicting the probability of default associated with certain bond types. Therefore, understanding these risks is critical for investors. The chapter also cautioned investors not to rely solely on credit reporting agencies for their due diligence when considering fixed income securities.

Discussion Questions

1. Explain how the seniority rank of debt affects the recovery rate for bond investors in the event of default on a fixed income security.
2. Explain the effect of an upgrade from A to AA on the credit spread for a bond.
3. Discuss the importance of inflation to fixed income investors.
4. Explain how including ESG analysis might have helped identify increased risk at BP before the Deepwater Horizon accident.

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PART II

MARKET SECTORS

5

Government Debt

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Introduction

Government debt, also called sovereign debt, public debt, and national debt, is the amount of money that a country's government has borrowed, typically issued as bonds denominated in a reserve currency. In other words, government debt is a central government's debt. This chapter focuses on U.S. government debt. The U.S. Department of the Treasury collects revenue from taxes charged to U.S. citizens. With the taxes collected, the government pays bills, controls the military budget, pays out social security, and assists with unemployment benefits and other government run entities. As of 2019, Steven Mnuchin serves as the Secretary of the Treasury. As the chief financial officer of the United States, he plays a key role in the sound financial success of the United States.

The mission statement of the U.S. Department of the Treasury is to maintain a strong economy and create economic and job opportunities by promoting the conditions that enable economic growth and stability at home and abroad, strengthen security by combating threats and protecting the integrity of the financial system, and managing the U.S. government's finances and resources effectively (Treasury 2017). The broad functions and responsibilities of the Treasury Department involving advising the President of the United States, controlling the distribution of coin and paper currency, collecting tax revenue from its citizens, and running the federal government. The responsibilities also include imposing potential sanctions against foreign adversaries in economic capacities. This power can be used as leverage to influence the viability of a foreign country that is acting against the best interests of the United States.

Background on U.S. Government Debt

Growth of U.S. total public debt outstanding has soared from about $848 billion in 1980 to $2.97 trillion in 1990, $5.71 trillion in 2000, and $12.3 trillion in 2010. As of May

2019, the amount stood at more than $22.3 trillion. To finance this debt, the Treasury issues several types of securities:

- U.S. Treasury bills (matures in days up to 1 year),
- U.S. Treasury notes (matures in increments of 2, 3, 5, 7, and 10 years),
- U.S. Treasury bonds (matures in 30 years),
- U.S. Treasury inflation-protected securities (TIPS) (inflation protection vehicles that mature in 5, 10, and 30 years), and
- U.S. floating rate notes (FRNs) (variable rate vehicle, paying interest at a reset period).

Treasury bills are offered on a weekly basis, trade at a discount, and pay the face value at maturity. Treasury notes are offered on a monthly basis, pay interest semi-annually, and have shorter maturity dates than bonds. Treasury bonds are also offered on a monthly basis and pay interest semi-annually and the principal amount is paid at maturity. First auctioned in 1997, TIPS provide inflation protection and pay interest semi-annually at a fixed rate. The principal of a TIPS increases with inflation and decreases with deflation as measured by the Consumer Price Index (CPI). As its name implies, FRNs pay an interest rate that fluctuates. The U.S. Treasury Department first auctioned FRNs in January 2014 to help investors in the environment of rising rates.

An attractive feature of Treasury securities is the complete and unconditional backing by the full faith and credit of the U.S. government. Given that the United States has never defaulted on its debt, market participants consider its debt to be very safe and suitable as a conservative investment for investors. U.S. government debt is highly liquid as indicated by the many transactions that occur in the secondary market after its auctions.

Ownership of U.S. Debt

After the financial crisis of 2007–2008, the supply of U.S. government bonds increased dramatically (Arias and Restrepo-Echavarria 2016). Treasury marketable debt outstanding has grown sharply to about $14 trillion as of June 30, 2017, up from $4.3 trillion as of June 30, 2007, just before the onset of the financial crisis (Mnuchin and Phillips 2017).

Accompanying the increased supply of Treasury securities, ownership has also changed dramatically. The recent rise in diversified portfolio and passive investment strategies has increased the holdings of Treasury securities particularly among mutual funds. Specifically, mutual funds have increased holdings from under 4 percent historically to more than 6 percent in 2017 (Board of Governors of the Federal Reserve System 2017). Despite this increase in holdings by mutual funds, foreign holders of Treasury securities have also increased substantially. Nondomestic ownership of Treasuries increased from $2.2 trillion in June 2007 to about $6.2 trillion in June 2017 (Board of Governors of the Federal Reserve System 2017). Regulatory changes after the financial crisis of 2007–2008 have driven many of the changes in holdings of Treasury investments by both mutual funds and the domestic banking sector (Mnuchin and Phillips 2017).

In particular, the Federal Reserve outlines that U.S. chartered banks held roughly $78 billion of Treasury securities in 2007 but by the first quarter of 2017, this number grew to more than $500 billion. This dramatic rise is due partly to new regulations such as the Basel III Accord capital requirements that call for financial entities to hold greater amounts of high quality liquid assets. Over the same period, money market mutual fund holdings grew from $92 billion to $741 billion. The rise in holdings is attributed to the SEC requirement forcing money market funds to hold a certain percentage of securities to retain a fixed net asset value. Finally, the Federal Reserve, through the System Open Market Account, is also a major holder of Treasury securities. In early 2017, the Federal Open Market Committee (FOMC) announced that it will begin to normalize its balance sheet. Despite these regulatory changes and developments, Treasury market daily volume remained steady since 2010 at about $510 billion per day (Mnuchin and Phillips 2017).

Both U.S. and foreign holders have been able to absorb the increase in U.S. Treasury issues. As of 2016, China and Japan were the top two foreign holders of U.S. Treasuries owning a combined 38 percent while Belgium, Saudi Arabia, and Russia held an additional 5 percent (Arias and Restrepo-Echavarria 2016). The low long-term yield environment is likely a result of high foreign demand for U.S. Treasury securities rather than a "near-zero" federal funds rate (Chien and Morris 2017).

U.S. Government Debt and Gross Domestic Product

The origin of U.S. government debt started with the financing of the Revolutionary War. In 1775, Michael Hillegas became the first treasurer of the United States. The current treasurer, Jovita Carranza, advises the Mint and Secretary of the Treasury on U.S. coinage and currency production. U.S. government debt as a percentage of gross domestic product (GDP) can ebb and flow over time. During early 2018, U.S. government debt was about 100 percent of GDP. In comparison, Japan's government debt was about 250 percent of GDP, while Switzerland's government debt was approximately 30 percent of GDP. The debt-to-GDP ratio is a debated topic concerning a country's viability. The long-term implications are still not clear, but many variables should be considered. A country with a low debt-to-GDP ratio shows an ability to pay its obligations and is considered more solvent and sound. A country with a high debt-to-GDP ratio could be financing its growth. A high ratio could be beneficial because a country could be experiencing an economic boom with low unemployment, wage growth, and increased tax revenue for the government.

Size and Scope of the U.S. and Global Debt Market

Perhaps surprisingly, the U.S. debt market is about twice the size of the U.S. equity market. The approximate amount the U.S. bond market represents is $40 trillion whereas the market capitalization of the U.S. equity market is about $20 trillion. Since the financial crisis of 2007–2008, the appetite for debt has increased dramatically with developed world governments especially Japan, Greece, Italy, and the United States. More recently, both developing and emerging market countries have seen an increase in debt issuance by their governments. This may be because of low interest rates. In fact, the global debt surpassed $200 trillion in 2016 (Rabouin 2017).

Auction Process of Government Debt

The auction process of treasuries initiates the issuance of government debt. Buyers of these securities include individual and institutional investors both inside and outside the United States. Changing technology has improved how investors buy treasuries. For example, an online government system called Treasury Direct (2017) expedites the process. The Uniform Offering Circular (UOC) sets forth the standard and rules for Treasury securities.

A *primary dealer* is a firm that buys government securities directly from a government, with the intention of reselling them to others. Thus, a primary dealer acts as a market maker of government securities. U.S. primary dealers include the Bank of Nova Scotia, BMO Capital Markets, BNP Paribas, Barclays Capital, Cantor Fitzgerald, Credit Suisse AG, Daiwa Capital Markets, Deutsche Bank, Goldman Sachs, HSBC, Jefferies, JP Morgan Securities, Merrill Lynch, Mizuho Securities, Morgan Stanley, Nomura Securities, RBC, Societe General, TD Securities, UBS Securities, and Wells Fargo Securities. To become a primary dealer, registration is required along with completing legal, technical, and operational set-up. The U.S. government can regulate the behavior and number of its primary dealers and impose conditions of entry.

Buying treasuries involves two types of bids: competitive and noncompetitive. With a *noncompetitive bid*, a bidder agrees to accept the discount rate (or yield) determined at auction and is guaranteed to receive the full amount of the bid. With a *competitive bid*, a bidder specifies the yield that is acceptable to the open market. A bid may be accepted in a full or partial amount if the rate specified is less than or equal to the discount rate set by the auction. Once the auction closes, all noncompetitive bids are accepted, and competitive bids are ranked based on yield from lowest to highest. Competitive bids are accepted, starting at the lowest yield until the offering amount has been exhausted. The highest accepted yield becomes the "stop." A competitive bid is not accepted if the rate specified in the bid is higher than the yield set at the auction. Although interest payments received by successful bidders may vary based on the yield specified in their auction bids, all securities in an auction are sold for a single price, computed based on the "stop" yield (Driessen 2016).

Risks and Rating Agencies

The U.S. government has never defaulted on its debt. This fact implies a high quality rating (AAA or AA) from the rating agencies. On the other hand, South American countries, such as Brazil, could have a different quality ranking and be graded differently, earning a rating of BB. In this example, Brazil would have to offer a higher yield than in the United States to attract investors because of the uncertainty of paying its obligations.

- Standard and Poor's is one of the three major credit rating agencies (CRAs). Its credit ratings are from highest to lowest: AAA, AA, A, BBB, BB, B, CCC, CC, C, and D. Accordingly, the first four ratings are considered investment grade and the rest are speculative grade.
- Moody's credit ratings are: Aaa, Aa, A, Baa, Ba, B, Caa, Ca, and C. Similar to Standard and Poor's, the first four ratings are considered investment grade and the remainder are non-investment-grade.
- Fitch's credit ratings are: AAA, AA, A, BBB, BB, B, CCC, DDD, DD, D, and RD. The first four ratings are investment grade and the rest are speculative grade.

Investors should treat these ratings as a second opinion in addition to their own due diligence. Treating these CRAs as the sole source of ratings could be a costly mistake. During the financial crisis of 2007–2008, CRAs had certain products and fixed income vehicles graded as investment grade, when they should have been much lower. The end result was a major disaster in the mortgage-backed securities market. Although government debt was not the direct catalyst for the financial crisis, the rating agencies made errors in their credit rating. As a result, these CRAs lost a portion of their credibility for investors to use their ratings.

Defaults and Implications

A default by the U.S. government on its debt would have many severe repercussions. The value of the U.S. debt could fall, interest rates could rise drastically as investors would demand a higher yield for their bond because of uncertainty, and military and social programs may cease to operate. As previously mentioned, government bonds are debt obligations issued and backed by the government of a specific country. The country of origin is required to make periodic interest payments and to pay back the face value of the specific debt at the time of maturity. The currency of these bonds is generally the same as the currency of the country where they are issued. Because payment on these types of bonds is a legal obligation of the issuing government, the market generally views such bonds as free of repayment risk (Austin 2016). The reason is because market participants view all future promised currency amounts of bond coupons and principal as certain cash flows. The certainty of these cash flows is based on upon two attributes. First, the government has taxation and confiscation powers, which enable it to use the funds generated from taxation to pay back the outstanding debt obligations. Second, the government can access its central bank to provide financing. In theory, the central bank has unlimited resources because it can always create money to use to pay their debts (Giovannini and de Melo 1993).

Accumulating too much debt can be problematic. At some point both domestic and international borrowers may start to believe that the debt issued by a sovereign nation cannot be repaid. If these investors do not want to be exposed to this additional risk, they are likely to sell their government bonds. Excessive asymmetric bond sales relative to bond purchases would probably cause prices to decline and yields to increase. If a government issues additional debt, the interest rate is likely to increase. Issuing debt at higher interest rates makes borrowing for a sovereign country more expensive and can be problematic especially if a situation arises where investors are unwilling to buy the newly issued debt.

However, a country may occasionally fail to satisfy its obligations. Market participants often regard a failure to make timely payments on its outstanding debt as a primary indicator of default (Austin 2016). The implications surrounding a default can vary substantially based on the severity of the default or the anticipation of an event. If bond holders and/or investors anticipate that a government may be unable to repay it debt obligations, they may demand higher interest rates. The rationale is that they want to be compensated for the increased risk of the government issuing the bonds being unable to repay its debt. When market participants perceive the ability of a government to service its debt as being low, this situation can lead to increasing interest rates. A sharp increase in interest rates or an inability of a country to honor its outstanding bond payments can lead to a sovereign wealth crisis. For example, Greece defaulted on a $1.7 billion payment to the International Monetary Fund (IMF) on June 29, 2015. The government had requested a two-year bailout from lenders for about $30 billion, its third in six years, but did not receive it.

The severity of a sovereign debt crisis can become exacerbated when a country is heavily reliant on short-term treasury securities. This situation is due to the security mismatch between short-term debt obligations and the funds generated from a country's long-term tax base. Besides a maturity mismatch, countries may also be exposed to a currency mismatch that can be equally as damaging. A currency mismatch can occur when a country does not have many issued bonds available in its own currency. Thus, the government relives mainly on issuing bonds denominated in a foreign currency. Such reliance can create additional problems when the value of the home currency decreases and can increase the difficulty of paying back the foreign denominated debt (Eichengreen and Hausmann 2005).

A sovereign government can control its own affairs and cannot be forced to repay its debt. However, it faces intense pressure from other countries to honor its debt obligations and in some extreme instances this has led to war. Generally, when a country undergoes a default, it cannot issue additional treasury securities. It may face political pressure to repay its debt and may have its foreign assets and investments confiscated. To avoid these unfavorable outcomes, governments often seek to negotiate with existing bond holders rather than default on the entire value of their obligations. Negotiations can often lead to a debt restructuring or delaying underlying payments and or a partial reduction of debt. A partial reduction of debt is defined as a *write-off* or *haircut*.

Depending on the severity of the potential default, a country can proactively seek to renegotiate terms of its existing obligations. This situation is called an *orderly default* and can help address potential debt obligations sooner rather than later.

The IMF is an independent organization that conducts financial surveillance over the international monetary and financial system (Bossone 2008). Besides providing financial oversight, the IMF often helps to manage debt crises in the event of a sovereign default by a government (Ardagna and Caselli 2014). This process includes delivering the funds necessary to pay the remaining part of the underlying debt and/or to help to negotiate settlement terms among the outstanding debt holders. In some instances, funds or loans from the IMF include conditional terms to help ensure that recipients appropriately use the capital provided. Some of these stipulations include implementing austerity measures aimed at limiting public sector services provided by the government, raising taxes to increase funds available to service outstanding debt, and nationalizing a particular sector until the financial outlook improves. The decision to implement one or more of these conditions is predicated on the severity of the particular situation.

A recent example that highlights a sovereign default in which the IMF provided assistance involves Greece and the Eurozone crisis in 2010. Before 2010, Greece had access to low cost capital supported by liquid capital markets and investor confidence supported by the adoption of the Euro in 2001 (Nelson, Belkin, and Mix 2011). Investors were confident that the Eurozone eligibility requirements, a strong European Central Bank, and rules limiting country debt would help support the historically weaker European economies such as Greece.

As a result, the Greek government took advantage of these perceived benefits and amassed a substantial amount of government debt. Debt levels rose from 68 percent of GDP in 1990 to more than 100 percent in 2006. The Greek government did not use the increased capital from debt issuance to help increase the competitiveness of the economy, but instead used the funds to pay for government spending and to offset low tax revenue. In late 2009, a new elected Greek government discovered that previous officials had underreported the extent of the budget deficits.

Questions about the ability of the government to service these obligations began to circulate and foreign investors in Greek debt became disillusioned with the economic prospects of the country. The lack of investor confidence effectively shut Greece out from the capital markets and left the country unable to issue additional debt. Investor pessimism continued to escalate, and worries started to spread beyond Greece into other Eurozone countries such as Ireland, Portugal, and Cyprus. Fear and panic ensued, and many believed that these debt problems threatened to collapse the entire European banking system (Nelson, Belkin, and Jackson 2017).

These concerns forced the Eurozone governments and the IMF to extend financial support to Greece in terms of two assistance packages in 2010 and 2012 totaling 240 billion Euros. These sources distributed the funds in phases contingent upon fiscal and structural reforms such as lowering the percent of deficit relative to GDP. The European Central Bank (ECB) provided support by offering to buy bonds in the secondary market and cut interest rates to help spur economic growth.

Benchmarks

A *benchmark* is a standard against which financial metrics (returns, interest rates, etc.) may be compared and/or assessed. The following features of U.S. government bonds or treasuries enable them to serve as a market benchmark (Fleming 2000).

Safety

Market participants generally view government securities in most industrial countries as the most creditworthy borrowers (Wooldridge 2001). In the United States, the Treasury market serves as the primary means to finance the U.S. government. As direct obligations of the U.S. government, market participants view Treasuries as one of the world's safest assets (He, Krishnamurthy, and Milbradt 2016). This view allows Treasuries to be an investment benchmark for risk-free interest rates and to be used to analyze securities in other markets that contain default risk as well as to forecast economic developments (Fleming 2000). This characteristic allows the government yield curve to be widely regarded as the best proxy for the nominal risk-free rate.

Liquidity

Liquidity is a crucial characteristic of a benchmark. Information about fundamentals and not supply and demand imbalances should drive shifts in a yield curve. The large amount of government debt outstanding and the fungibility of issues facilitate trading. These characteristics allow government securities to be more liquid relative to other fixed income instruments. The most recently issued or "on-the-run" government securities tend to be the most liquid government securities. The U.S. Treasury market has sought to maintain a "fixed supply" of issues. This strategy has been very important in developing the liquidity of the trading instruments (Crandall 2000).

Maturities

Governments usually borrow funds over more durations than corporations or other institutions. As a result, governments issue debt over a wider range of maturities than non-government debt, which assists in the construction of yields curves.

Repurchase Agreements

Repurchase agreements, also called *repos*, are short-term loans secured by safe liquid collateral. A repo transaction is usually short-term in duration. It usually involves a borrower who agrees to sell a specific debt security to a lender and is obligated to buy the same security back from the lender at a pre-determined future date. At the time of the transaction, a borrower exchanges the debt for funds from the lender. A *repo rate* is the difference between the current price and the agreed upon price in the transaction. Repo transactions are fully collateralized and have lower rates than unsecured federal funds lending among banks. A *reverse repo* transaction is the opposite of a repo transaction. A lender buys a debt security and agrees to sell it back to the borrower on a future date at a price agreed upon by the borrower and lender (Saxton 2001).

The repo market is structurally quite large and relies primarily on Treasuries as the underlying financing security. In the current post-crisis era, total repo activity is estimated around $5 trillion and the outside value of securities on loan is believed to be just under $2 trillion (Baklanova, Copelan, and McCaughrin 2015; Mnuchin and Phillips 2017).

Derivatives

The market for Treasury derivatives is large and continues to grow. Market participants can gain access to these financial instruments via the Chicago Board of Trade (CBOT). Here, futures and options are listed for 2-, 5-, and 10-year Treasury notes and 30-year Treasury bonds. Additionally, the CBOT offers futures contracts on 13-week Treasury bills. In a futures transaction, a seller enters into an agreement to deliver a specific Treasury to the purchaser of a contract at a pre-determined date. To facilitate trading of futures, contracts are standardized and trade on a formal exchange. Futures traders generally close their positions before delivery and securities are rarely delivered. However, if delivery is made, the seller is allowed to choose among several eligible securities from the deliverable basket. Ideally, the seller seeks to buy the security that provided the lowest cost for delivery to the buyer of the futures contract. This contract is referred to as "the cheapest to deliver." The cheapest to deliver security is actively traded and is often more liquid than other Treasury securities. This security can often trade at a premium to similar Treasuries because of the contracts liquidity and demand from market participants. In certain circumstances, the cheapest to deliver contract can lead to distortions in the Treasury yield curve (Saxton 2001).

Another type of derivative contract offered on Treasuries is an option contract, which is based on Treasury futures. Options give the buyer the right, but not the obligation, to purchase a futures contract at a specified price. Futures trading can be volatile and result in losses. Investors can use options to mitigate some of these risks. Market participants can gain long or short Treasury exposure by electing to use options rather than futures contracts. They offer an alternative investment vehicle to help gain Treasury market exposure.

Call options give investors the right to buy a futures contract. Investors can use these options to speculate on whether the price of the underlying futures contract is likely to increase in the future. They can use put options if they anticipate that the underlying futures contract is likely to decrease in the future. Put options effectively lock in a sale price for the underlying futures contract. If the market moves contrary to the option holder's position, individuals can let these options expire.

Government Bond Uses

This section discusses using government bonds for various purposes. It begins by discussing the role of government bonds in price discovery and portfolio management. Other uses include hedging, position funding, speculation, and risk-return optimization.

Price Discovery

To help investors determine whether to borrow or to invest in a particular economy, capital markets should incorporate all available information about the future prospects of borrowers and the willingness of investors to take risks (Wooldridge 2001). This process becomes more efficient when participants agree on specific instruments to use as benchmarks. Historically, government yield curves have been the instrument of choice to properly assess the cost of funds at different borrowing horizons, offer price discovery about inflation, and other macroeconomic variables. U.S. Treasury securities play an important role in global finance as a risk-free benchmark to help establish how to price financial instruments (Mnuchin and Phillips 2017). The usefulness of a yield curve as a benchmark for price discovery about macroeconomic fundamentals depends on the determinants of the term structure (Woolridge 2001).

Portfolio Management

Market participants also use U.S. Treasuries to provide various portfolio management functions including hedging interest rate risk on other dollar-denominated debt securities, funding long-term investments, speculating on the future direction of interest rates, and optimizing the risk-return balance on portfolios. To help achieve all of these functions, Treasuries are supported by active repo agreements, futures, options, and a liquid cash market (Saxton 2001).

Hedging

To be a useful pricing or hedging vehicle, a hedging security should be highly correlated with the prices of securities in other markets. Treasury securities fulfill this definition. For example, an investor's loss in a long position in a correlated security could be offset by the investor's short position in Treasuries. Short positions are often used for hedging transactions and finding securities to borrow can often be problematic. The repo market helps facilitate hedging initiatives by enabling investors to borrow Treasury securities at a relatively low cost compared to other investment securities. Futures and options markets also offer other alternative vehicles for hedging transactions. Liquidity is often paramount in hedging activities. Due to the size of the Treasury market, investors who want to hedge can execute offsetting transactions at minimal costs (Fleming 2000).

Position Funding

Portfolio managers can also use the repo market to fund their long-term investments in Treasury securities. The repo rate is often below the federal funds rate because Treasury securities or other forms of debt collateralized repurchase agreements. In May 2018, the federal funds rate was 1.75 percent. The Federal Reserve signaled it expects to raise rates to 2 percent in 2018, 2.5 percent in 2019, and 3 percent in 2020 (Amadeo 2018).

Speculation

The Treasury securities and the derivatives products previously discussed can also be used as a means to speculate on future interest rate movements. Speculating on the direction of interest rates can be conducted using Treasury securities and their derivatives. For example, if an investor believes that long-term interest rates are likely to decline, the investor may elect to purchase $10 million of 10-year Treasury notes in the cash market using only $1 million of funds and financing the remaining $9 million of Treasuries to cover the purchase. Borrowing $9 million of funds in the repo market allows an investor to leverage potential returns by a factor of 10 or more. This leveraged principal can also be applied to Treasury futures traded on the CBOT. Here, investors can buy futures contracts on Treasury securities in anticipation that the price of Treasury securities in the cash market will rise above the price that they paid on the futures contract at the time of delivery (Saxton 2001).

Conversely, market participants can also position themselves if they believe long-term interest rates are likely to rise. For example, an investor could short $10 million of 10-year Treasury notes in the cash market, temporarily covering this position by reversing the notes in the repo market until the investor is ready or must buy the bonds sold short in the cash market. Investors could profit if bond prices fall between when they sold the bonds short and when they delivered the bonds (Saxton 2001).

Speculators can also use Treasury derivatives to bet on rising interest rates in the future. They can sell Treasury futures at the Chicago Board of Trade (CBOT), hoping the price of Treasuries in the cash market at the time for delivery falls below the futures price received by sellers. Alternatively, at the CBOT, speculators could buy put options on Treasury futures, hoping that the futures price falls below the strike price during the term of the option. Speculators may also sell call options on Treasury futures, hoping to collect the premium (Saxton 2001).

Risk-Return Optimization

Market participants usually consider U.S. Treasuries to be free of default risk, which enables them to optimize the risk-return of their portfolios. Treasuries provide both low and high-risk investors who elect to engage in short-selling the option to achieve their desired portfolio mix. Achieving a desired portfolio mix is enhanced by the extensive supply of these securities and the large size of the repo, futures, and options markets for U.S. Treasuries compared to other debt securities. These characteristics provide investors with the opportunity to short securities at a much cheaper cost.

Based on the capital asset pricing model (CAPM), a study concluded that the efficient portfolio risk-return frontier with and without Treasuries would require a nearly 1 percent rise in overall wealth to compensate all investors for the loss of Treasuries from the pool of all investment assets. In contrast, investors with higher risk tolerance who participate in short-selling would require more than a 5 percent increase in their wealth to be compensated for the loss of Treasuries (Saxton 2001).

Future Outlook

Public debt refers to the amount of debt the U.S. federal government has borrowed in the financial markets by issuing Treasury bills, notes, and bonds. Investment professionals and analysts often use total debt as a percent of GDP for comparative purposes. This ratio facilitates evaluating debt levels relative to different output, income, price levels, and populations. All of these factors help contribute to a government's ability to manage debt. Using a ratio of debt-to-GDP can be helpful when examining the sustainability of a country's budget (Chicago Board of Trade 2006).

The U.S. federal debt levels have increased dramatically since 2007. At the end of 2007, the ratio of debt as a percentage of GDP was 35 percent. Government policies and fiscal interventions in the economy caused the overall debt levels to grow considerably between 2008 and 2012. The ratio of debt-to-GDP doubled to 70 percent by the end of 2012. According to the Congressional Budget Office (CB0) (2017), government debt is expected to increase to more than 77 percent of GDP by the end of 2017. Historically, this level is concerning given that the United States has average a ratio of debt-to-GDP of around 40 percent between the 1960s and early 1980s. The only other time in history in which the United States has had higher relative debt levels was during World War II.

According to the Congressional Budget Office (2017), federal deficit levels could approach unprecedented levels if current spending patterns persist. Debt levels would continue to escalate due to the increasing gap between revenues and government spending. Based on the present trajectory, the CBO estimates that debt as a percentage of GDP could rise to 89 percent by 2027 and to more than 100 percent by 2035. The potential ramifications of increasing debt levels are severe. Specifically, the CBOT highlights the following: (1) decreasing income and long-term savings, (2) budget pressure due to the increased levels of debt interest costs, (3) limited capacity by elected officials to address tail risk and or unexpected events, and (4) a heightened probability of a future financial crisis

Summary and Conclusions

Government debt plays an important role among nations in both domestic and international markets. The U.S. government auctions Treasury securities to investors to finance and operate the government and has never defaulted on its debt payments. The main benefits of U.S. Treasuries are liquidity and safety. The U.S. Department of the Treasury helps in managing the country's balance sheet. Governments are likely to continue issuing debt to finance military spending, healthcare, infrastructure and other needs to help ensure a nation's safety and prosperity.

Discussion Questions

1. Identify the different types of U.S. Treasury securities.
2. Describe two types of auctions used for U.S. Treasury securities.
3. Explain several uses and benefits of U.S. Treasury securities.
4. List some consequences of governments increasing the debt level.

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Municipal Bonds

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Introduction

Municipal bonds are an important section in the bond market. Government entities including states, local governments, U.S. territories, and special authorities and districts issue municipal bonds to help finance capital projects. The size of this market has grown from $361 billion of outstanding municipal debt in 1981 (U.S. Securities and Exchange Commission 2016) to $3.83 trillion in the fourth quarter of 2016 (Reuters 2017).

A municipality rarely seeks bankruptcy protection, which reduces the risk of default and increases the chances of recovery in the event of default. Non-government municipal bond borrowers are not bankruptcy remote and their ability to declare bankruptcy creates additional risk for investors. However, municipal bankruptcies and defaults are quite rare, particularly for rated bonds. In fact, rated municipal bonds are less likely to default than comparably rated corporate bonds. For example, the average cumulative 10-year default rate for AA bonds is 0.02 percent for municipal bonds versus 0.78 percent for global corporate bonds. For BBB bonds, default rates are 0.40 percent and 3.93 percent for municipal bonds and corporate bonds, respectively (Moody's 2017).

Economic cycles affect municipal bonds. For example, bonds backed by fees from an entertainment venue are vulnerable to external economic circumstances, such as the health of the economy and consumer behavior. An additional attractive aspect of municipal bonds is that interest on municipal bonds is exempt from federal income tax and potentially exempt from state income tax as well. Similar to other fixed-income securities, municipal bond market prices have an inverse relation with interest rates.

History of Municipal Bonds

Conceptually, municipal debt first appeared during the early Renaissance period as Italian city-states borrowed money from wealthy banking families as one way to address deficits or finance government activities. The more structured and formalized municipal bonds that one would recognize today began in the early 1800s. In 1812, the City of New York issued the first recorded municipal bond to help finance a canal project. As other cities looked for the means to address deficits, municipal bonds became a frequent financing strategy.

As the United States entered an infrastructure boom after the Civil War, municipalities relied on municipal bonds to help finance large projects, such as the construction of railroads. In subsequent decades, the municipal bond market suffered various setbacks. One setback occurred during the 1930s Great Depression, when approximately 4,800 municipalities defaulted on principal or interest payments (Joffe 2012). As a result, governments began amending their constitutions to restrict the issuance of municipal bonds. Although such actions initially impeded the growth of the bond market, these checks and balances ultimately provided a more stable and reliable environment and the foundation for today's bond market.

In 1971, the introduction of municipal bond insurance provided an additional layer of security for investors. This insurance, which protected bond holders from any missed principal or interest payments, provided an even stronger foothold for the market, and paved the way for robust growth over the next four decades.

Municipal bonds are now part of the core financial strategy for many government entities. The public is often unaware of the large projects financed by municipal bonds such as the Golden Gate Bridge in the 1930s to the Denver International Airport in 1995.

Types of Municipal Bonds

Municipalities use municipal bonds to raise capital for various projects. Certain non-government entities, such as hospitals, schools, and airports, use conduit issuers to access the municipal bond market. Conduit issuers are usually semi-governmental authorities but, in some instances, a city can issue bonds for the direct benefit of a private issuer. Although the issuer is the legal entity enabling the sale, the borrower is the private entity that is obligated to repay the bonds (Oregon.GOV 2017).

Generally, long-term municipal bonds are structured to amortize over 20 to 30 years. Municipalities sometimes issue short-term bonds, also called *notes*, to help with cash flow mismatches or to fund project construction, expecting that long-term bonds will ultimately refinance the notes. Bonds and notes are normally issued in $1,000 units, but are sold in groups of five, so the smallest transaction would be for $5,000 of face value.

General Obligation Bonds

Municipalities typically use general obligation (GO) bonds to fund long-term projects managed by the government. When issuing GO bonds, the municipality is legally obligated to service the debt and provides an unconditional pledge to raise property taxes sufficient to repay the principal and interest. Issuers sometimes face statutory limits on tax rates that may be levied to service debt but in other instances issuers possess unlimited taxing power. Unlimited-tax GO debt carries less risk than limited-tax GO debt and is considered a better credit risk.

Revenue Bonds

Revenue bonds are a type of municipal debt whose interest and principal payments are usually contingent on having sufficient revenues from specific revenue sources. The interest payments on revenue bonds are also eligible for a federal income tax exemption. A traditional municipal entity or a government agency issuing on behalf of a municipality or private corporation may issue revenue bonds. Revenue bonds are secured by different sources than GO bonds. Although GO bonds can be repaid using any moneys available to the municipality, including various tax sources, revenue bonds usually rely on revenue from a specific project. As such, revenue bonds are perceived to exhibit increased risk and typically pay higher interest rates than GO bonds.

Circumstances dictate the relative strength of GO bonds over revenue bonds. A fiscally distressed issuer might have both GO bonds and revenue bonds outstanding. If a popular sports venue backed the revenue bonds, investors might prefer the dedicated revenue stream from a popular venue to the gamble that the issuer will successfully tax its way out of its fiscal difficulties. Conversely, a default on revenue bonds can cause a chain reaction and result in a subsequent GO default. Jefferson County, Alabama, serves as a good example of such an occurrence. In April 2008, the county's sewer revenue bonds went into default, followed by the GO bonds in September of the same year (Kristof 2012).

Infrastructure

Governments or authorities issue municipal infrastructure bonds to fund critical infrastructure such as water/sewer systems, transportation systems, and airports. Infrastructure bonds are frequently issued as revenue bonds, backed by certain specified fares or fees. In some scenarios, bonds issued by infrastructure systems such as transportation systems are actually backed by sales tax or other state revenues. In these cases, although the issuer sells the bonds, the rating for the bonds may be based on the credit rating of the state or on the likelihood the state will appropriate the revenues and that the issuer will ultimately be able to repay the bonds.

For example, the Metropolitan Transportation Authority (MTA), which is an authority created by of the State of New York, issues bonds backed by the MTA's revenues, but also has a class of bonds backed by several state fees that have no direct relation to the transportation system. Debt service on the state-backed bonds, called Dedicated Tax Fund (DTF) bonds, is paid from certain moneys transferred from the State. As such, the DTF bonds are rated based on the creditworthiness of the State of New York and not the credit rating of the MTA.

Sports

Dedicated revenue streams back certain municipal bonds such as a sports complex financed with bonds issued by public authorities. Assume a Major League Baseball franchise wants to relocate or move into a new stadium. Several cities may compete for that team by offering tax incentives or the opportunity to obtain better financing terms. A controversial question when cities compete for sports teams is how to fund the new complex and voters may reject taking on GO debt for the project. One option is for the city to issue revenue bonds, secured against the stadium leases and admission fees. If the city issues tax-exempt bonds backed by the revenues from stadium events, the team will receive its new stadium with a reduced cost of financing.

An early fraud case associated with municipal bonds involved the construction of a sports stadium in the town of Ramapo, New York. The voters rejected a plan to provide the town a guarantee to support the financing of a minor league baseball stadium. Undeterred by the voice of the people, the town board members legally formed a corporation, Ramapo Local Development Corporation (RLDC), issued $25 million in revenue bonds to finance construction of the stadium, and provided a town guarantee of the debt service payments. The stadium did not ultimately generate sufficient revenue to pay the principal and interest on the RLDC bonds. After using town funds to repay bond holders, town officials committed securities fraud by providing materially false statements about the ability of the RLDC to fund debt service payments from stadium operations and regarding the financial state of the town (Department of Justice 2017).

Tax Exemption

This section examines the tax-exempt status of municipal bonds and illustrates the after-tax yield and taxable equivalent yield calculations.

Tax Exempt

The two main types of tax exemption on municipal bonds are the exemptions to federal and state income tax. Tax-exempt municipal bonds provide interest income that is exempt from all federal income taxes. However, the value of the tax exemption varies. As the tax rate of an individual or corporation increases, so does the value of the tax exemption.

In most states, interest income from municipal bonds issued by an entity within that state is nontaxable, provided that the bondholder is a resident of that state. For example, if a Virginia resident had purchased a municipal bond issued by a state, local, or conduit issuer in the state of Virginia, interest income would be exempt from state income tax. However, if that same Virginia resident bought a bond issued by a municipality in another state, interest income would be federally tax-exempt, but taxed by the state of Virginia.

Alternative Minimum Tax

Traditional tax-exempt municipal bonds are exempt from the *alternative minimum tax* (AMT), an add-on to income tax that applies to certain households with substantial tax-exempt income. Private activity bonds (*PABs*) are municipal bonds issued to fund, and secured by, projects or property that are considered private business use. However, interest on certain PABs is considered income for purposes of calculating the AMT. Because certain investors are taxed on AMT bonds, a smaller group of investors receives the value of the tax exemption, which leads to depressed demand. As such, AMT bonds tend to pay higher interest rates and appeal to buyers not concerned with the tax exemption or less likely to pay the AMT.

Yield Calculations

Since investors keep all the interest income earned on tax-exempt bonds, an investor is willing to accept a lower yield on a tax-exempt bond than on a comparable taxable bond. If an investor in the 40 percent tax bracket buys a bond with an after-tax yield of 5 percent, the investor retains 60 percent of the original yield and earns an after-tax yield of 3 percent. An investor in the 40 percent tax bracket should therefore not discriminate between a 3 percent tax-exempt yield and a 5 percent taxable yield.

Equation 6.1 shows the after-tax yield calculation determining how much income is retained from a taxable bond.

$$\text{After-tax yield} = \text{Pre-tax yield} \times (1 - \text{Tax rate}) \qquad \textbf{(6.1)}$$

For example, 3 percent = 5 percent × (1 – 0.40) = 5 percent × 0.60. The taxable equivalent yield in Equation 6.2 dictates the minimum taxable yield that an investor should require in order to match a given tax-free yield.

$$\text{Taxable equivalent yield} = \text{After-tax yield} / (1 - \text{Tax rate}) \qquad \textbf{(6.2)}$$

For example: 5 percent = 3 percent/(1 – 0.40) = 3 percent/0.60.

Credit Considerations

Besides the traditional credit research issues such as the revenue/expense breakdown and an analysis of the issuer's long-term fiscal health prospects, a proper analysis of municipal bonds encompasses several additional factors including unique macro and financial risks. Macro risks are primarily comprised of economic and governance risks such as how well an issuer manages tax and revenue collection, Federal Reserve policy, and changes in tax rules or regulatory regime. Financial risks include credit, market, liquidity, operational, and legal risks. This section examines the issues of willingness to pay, the unique status of appropriation debt, and municipal bond structures.

Financial Analysis

GO bond issuers are frequently subject to strict debt limits, imposed by the state government or local voters, on the maximum par amount of GO debt issuance. To circumvent

GO debt limits, some municipalities issue bonds that are paid subject to appropriation. Appropriation-backed bonds saddle the issuer with a moral, but not a legal, obligation to pay debt service. At times, an issuer provides its appropriation pledge to lend credit support to a revenue bond. If the revenues prove insufficient, the issuer has a moral obligation to pay the debt service on the bonds.

In practice, an issuer usually pays debt service on all bonds, including moral obligation bonds. An issuer that defaults on a moral obligation bond is likely to suffer from a lack of market access for any type of future issuance. Any default is a sign of distress, or a lack of political will to live up to the issuer's commitments, signs that often drive away future investors. Thus, any short-term gain from default is almost assuredly offset by higher future borrowing costs. Additionally, the default on a moral obligation would likely result in a substantial downgrade of the issuers non-defaulted outstanding GO bonds, further limiting market access. For example, Moody's downgraded the city of Vadnais Heights, Minnesota, to junk status (Ba1) on September 5, 2012, after the city announced that it would cease to appropriate funds needed to support rental payments on the city's lease revenue bonds (Moody's 2012). Similarly, S&P has a maximum GO debt rating of BBB–, one notch above junk status, for any issuer that defaults on its appropriation debt, even though an issuer has no legal obligation to repay appropriation debt (S&P 2016).

Another important consideration is assessing the entity that actually drives the debt issuance decision-making of a given issuer. A state or other public entity may induce a related issuing entity to take on debt, which is not necessarily in the issuer's best interest. For example, an issuer may raise debt capital that indirectly provides funds to support unrelated state purposes or public policy goals. States frequently issue bonds against revenue-backed toll roads only to divert the resulting cash surpluses, generated by the extra debt issuance, to public transportation systems or other politically preferred projects.

For instance, the Triborough Bridge and Tunnel Authority (TBTA) owns the New York City network of tunnels and bridges. Although TBTA generates substantial toll revenue and the costs to operate a mature bridge and tunnel network are relatively minimal, the story is more nuanced. In 1968, New York State caused the TBTA to begin providing financial support for the Metropolitan Transportation Authority (MTA) regional transit services (New York Metro Transportation Authority 2008). TBTA still issues bonds backed by its own revenues and maintains very high coverage ratios. However, since excess TBTA resources are diverted to the MTA, TBTA does not have the expected reserve cushion based on its operating and debt profile.

Warning Signals

The warning signals for municipal bond issuers are similar to those of other debt issuers. If an issuer takes on too much debt, it may have difficulty repaying its obligations. If an issuer has increasing expenses without the concomitant ability to increase revenues, that too could result in major risk of future default.

A unique feature of municipal bonds is the degree to which politics, rather than business factors, create those risks. Local municipal governments can theoretically raise taxes and may even have the approval of their constituents to do so. However, a state usually exerts some degree of control over a local government's ability to raise taxes. The state can also offload expenses, even ones traditionally funded by the state, on local municipalities or saddle municipalities with new mandates. These risks are often unpredictable and beyond the control of an issuer.

For example, after the announcement of Governor Cuomo's 2018 "Countywide Shared Services Property Tax Savings Plan Initiative," a state requirement that New York State counties conduct certain cost-saving analyses, the New York State Association of Counties and county politicians enjoined Governor Cuomo to reduce state mandates. Opponents of the Initiative publicly stated that if Governor Cuomo wants to reduce county property taxes, he should go to the source of the problem, which they maintained was the substantial portion of a county's budget used to satisfy unfunded mandates passed down by the state government (National Association of Counties 2017).

Similarly, municipal codes frequently mandate using a unionized workforce, which is often not the best financial decision for an employer. Collective bargaining units drive compensation higher and an issuer may have limited ability to reduce the size of, or negotiate with, its workforce.

Another risk indicator for a municipal issuer is operating out of *structural balance*, a situation in which an issuer does not have enough recurring revenues to cover recurring expenses. Even if the issuer can balance the budget in a particular year through divestitures or other financing activities, the lack of structural balance may foreshadow trouble. Similarly, lack of sufficient reserves or lack of market access can set the stage for future financial problems. An issuer with these limitations is at increased risk of default, as a result of even temporary budgetary or timing problems.

Disclosure irregularities can also be a sign of impending trouble. Puerto Rican issuers had a reputation of stonewalling bankers attempting to conduct due diligence. Although a lack of disclosure does not always portend a default, it could indicate that the issuer is unaware of what is happening or is intentionally withholding information, and the investment community should interpret such behavior as a major red flag. In April 2017, shortly after the announcement that Puerto Rico expected to default on its outstanding debt, the Securities and Exchange Commission (SEC) preliminarily recommended that the Financial Institution Regulatory Association (FINRA) file an action against several bankers involved in Puerto Rico's March 2014 GO bond issuance (Braun 2017).

Another risk factor for municipal bonds is the lack of geographical diversity of the revenue base, so demographic trends can have an outsized impact on a municipality's fiscal health. For example, declining population in the city of Detroit resulted in excess housing capacity. As property values declined, investors purchased cheap properties in middle-class neighborhoods to rent to low-income people, which resulted in declining home ownership. Between 2006 and 2010, the home ownership rate dropped to 54.5 percent in Detroit compared to 74.2 percent in Michigan. Additionally, the city owned numerous parcels as a result of tax foreclosures. Between FY2007 and FY2012, the assessed value of residential property declined by 46.5 percent or $4.2

billion (Citizens Research Council of Michigan 2013). As a result of the lower income population, lower tax assessments, and disrepair, Detroit received dramatically reduced tax revenue. It lacked the ability to rapidly reduce municipal overhead costs, which contributed to the ensuing bankruptcy, the largest in municipal history (Forbes.com 2017).

High Yield

Various classes of municipal and private borrowers use high yield (HY) municipal debt. The following discussion includes two categories of HY debt and the two types of buy-side professionals who tend to invest in such debt.

High profile distressed issuers attract the interest of large, opportunistic hedge fund investors. These funds look for uncorrelated returns and are willing to invest in securities or issuers at or near default, if they believe an opportunity exists to collect in bankruptcy and the market is discounting these bonds too heavily. Alternatively, hedge funds may believe that their clout and/or lobbying abilities create or add value by enabling them to influence the outcome of bankruptcy proceedings. One recent example of this situation is Puerto Rico, which attracted investors willing to assume the substantial negative risk of going through a bankruptcy process along with the potential upside if the results fall in their favor.

The second category of HY muni debt is issued by smaller, riskier issuers. These bonds attract smaller buy-side funds or money managers. These investors tend to buy debt of the smaller, start-up issuers because it gives them the opportunity to use traditional investment analysis to generate alpha and because these smaller issuers garner less interest from the larger, more powerful investors. Examples include the senior living sector and charter school funding.

Disclosure in the senior living sector has improved in recent years, with many borrowers providing reliable monthly financial and operational updates. Additionally, buy-side analysts can provide added value by analyzing the financials and separating the stronger borrowers from the weaker ones. In the case of a senior living facility, a pre-construction bond might yield 7 or 8 percent. Upon the commencement of operations, the yield spread on that bond should compress, resulting in sizable price appreciation because the completed project is less risky and demands a lower yield. By picking winners pre-construction and holding them for several years, investors can achieve substantial capital appreciation and potentially earn much more than the generous stated yield of the bonds.

Charter school investments expose investors to additional risks not associated with some other HY muni investments. Much of the available disclosure is not audited and analysts frequently source critical operational metrics from the most recent annual report, which is rarely current and can be more than 15 months old. Experienced operators run many charter schools, so an investor can mitigate certain risks by investing with established operators. However, picking a bond issue based on the school having an experienced operator does not mitigate the political risk of the charter not being renewed.

One strategy implemented by some of the "smaller" investors is taking a major stake in smaller deals between $10 and $80 million. By holding much or all of the debt of a small charter school or senior living borrower, even these relatively small investors have valuable access to, and influence with, the borrower's senior management. This situation provides investors with a chance to help drive success, along with the opportunity to anticipate and address problems well before they become insurmountable.

Insurance and Credit Support

Before the financial crisis of 2007–2008, bond insurance was a frequent feature of municipal bonds. Bond insurance was designed as a way to make small, unknown, credits more similar to one another and more attractive to the buy-side by having them ride on the "coat-tails" of the insurance company and its credit rating. A bond insured by an AAA-rated insurer could theoretically be purchased without an investor doing any credit research. As a result, bond insurance opened up the market for large investors to buy bonds issued by otherwise overlooked small or lower rated issuers. In 2007, the municipal bond insurance penetration rate on new issues was 60 percent. Although issuance of municipal bonds backed by insurance dropped during and after the financial crisis, municipal bond insurance is making a comeback and was up to 6.4 percent in 2015 (Garruppo and Binkiewicz 2016).

A new municipal bond insurer, Build America Mutual (BAM), was founded in 2012. As a mutual company, BAM is owned by issuers and therefore has less of a pure profit motive than its competitors, which is similar in spirit to a credit union operating for the benefit of its members and not to earn a profit. Besides potentially offering lower rates, a mutual company has less incentive to engage in reckless behaviors exhibited by some of the profit-driven municipal bond insurers that contributed to the financial crisis.

From an issuer's perspective, an issuer should explore any factor that can reduce its borrowing costs. If the uninsured borrowing rate is 5 percent, and the insured borrowing rate is 4 percent, in theory the issuer should pay up to the 1 percentage point spread to insure the bonds.

Conversely, using bond insurance or credit support can also have negative implications for an issuer. If the credit quality of an insurer or credit support provider declines below the issuer's underlying rating, an insured issue can hypothetically be left with an impaired rating. The issuer may be unable to "fire" the insurer or credit support provider, which could make the issuer's bonds less attractive. This concern was most pronounced in the aftermath of the financial crisis when credit agencies downgraded bank providers of credit support after the banks provided letters of guarantee to municipalities issuing variable rate bonds. Although the municipalities had higher ratings than those of the banks, the banks would not relinquish their fiduciary duty to investors to stand behind their guarantees. This ultimately hurt the ratings on the municipal issues guaranteed by the banks.

Another risk of insurance is the potential for it to reduce the appeal with some sophisticated investors. Investors comfortable with an issuer's credit may prefer to buy identical uninsured bonds at the higher yield and may shy away from insured bonds.

Structuring

Municipal bonds have unique characteristics compared to other types of the fixed income. This section discusses the municipal version of level debt service, a way to contain the risk associated with variable rate debt exposure and the classic municipal "10-year par call."

Fixed versus Variable Rate Debt

Fixed rate debt has become the backbone of municipal finance. Municipal governments have a responsibility to protect the public interests and to avoid undue risk. When an issuer has fixed rate debt outstanding, public officials know the precise debt service and maturity dates, which helps with budgetary planning and ensures that issuers are not surprised by spikes in interest rates or due dates. Thus, fixed rate debt contrasts to certain types of short-term or variable rate debt, which exhibit changing rates and at times have uncertain maturity dates.

Nonetheless, variable rate debt has a place in the long-term strategic plan of municipal issuers. Over recent decades, the debt markets have experienced an *upward sloping yield curve*, which means that the rates on long-term debt have exceeded rates on short-term issues. Although the short end of the curve is much more volatile than the long end, other than temporary market dislocations, the short-term market has consistently provided issuers with more attractive (lower) rates than those provided by long-term markets. A stable issuer that consistently kept a portion of its debt in short-term instruments would have realized lower interest costs than an issuer exclusively exposed to the higher rates found further out on the curve. Nevertheless, many municipal issuers refrain from issuing short-term debt.

Municipal issuers can be largely insulated from the negative impacts of fluctuating rates by using variable rate debt as a hedge. Many issuers have a share of their assets in short-term instruments, such as demand deposits or certificates of deposit (CDs). These assets produce variable revenues from interest income, which fluctuate along with short-term interest rates. If an issuer wants to take advantage of the lower rates available on the short end of the curve, without risking negative budgetary and cash impacts that result from short-term interest rate volatility, that issuer should issue variable rate debt in an amount that corresponds to its short-term variable rate assets. For example, if an issuer has $100 million of short-term assets (e.g., demand deposits), that issuer can issue $100 million of variable rate debt, tied to the short end of the curve, without assuming material interest rate risk. An unexpected increase in short-term rates would result in additional interest expense that is likely to be at least partially offset by an unexpected increase in interest revenue from the short-term variable rate assets. An issuer using this hedging strategy can issue variable rate debt up to its amount of variable rate asset exposure, regardless of the size of the issuer's outstanding debt portfolio.

However, the issuer must understand and assume the basis risk inherent in this hedging strategy. *Basis risk* is the exposure to an imperfect hedge, when rates on corresponding portions of the hedge do not move in sync. Although short-term rates in different markets generally move in tandem, the magnitude of a change in the tax-exempt borrowing rate for municipalities may differ from that of a change in Treasuries or the particular rate the bank pays on demand deposits. Due to basis risk, a municipality employing this strategy will experience a gain or loss depending on the relative magnitude of the different rate movements.

Serials Bonds and Level Debt Service

Municipal bonds are normally issued with a level debt service structure, in which an increasing portion of the principal is paid off each year. In this way, level debt service for a municipal bond is structured similarly to a conventional amortizing fixed-rate mortgage. This structure is in contrast to most long-term bonds such as Treasuries and corporates, in which a security is structured to mature as a large bullet payment.

Among other benefits, level debt service ensures that debt is not incurred today and left to be entirely repaid by the next generation. Instead, the debt is slowly paid off, normally over the project's useful life. In a typical structure, the final maturity does not stretch beyond the project's useful life. For example, a bridge might be amortized over 30 or more years, whereas road repaving may be limited to a five-year term, depending on the particular project's useful life.

One important difference between level debt service found in a conventional mortgage and that of municipal bonds is that municipal bonds are generally issued as serial bonds. Each annual or semi-annual maturity is issued as its own bond, with a discrete yield, coupon, and call feature. A 20-year municipal bond issue might be comprised of 20 serial bonds, with maturities ranging from one to 20 years. The serial maturities are usually sold on the same day and structured so that, in aggregate, the entire series provides level debt service to the issuer.

When issuing serial bonds, the borrower is debundling the various maturities by enabling the buyer to pick any maturity along the yield curve and receive the appropriate yield. The serial bond structure can also affect an issuer's ability to execute *refundings*, which is municipal terminology for "refinancings," of outstanding callable bonds. Each serial bond has its own maturity date and coupon, resulting in a different calculus for each serial bond component of the larger series.

Call Option

Many fixed income instruments have a call option. An issuer may buy back a *callable bond* at a predetermined price on, and frequently after, a specified date before maturity. In the municipal bond sector, bonds normally have an optional 10-year par call. This arrangement enables the issuer to call the bonds if the issuer has excess cash or to refinance the bonds if interest rates decline. For example, if a 20-year bond is issued in 2020 with a 5 percent coupon and a 10-year par call, the issuer pays a 5 percent coupon annually for 20 years but has the option to repay the principal to the bond holders after 10 years. If rates drop to 4 percent, the issuer may choose to repay the 5 percent 2020s and reissue the bonds as 4 percent bonds (i.e., refunding).

An issuer may refund bonds for several reasons. Interest rates can decline for various reasons including general market movements, improvement in the issuer's credit quality, or bonds rolling down the yield curve. In a "normal yield curve environment," a bond with 20 years to maturity has a higher interest rate than one with 10 years to maturity. This structure is similar to a bank CD, where a five-year CD pays more than a one-year CD. For example, if in 2020 an issuer sells bonds with a yield of 5 percent set to mature in 2040, a 2030 refunding and reissuing of the 2040 maturity results in new 10-year bonds maturing in 2040. All else being equal, the newly issued 2040 maturity will have a lower yield.

Municipal Bond Investment Pros and Cons

Municipal bonds are an attractive investment class. Depending on the investor's tax situation, municipal bonds frequently yield more on a taxable equivalent basis. In certain states for the 2017 tax year, the combined top federal and state tax brackets came close to 50 percent of income, in which case a municipal bond yielding 2 percent would provide an investor with as much income as a corporate bond yielding 4 percent.

A municipality rarely seeks bankruptcy protection, which reduces the risk of default and increases the chances of recovery in the event of a default. Municipal bonds in some higher risk sectors, such as charter schools, certain hospitals and universities, and senior living facilities, can declare bankruptcy, and a bankruptcy could prove harmful to bond holders. However, bankruptcy is a rare occurrence, particularly for rated bonds. In fact, rated municipal bonds are less likely to default than comparably rated corporate bonds (Moody's 2017). Unrated bonds are still riskier and are sometimes unrated due their inability to gain a rating high enough to offset the cost of procuring the rating.

Municipal bonds are also partially insulated from certain business cycle risks assumed by corporate bond investors. If a company invests in a new product that turns out to be unsuccessful or has extreme competition that impairs its ability to raise prices, yields on the company's bonds can be affected. Municipal bonds have a more stable type of revenue with pricing power that enables them to raise revenue to cover debt service and other expenses.

Another argument for municipal bond investing is that the bonds have a built-in natural hedge—the tax rate. The value of a tax-exempt municipal bond increases as tax rates increase. If a corporate bond investor receives a 4 percent yield and is taxed at a rate of 25 percent, the investor would earn 3 percent after taxes and would require a 3 percent yield on a tax-exempt issue to achieve the same return. If tax rates increase to 50 percent, the corporate investor would only earn 2 percent after tax (given that 50 percent of the 4 percent yield goes to taxes) and would only require a 2 percent yield from a comparably risky tax-exempt issue. As such, an increasing tax rate would cause existing tax-exempt bonds to be more attractive and would drive up the price of outstanding tax-exempt issues.

The converse also holds: as tax rates decline, so does the value of municipal bonds. As an example, following the 2016 upset victory by Donald J. Trump, a candidate who promised major reductions in tax rates, tax-exempt borrowing rates went up and prices of outstanding tax-exempt bonds dropped. This situation was due to the expectation that lower tax rates would reduce the benefit of tax-exempt interest. Similarly, if a person moves into a higher tax bracket as a result of tax changes or personal circumstances, the after-tax yield on that individual's corporate bonds decreases (more money going to taxes), while the income on tax-exempt issues would not be affected. On December 22, 2017, President Trump signed the Tax Cuts and Jobs Act, which cut the corporate tax rate from 35 percent to 21 percent beginning in 2018. The top individual tax rate drops to 37 percent beginning in 2018 (Amadeo 2018).

In contrast, tax-exempt municipal bonds are a less attractive investment when the tax exemption provides little value. If an investor is in a low tax bracket, corporate bonds provide better value because nominal yields on corporate bonds are much higher than rates on tax-exempt issues. Similarly, an investor with a tax-sheltered account would generally benefit from higher yielding taxable issues. As such, conventional wisdom suggests using taxable securities in tax-sheltered retirement accounts.

Hot Topics

Pension Bonds

Defined benefit pension plans largely disappeared from the corporate landscape due to the massive exposure of companies' uncertain investment yields and the increasing lifespan of the population. Nevertheless, in many instances government employees are still provided with such pensions. When the pension plans are not funded on an ongoing basis, liabilities continue to grow and governments look for creative ways to provide funds for the expected pension liabilities.

State or local governments issue pension obligation bonds (POBs) to remedy underfunded pension obligations. With a POB, the government normally issues GO debt to provide funds for the underfunded pension plan.

The underlying assumption of a POB issuer is that the pension fund investments earn more than the debt used to secure the capital. If a government issues POBs at 5 percent and invests its pension assets in instruments yielding 10 percent, the issuer achieves a rate of return greater than the interest rate owed on the bonds. Nevertheless, issuing POBs can be very risky for the same reason present in any levered strategy. An issuer who places borrowed monies in a fund that does not earn the POB borrowing rate or loses money is worse off than if the money had never been borrowed and invested. For example, the State of New Jersey borrowed money in 1997 to help fund the pension deficit. Although returns on pension assets were robust for the first two years, subsequent subpar returns generated years of losses (Mansnerus 2002). Another example involves Stockton and Orange County, California, that used pension bonds to capitalize their pension funds (Hofmeister 1994). Like the State of New Jersey, both California municipalities subsequently suffered losses in the value of pension fund assets (Christie 2012)

Public-Private Partnerships

Municipal governments shoulder the responsibility of providing much critical infrastructure. The private sector can sometimes operate more efficiently and at times assist governments in reducing risk. In recent years, public-private partnerships provoked much conversation due to their ability to reduce risk and generate abuse.

Public-private partnerships (PPP or P3) are another option for municipal or infrastructure issuers. Engaging the private sector creates alternate options in the various steps and components of public projects. In a *P3*, the private sector takes over some aspect of a project's design, build, or operation and may also secure private sector financing.

In a typical *P3* transaction, the government entity (sponsor) transfers portions of a project's return and its risks to a private operator. In exchange, the private operator receives certain contractual payments from the sponsor and/or the right to some portion of revenues that result from the project. The contractual payments or "availability payments" are tied to the project's availability and require that the project be maintained in a particular manner, typically specified in the contract.

The goal of a P3 transaction should be to transfer risk to the private sector or reduce risks and expenses by engaging a more specialized and experienced (private) developer or operator. A bridge that costs $1 billion to construct will not necessarily become materially less expensive by engaging a private-sector designer or builder or by using private sector financing. However, if the private entity had a particular expertise in a unique aspect of this particular bridge or is willing to provide a price lock that reduces the governmental entity's exposure to cost or time overruns, then the P3 may be beneficial. Similarly, private sector financing is not necessarily less expensive. Private sector entities are usually entitled to equity-like returns, which translates into a higher rate of return than the return on traditional debt financing.

At times, a municipality lacks the political will to increase taxes or fees to support an infrastructure asset. In those scenarios, the municipality may choose to transfer the asset to a private operator that will raise user fees. The asset costs money to build and the higher rates are to compensate one or more of the stakeholders for their upfront or ongoing investment in the project. For this reason, when rates go up following a P3 transaction or the transfer of a public asset to a private sector operator, the P3 did not cause the rate increase. Rather, the increases result from either the inherent cost involved in building or maintaining the project, or the cost to compensate the private entity for the upfront or ongoing payments made to the municipality.

To recap, distinguishing between using private sector firms or capital and the project's actual funding is essential. A road or sewer system that requires funds to operate still requires funds in a P3 scenario. If the government lacks the political will to provide the funds or charge user fees, the project will go unfunded, irrespective of the public/private status of the builder, operator, or financing permutations. Moreover, if the government entity receives upfront or ongoing payments from the private sector entity, these payments will almost certainly necessitate additional revenue generation, which typically results in higher user fees. An example of a P3 that drove an increase in user fees was the 2013 plan by the Port Authority of New York and New Jersey to improve bridges connecting New York and New Jersey. The project received substantial funding from private sector capital and the private sector investors are and will continue to recoup their investment via portion of the toll increases. (Port Authority of New York and New Jersey 2013)

Types of Bond Sales

The two primary ways to sell municipal bonds are through a negotiated and a competitive sale. A *negotiated sale* involves the selection of a bank or banks, often through a request for proposal (RFP) process, to distribute the bonds. Bonds sold at a competitive sale are put out to bid; the issuer announces the sale and any relevant parameters, after which one or more banks bid on the bonds.

In a *competitive sale*, banks compete for the right to buy either the entire deal or a particular *tranche*, which is piece of a larger deal and can include one or more serial bonds. The deal or tranche goes to the highest bidder. In theory, a competitive sale provides an issuer with the lowest yield/highest price the market will bear on the day of sale because the bids are typically blind (i.e., unknown to any other bidder), and each bank submits its best bid. In fact, some states require their component municipalities to sell all ordinary deals competitively.

Negotiated sales are typically used for more complicated deals. In a *negotiated sale*, a bank is selected and essentially hired to underwrite the deal for a fixed price per bond. In exchange for this consideration and for the exclusive right to market the bonds, the bank/syndicate pre-markets the bonds and helps the issuer attain broader distribution. If the deal does not receive a favorable reception on the day of pricing, the bank or syndicate also agrees to underwrite, essentially buying any "unwanted" bonds.

One downside of a competitive sale is that the winning firm does not know it will be marketing the deal unless and until it submits the highest bid and wins, which limits the ability of the ultimate winner to premarket the deal. To mitigate the risk of being unable to distribute the bonds, a bank may submit a lower bid than would be otherwise indicated, which translates into a higher yield for the issuer. In contrast, in a negotiated deal, the bank's compensation is fixed ahead of time. The bank gets paid if it sells the bonds, even if the bonds are sold for a higher yield/lower price than the bank originally guaranteed. Moreover, in a negotiated deal, the spread must be large enough to compensate the originations team (i.e., investment bankers), above and beyond compensating the bank for the risk inherent in any deal.

Negotiated sales are most appropriate when an issuer needs additional help with distribution or where an issuer wants to generate attention and ideas from investment bankers. If an issuer believes a deal may not be properly understood or accepted by the market, it is worthwhile to have a bank premarket and sell the deal, even though the issuer incurs the fees associated with a negotiated transaction. Additionally, bankers are most interested in providing ideas to issuers that issue debt via negotiated sales. If an issuer wants bankers to "pay attention" and provide the issuer with ideas and advice, the issuer should maintain a reputation of completing at least some deals via negotiated sale.

Summary and Conclusions

Municipal bonds enable municipalities to raise capital for long-term investments in critical infrastructure and other projects. This objective is usually accomplished by issuing general obligation or revenue bonds. GOs are secured against the taxing authority of the entity whereas revenue bonds are secured against the future revenue resulting from the project. An important benefit enjoyed by municipal bond investors is the tax exemption on municipal bond interest income. The tax exemption, coupled with the lower credit risk vis-à-vis corporates, makes municipal bonds an attractive investment for both investors in high tax brackets and investors just looking to diversify or reduce their exposure to corporate credit risk.

Nevertheless, municipals have their own set of risks such as political risk and potential price volatility resulting from macro tax changes. In the monumental 2017 tax cuts of the Trump administration, a higher standard deduction and limited deductibility of state and local taxes may reduce the ability of high tax jurisdictions to continue to raise taxes, which could ultimately lead heavily indebted issuers to experience difficulties repaying their debt.

Municipal bonds can be structured with fixed or variable interest rates. With fixed rates, debt service payments are predictable and do not change over time. Municipalities can also issue variable rate debt, which usually provides an issuer with reduced debt service. However, variable rates give the borrowers less predictability and can cause fiscal troubles for municipalities, especially those with limited reserves. Municipal borrowers can reap the benefits of issuing debt at the short end of the curve, while avoiding much of the potential risk, by issuing variable rate debt in an amount that corresponds to the issuer's variable rate assets.

Discussion Questions

1. Discuss the circumstances under which an issuer needs to repay municipal bonds.
2. Discuss two ways that municipal debt can be structured.
3. Explain the benefits of investing in municipal bonds.
4. Discuss the pros and cons of public-private partnerships.

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7

Corporate Bond Markets

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Introduction

Corporate bond markets are financial markets in which long-term bonds are issued and then bought and sold in secondary markets. The long-term nature of the bonds distinguishes bond markets from *money markets*, which are markets in which financial instruments with short maturities usually ranging from overnight to just under a year are traded. Corporate bond markets enable corporations to raise external funds, often to fund growth projects. Because undertaking growth projects is an important driver of firm value (Myers and Majluf 1984), corporate bond markets play a vital role in helping managers maximize firm value.

According to the Securities Industry and Financial Markets Association (SIFMA) (2019), outstanding corporate debt in the U.S. markets totaled about $9.2 trillion as of the third quarter of 2018, while the total amount of outstanding debt in the U.S. markets was about $42.3 trillion. Corporate debt is about 22 percent of the total amount of outstanding debt, while Treasury and mortgage-related debt represent about 36 percent and 23 percent, respectively. SIFMA also reports that the total amount of outstanding corporate debt in the U.S. markets has increased each year from 1980 to 2017.

Although firms cannot always finance growth projects from internal funds (i.e., retained earnings), Myers and Majluf (1984) posit that firms prefer to do so. They further postulate that, should the need for external funding arise, firms broadly prefer to issue debt before equity. Myers and Majluf also contend that firms prefer debt financing to equity financing in part because stock prices typically fall when a firm announces that it plans to conduct a *seasoned equity offering* (SEO), which is any issuance of equity after the initial public offering (IPO).

Corporate bond markets also allow firms to signal their value. This signaling feature is important because it creates a separating equilibrium that allows more valuable firms to distinguish themselves from less valuable firms (Ross 1977). To arrive at this finding, Ross relaxes the assumption of Modigliani and Miller (1958) that investors have perfect information about a firm's future opportunities and hence its value. A common assumption is that managers possess superior information compared to shareholders and signal the value of their firms. Ross finds that the corporate debt markets provide a mechanism for managers to signal that value.

Ross (1977) maintains that the signaling mechanism works because debt requires managers to allocate a portion of the firm's cash flows to repaying interest and principal otherwise the firm could end up in bankruptcy. Only firms that can service the interest and principal payment are likely to borrow, creating a separating equilibrium between more and less valuable firms. This credible threat of liquidation dissuades less valuable firms from trying to mimic the issuance pattern of more valuable firms.

Corporate bond markets also allow firms to build a reputation as a solid borrower, defined as one that repays its debts on time and in full. Diamond (1989) provides a rational basis for the view that, over time, borrowers with strong credit histories act to maintain their reputational capital. Those borrowers do so by eschewing excessively risky projects and taking on projects that are incentive-compatible. These actions lead to developing a strong credit rating. Furthermore, carrying debt allows firms to receive a tax benefit, allowing them to deduct interest payments for tax purposes (Miller 1977).

Although the aforementioned benefits to carrying debt exist, issuers also incur costs. Perhaps the greatest threat associated with debt is the cost of bankruptcy. As Modigliani and Miller (1958) note, along with the tax benefits of debt, the threat of bankruptcy increases because firms need to allocate cash to repay the debt. Thus, as a firm's debt-to-assets ratio increases, its bankruptcy risk also increases. This idea is the basis of the family of trade-off theories that suggest the existence of an interior solution that maximizes the benefits of debt subject to the costs of debt. The earliest trade-off theory is credited to Modigliani and Miller (1963) who include corporate taxes into the original Modigliani and Miller (1958) framework and showed the tax-shielding benefits of debt. Later, Kraus and Litzenberger (1973) introduce off-setting bankruptcy costs and formalize the trade-off theory. However, Miller (1977) asserts that the bankruptcy costs of debt are trivial relative to the large tax benefits of debt. A second cost associated with debt is the erosion of a firm's credit rating due to the inability to repay its debt.

Types of Corporate Bonds

Although most corporate bonds are similar in that they pay interest semi-annually, different types of corporate bonds are also available. However, before discussing corporate bonds, an important observation is that even the safest corporate bond is riskier than U.S. Treasury debt because all corporate bonds involve default risk. Unlike Treasury debt, corporate bonds are not backed by the full faith and credit of the U.S. government. This feature of corporate bonds means that holders of corporate bonds might not receive full repayment of interest and principal if the firm becomes insolvent or files for bankruptcy.

Secured bonds are bonds that are backed by specific collateral. Thus, if a firm becomes insolvent, secured bondholders receive the collateral as repayment of the firm's debt. Clearly, receiving the collateral is contingent on its availability assuming that less-subordinated borrowers do not claim the collateral beforehand. If one party's bond contract stipulates that it is to receive cash payments or collateral before another party, the latter party holds subordinated debt relative to that of the former party. In other words, the former party holds unsubordinated (more senior) debt relative to that of the latter party.

Secured and less-subordinated bonds, respectively, reduce a bondholder's risk by offering collateral as a potential substitute of repayment and by increasing a bondholder's position in the payment hierarchy that exists if the firm goes bankrupt. In that case, bondholders can claim the firm's assets as repayment based on a hierarchy determined by whether their debt is subordinated or unsubordinated relative to that of other bondholders. Unsecured bonds are not backed by collateral and thus do not offer any potential substitute of repayment for the bondholder. If the company becomes insolvent, unsecured bondholders can only hope that enough funds remain after more senior bondholders receive their debt repayments. If no funds remain, the unsecured bondholders suffer a loss.

The aforementioned bonds are assumed to be *plain vanilla bonds*, which signify the most basic or standard version of a bond. Other bonds include option-like features, making those bonds potentially very different from plain vanilla bonds. One type of bond with an option-like feature is a *callable bond*, which is a bond that the issuer can buy back (i.e., "called") at a specified call price before maturity. With callable bonds, the issuing firm has the option (i.e., the right but not an obligation) to call the bond based on a pre-determined call schedule.

The call feature is valuable to firms to potentially reduce their coupon payments. For example, if market rates were high when a firm issued callable debt but subsequently fell, the firm might want to eliminate the higher coupon payments by invoking the call provision in the bonds. Since bondholders must relinquish callable bonds if the firm calls the bonds, a chance exists that bondholders might not receive all coupon payments over the bond's stated maturity. Thus, callable bonds are issued with higher coupon rates relative to plain bonds of the same issuer. Perhaps the most salient reason that callable bonds have higher coupon rates is that they face higher reinvestment rate risk relative to plain vanilla bonds. If a bond is called and if investors want to reinvest the proceeds in a new bond, that new bond might not pay the same coupon rate as the originally issued bond.

A second type of bond with an option-like feature is a *puttable bond*, which is a bond that gives the bondholder the option to retire a bond. Holders of puttable bonds exercise their put option when market rates for bonds of similar quality are high. By putting the bonds in this scenario, bondholders can reinvest the principal into bonds that pay a coupon rate equal to the current higher market rate.

A third type of bond with an option-like feature is a *convertible bond*, which is a bond that gives the bondholder the option to convert the bond into stock at both a specified conversion ratio. Holders of convertible bonds rationally exercise their conversion option when the underlying equity price has increased substantially so that the market price exceeds the conversion price by a sufficient margin.

Bond Issuance Process

When corporations seek to raise debt capital, they rarely, if ever, deal directly with the capital markets. The reason is that most corporations are not financial services firms and thus do not have the required expertise to conduct a bond offering. For that reason, corporations use the services of at least one investment bank. If the firm uses more than one investment bank, the issuing firm is said to use a *syndicate*.

The bond issuance process is similar to the equity issuance process. First, the firm needs to decide whether the bond offering will be a private placement or a public offering. If the firm decides on a private placement, the debt securities do not need to be registered with the U.S. Securities and Exchange Commission (SEC). However, the firm still needs to decide whether it wants its debt to be traded among institutions. If so, the debt issue will be subject to Rule 144A, which is a SEC rule modifying a two-year holding period requirement on privately placed securities to permit qualified institutional buyers to trade these positions among themselves.

Investment banks are required to underwrite Rule 144 private debt placements, and the banks must use firm-commitment offerings, just as the banks are required to underwrite public offerings of debt under a firm commitment. Under a *firm-commitment offering*, the investment bank buys the debt securities from the issuing firm. At this point, the issuing firm has received the proceeds of the offering and exits the process. The investment bank bears the risk of placing the securities with qualified institutional investors in hopes of selling the offering in full and generating a profit.

Although the process of issuing privately-placed or public debt has some similarities, key differences exist in the characteristics of firms that tend to place debt privately versus issue debt publicly. Private placements are generally conducted by mid-sized firms that are not as well-known as the large, well-recognized firms that issue debt publicly. Not surprisingly, private placements often offer higher yields to attract investors but have less liquidity.

Bond Prices and Market Interest Rates

Malkiel (1962) observes five key aspects involving bond behavior.

- *Market interest rates and bond prices move in opposite directions.* In other words, as market interest rates rise (fall), bond prices fall (rise). This relation, called *interest rate risk*, is perhaps the key relation between a bond's price and the market interest rate. As discussed later in this chapter, bond managers need to protect the value of their bond investments from movements in market interest rates. In academic and industry parlance, bond managers need to immunize or at least reduce the sensitivity of their bond investments to changes in market interest rates.
- *Directional changes in a bond's yield to maturity (YTM) generate asymmetric changes in a bond's price.* That is, a given increase in a bond's YTM generates a price decrease of a magnitude that is less than the magnitude of the price increase associated with a decrease in YTM of the same amount. An alternative interpretation is that bond prices increase (decrease) at an increasing (decreasing) rate as the YTM decreases (increases). This observation is a key property of bond convexity, which is discussed later in this chapter.

- *The sensitivity of a bond's price to changes in market interest rates increases with the maturity of that bond.* That is, ceteris paribus, bonds with a longer life are more sensitive to interest rate changes than bonds with a shorter life. The reason is simply that long-lived bonds are exposed to market forces for a longer period of time, meaning that more shocks can occur to market interest rates, which affect bond prices. This observation leads to the next key aspect of the behavior of bond prices.
- *As a bond approaches maturity, its price sensitivity to changes in the YTM decreases.*
- *Bond prices that have high coupon rates are less sensitive to changes in interest rates than bonds with low coupon rates.* Along similar lines, Homer and Leibowitz (1972) also observe that the price of a bond with a higher yield to maturity (YTM) is less sensitive to changes in the YTM than a bond with a lower YTM.

Estimating Changes in Bond Prices

Given the inverse relation between market interest rates and bond prices, the value of a bond portfolio falls when market rates rise. Two common complementary measures exist to estimate the change in the price of a bond portfolio for an increase in market interest rates: duration and convexity. The key difference between duration and convexity is that the former is a linear approximation of a bond's price change whereas the latter is a curvilinear approximation.

Several measures of duration are available. One measure, called *Macaulay duration*, is defined as the weighted-average time to maturity of a bond. Another common measure is *modified duration*. Macaulay duration is computed using Equation 7.1, which first appeared in Macaulay (1938).

$$\text{Macaulay duration} = 1\times w_1 + 2\times w_2 + 3\times w_3 + \text{L} + N\times w_N \tag{7.1}$$

The coefficients refer to the period during which a bond makes a payment. Each w_i equals the present value of the i^{th} cash payment divided by the bond's market price. Thus, each w_i is weighted by the time at which the i^{th} payment occurs.

To illustrate, suppose that an investor has a three-year, 5 percent bond with a par value of $1,000 and a YTM of 5.5 percent. The nondiscounted coupon payments are $50 in each of the first two years and $1,050 in the third year. The discounted values of those payments are $47.39, $44.92, and $894.19, respectively. Summing those values yields $986.50, the bond's market price. The first weight, w_1, is computed as $47.39/$986.50, which is 0.048. Similarly, w_2 and w_3, respectively, are 0.046 and 0.906. Thus, multiplying each w_i by the appropriate coefficient according to Equation 7.1 yields a Macaulay duration of 2.858 years.

Since the bond makes coupon payments, its Macaulay duration is less that its life, which in this example is three years. The bond's life is not shortened to 2.858 years. A Macaulay duration of 2.858 years is a theoretical (not actual) measure of the bond's life in terms of the timing of its cash flows. Although not shown, another important feature of Macaulay duration is that, for zero-coupon bonds, the Macaulay duration and the life are equal.

Analysts use duration to approximate the percentage and dollar changes in a bond's price. To approximate the percent change in a bond's price for a given change in market rates involves using Equation 7.2.

$$\text{Percent change in price} \approx \text{Duration} \times (\Delta(1+\text{YTM}))/(1+\text{YTM}) \qquad (7.2)$$

Equation 7.2 can also be written as Equation 7.3:

$$\text{Percent change in price} = -\text{Modified Duration} \times (\Delta\text{YTM}) \qquad (7.3)$$

To illustrate, suppose that the YTM of the same bond above increases from 5.5 to 5.6 percent. The change in YTM is 0.1 percentage point and is written as 0.001 as a decimal. Thus, the percent change in price is (−2.858)(0.001)100, or −0.2858 percent. The negative sign indicates that an increase in YTM results in a decrease in the bond's price.

In Equation 7.3, modified duration equals duration divided by (1 + YTM). Also, for reasons that are straightforward, Δ(1 + YTM) simplifies to the term ΔYTM. In Equations 7.2 and 7.3, the percentage change in the bond's price is estimated. Estimating the dollar change simply involves multiplying the estimated percent change in price by the bond's current price.

Importantly, the Macaulay duration of a firm's assets relative to that of its liabilities is related to profitability. Samuelson (1945) finds that a firm incurs losses when interest rates rise but experiences gains for a decline in interest rates, if the duration of a firm's assets is greater than the duration of its liabilities.

Although duration is a technique used to linearly approximate the percentage and dollar price changes of a bond, convexity is a technique used to quadratically approximate those changes. Equation 7.4 accounts for convexity in estimating the percentage and dollar changes, included in Equations 7.2 and 7.3, using the term "½ Convexity (Δ in market rate)," where

$$\text{Convexity} = \left[\frac{1}{price(1+YTM)^2}\right]\left[\sum_{i=1}^{n} CF_i \frac{(i^2+i)}{(1+YTM)^i}\right]$$

Thus, the equation including convexity is stated below.

$$\text{Percent change in price} \approx -\text{Modified Duration} \times (\Delta\text{YTM}) + \tfrac{1}{2}\text{Convexity}(\Delta\text{YTM})^2 \qquad (7.4)$$

To illustrate using the previous bond, the term in the first set of brackets is {1/[\$986.50 × (1.056)^2]}, which equals 0.000909. Moving to the second set of brackets, the first term is \$50(1^2 + 1)/(1.056), which equals 94.697. The second term is \$50(2^2 + 2)/(1.056)^2, which equals 284.091. Similarly, the third term equals 10,699.877. Thus, the convexity of the bond is 10.071. When adding the term in quotes above to Equation 7.3, the percent change in the bond's price when accounting for convexity is −0.2858 + ½ × 10.071 × 0.001), which is −0.2808.

Protecting Bond Value from Interest Rate Movement

A common technique for protecting a bond's value from interest rate fluctuations is *immunization*, a method developed by Redington (1952). When immunizing a bond portfolio, the duration of the asset is set equal to the duration of the liability to be incurred, and the optimal weights for investing at the present time ensures that the liability is fully funded. To illustrate, suppose that a new year has just begun and a pension plan is obligated to pay out $20 million at the end of the year. If the market rate of interest is 8 percent, then the present value of the outlay is $20 million/(1.08) = $18,518,518.52. How should the firm fully fund this obligation if it uses zero-coupon bonds and perpetuities that pay annual coupons?

Solving this problem requires setting the duration of the asset equal to the duration of the liability. Given that the liability consists of only one payment and comes due in one year, its duration is one. The next step is to find the asset's duration. Because the asset portfolio consists of zero-coupon bonds and perpetuities, let x be the weight of funds invested in the zero-coupon bonds and $(1 - x)$ be the weight of funds invested in the perpetuities. The duration of a zero-coupon bond is always equal to its maturity (here, one year), and the duration of a perpetuity is $(1 + i)/i$, which becomes 1.08/0.08 = 13.5. Thus, the duration of the asset portfolio is $(1)(x) + (13.5)(1 - x)$. Setting the duration of the asset portfolio equal to the duration of the liability yields $x = 1$. This solution means that 100 percent of the present value of the liability (i.e., the entre $18.5 million) should be invested in the zero-coupon bonds. In situations in which a liability is to be incurred beyond one year, x is typically less than one, indicating that a fraction of funds should be invested in both the zero-coupon bonds and perpetuities.

Yield Curve

The *yield curve* is a graph of the YTMs of bonds from the same issuer or multiple issuers with the same credit rating against their respective times to maturity. Accordingly, YTM is plotted on the vertical axis and time to maturity is shown on the horizontal axis. Time to maturity is often referred to as "term." Thus, the yield curve depicts the term structure of interest rates.

Typically, longer-term bonds offer higher YTMs, suggesting an upward-sloped yield curve, but the yield curve can be relatively flat, humped, or inverted (downward or negative sloped). An upward-sloped yield curve is considered normal because investors rationally expect to receive higher yields when their funds are tied up longer in investments. A *flat yield curve* is one in which the yield for all maturities is approximately equal. In a *humped yield curve*, yields increase with maturity for a range of maturities and then the yield curve becomes inverted. An *inverted* or *negatively sloped yield curve* occurs such that the longer maturity bonds have lower yield (Fabozzi 2007).

Various theories exist to explain the shape of the yield curve. Two of those theories—the expectations theory and the liquidity-preference theory—are discussed in this section. *Expectations theory* states that the shape of the yield curve is determined exclusively by expected short-term bond yields. To illustrate, assume that the current YTM on a one-year zero-coupon bond is 5 percent and that the market expects the one-year rate next year to increase to 8 percent. What does this information imply about the YTM on a two-year zero-coupon bond? The given information means that investing \$1 today would become (\$1)(1.05)(1.08) = \$1.134. Thus, the two-year zero-coupon YTM would need to be the interest rate i that solves $(1 + i)^2 = (1.05)(1.08)$, or approximately 6.5 percent.

In this example, the market believes that short-term interest rates will increase from Year 1 to Year 2. In general, if the market expects the one-year rate in Year_{n-1} to increase in Year_n, an upward-sloping yield curve will result. If the market expects the one-year rate in Year_n to decrease from its Year_{n-1} level, a downward-sloping yield curve will result.

Another important theory of the term structure of interest rates is the *liquidity-preference theory*, which asserts that the upward-sloping nature of a yield curve is due, in part, to investors' preference to hold assets that are more liquid, which in this case is short-term bonds. Compared to long-term bonds, short-term bonds are more liquid because they tie up investors' cash for a shorter period. Thus, liquidity-preference theory claims that investors demand a liquidity premium, which results in a higher YTM when the premium is added to the existing YTM to hold long-term bonds.

Credit Ratings

Tables 7.1 through 7.4 contain the short- and long-term issuer rating categories for Moody's Corporation, Standard and Poor's (S&P), Fitch, and Dominion Bond Rating Service (DBMS). These companies are the four Nationally Recognized Statistical Ratings Organizations (NRSROs) in the United States. Moody's, S&P, and Fitch are the "legacy" credit rating agencies, meaning that they have a longer presence in the market than DBMS. In 2003, the Security and Exchange Commission (SEC) certified DBMS as the nation's fourth NRSRO.

Empirical evidence suggests that managers pay close attention to their firms' credit ratings, underscoring their importance. A survey conducted by Graham and Harvey (2001) finds that credit ratings are the second most important concern for managers when determining capital structure. The authors find that almost 60 percent of chief financial officers (CFOs) consider credit ratings important or very important to capital structure decisions. According to Kisgen (2006), firms that are on the cusp of a credit rating upgrade or downgrade tend to issue less debt than other firms.

Consistent with these empirical findings, Kisgen (2009) finds that firms reduce their debt-to-asset ratios after a downgrade of their credit rating. The author suggests that managers seek to keep their firms' credit ratings above a minimum level instead of a particular debt-to-assets ratio. That is, Kisgen suggests that managers target credit ratings, not capital structure.

Table 7.1 **Moody's Corporation's Issuer Credit Rating Categories and Definitions**

Short-Term Rating	Description
P-1	Prime borrower, superior ability to repay debt
P-2	Prime borrower, strong ability to repay debt
P-3	Prime borrower, acceptable ability to repay debt
NP	Sub-prime borrower, not categorized in any level above
Long-Term Rating	**Description**
Aaa	Highest quality, subject to lowest level of credit risk
Aa	High quality, subject to very low credit risk
A	Upper-medium grade, subject to low credit risk
Baa	Medium grade, subject to moderate credit risk and may thus have certain speculative characteristics
Ba	Speculative, subject to substantial credit risk
B	Speculative, subject to high credit risk
Caa	Speculative of poor standing, subject to very high credit risk
Ca	Highly speculative, likely in or very near default with some prospect for recovering principal or interest
C	Lowest-rated, typically in default with little prospect for recovering principal or interest

This table contains short- and long-term bond rating categories for Moody's and the definitions of those categories. The ratings are listed in descending order of borrower quality.

Source: Moody's.com (2017).

Despite the importance of credit ratings to the financial markets, research suggests that credit ratings are not always accurate. Credit ratings are typically too high in part because rating agencies are systematically optimistic about the ability of corporate borrowers to repay their debts (Mason and Rosner 2007; Skreta and Veldkamp 2009; Bolton, Freixas, and Shapiro 2012). Another reason that credit ratings are typically too high is that borrowers can "shop around" for the most favorable credit rating. This rate shopping is perhaps the main issue with this model, known as the "issuer pays" model. An issuing firm wanting to borrow funds can shop around if a credit rating agency proposes a rating with which the issuing firm is not pleased.

In contrast, the "investor pays" model works as its name suggests—investors pay credit rating agencies for ratings firms. Since investors pay, an advantage of this model is that issuing firms cannot shop around for the most favorable rating. However, a disadvantage is that the issued rating is unlikely to be made public. The investor who pays for

Table 7.2 **S&P Corporation's Issuer Credit Rating Categories and Definitions**

Short-Term Rating	**Description**
A-1	Strong capacity to meet financial obligations
A-2	Satisfactory capacity to meet financial obligations
A-3	Adequate capacity to meet financial obligations
B	Vulnerable with significant speculative characteristics; issuer has the capacity to meet obligations but faces major issues that could make it unable to meet financial obligations
C	Vulnerable to nonpayment that would result in being downgraded to SD or D rating; repayment of obligations depends upon favorable business, financial, and economic conditions
R	Under regulatory supervision due to financial condition
SD and D	Issuer receives SD (selective default) or D (rating) when it has failed to meet at least one of its obligations. Issuer could also receive D rating if S&P Global Ratings believes that the issuer will default on the vast majority or all obligations.
NR	Not rated

Long-Term Rating	**Description**
AAA	Extremely strong capacity to meet financial obligations
AA	Very strong capacity to meet financial obligations
A	Strong capacity to meet financial obligations but riskier than firms rated AAA or AA
BBB	Adequate capacity to meet financial obligations, but that capacity could weaken under adverse economic conditions or other circumstances
BB, B, CCC, and CC	Borrowers in this category have significant speculative characteristics. Borrowers in the BB group are the least speculative.
R	Under regulatory supervision due to financial condition
SD and D	Issuer receives SD (selective default) or D (rating) when it has failed to meet at least one of its obligations. Issuer could also receive D rating if S&P Global Ratings believes that the issuer will default on the vast majority or all obligations.
NR	Not rated

This table contains short- and long-term bond rating categories for S&P and the definitions of those categories. The ratings are listed in descending order of borrower quality.

Source: Standardandpoors.com (2017).

Table 7.3 **Fitch Corporation's Issuer Credit Rating Categories and Definitions**

Short-Term Rating	Description
F1	Strongest capacity to meet financial obligations in a timely manner relative to other issuers in the same country
F2	Good capacity to meet financial obligations in a timely manner relative to other issuers in the same country
F3	Adequate capacity to meet financial obligations in a timely manner relative to other issuers in the same country
B	Uncertain capacity to meet financial obligations in a timely manner relative to other issuers in the same country; that capacity is strongly subject to short-term changes in the overall economy or the financial markets.
C	Highly uncertain capacity to meet financial obligations in a timely manner relative to other issuers in the same country; that capacity depends solely on favorable, sustained changes in the overall economy or the financial markets.
RD	Issuer has defaulted on at least one financial obligation but is meeting others.
D	Issuer either has defaulted or is on the brink of default.

Long-Term Rating	Description
AAA	Strongest capacity to meet financial obligations in a timely manner relative to other issuers in a country; lowest default risk relative to other issuers in nation.
AA	Strong capacity to meet financial obligations in a timely manner relative to other issuers in a country; very low default risk relative to other issuers in nation.
A	Strong capacity to meet financial obligations in a timely manner relative to other issuers in the same country; low default risk relative to other issuers in nation but more susceptible to macro-level changes than AAA or AA firms.
BBB	Moderate default risk relative to other issuers in nation but more susceptible than firms rated A, AA, or AAA to macro-level changes.
BB	Elevated default risk relative to other issuers in nation but more susceptible than higher-rated firms to macro-level changes.
B	Significantly elevated default risk relative to other issuers in nation but more susceptible than higher-rated firms to macro-level changes.
CCC	Very high default risk relative to other issuers in nation.
CC	Default risk is among the highest for issuers in nation.
C	Issuer is close to, or has already begun, default.
RD	Issuer is deemed to have defaulted on at least one obligation but is not bankrupt.
D	Issuer is in default.

This table contains short- and long-term bond rating categories for Fitch Corporation and the definitions of those categories. The ratings are listed in descending order of borrower quality.

Source: Fitchratings.com (2018).

Table 7.4 **DRBS Issuer Credit Rating Categories and Definitions**

Short-Term Rating	Description
R-1 H	Highest capacity to meet financial obligations in a timely manner; highest credit quality.
R-1 M	Very high capacity to meet financial obligations in a timely manner; superior credit quality.
R-1 L	Substantial capacity to meet financial obligations in a timely manner; good credit quality.
R-2 H	Capacity to meet financial obligations in a timely manner is on the high end of adequate; acceptable credit quality.
R-2 M	Capacity to meet financial obligations in a timely manner is adequate; acceptable credit quality but could be affected by economic or financial factors.
R-2 L	Capacity to meet financial obligations in a timely manner is on the low end of adequate; acceptable credit quality but could be affected by economic or financial factors.
R-3	A capacity exists to meet financial obligations in a timely manner; lowest level of acceptable credit quality.
R-4	Uncertain capacity to meet financial obligations in a timely manner; speculative credit quality.
R-5	Highly uncertain capacity to meet financial obligations in a timely manner; highly speculative credit quality.

Long-Term Rating	Description
AAA	Strongest capacity to meet financial obligations in a timely manner; highest credit quality.
AA	Strong capacity to meet financial obligations in a timely manner; superior credit quality.
A	Substantial capacity to meet financial obligations in a timely manner; issuer has satisfactory credit quality but is more susceptible to macro-level changes than AAA or AA firms.
BBB	Acceptable capacity to meet financial obligations in a timely manner; issuer has adequate credit quality but is more susceptible than higher-rated firms to macro-level changes.
BB	Uncertain capacity to meet financial obligations in a timely manner; issuer has speculative and non-investment-grade credit quality.
B	Reasonably high level of uncertainty regarding the capacity to meet financial obligations in a timely manner; issuer has highly-speculative credit quality.

Table 7.4 **Continued**

Long-Term Rating	Description
CCC, CC, and C	Danger of default exists; very highly-speculative credit quality.
D	Issuer has missed at least one interest or principal payment, has stated that it will miss at least one more payment, and/or has engaged in a distress exchange.

This table contains short- and long-term bond rating categories for DRBS and the definitions of those categories. The ratings are listed in descending order of borrower quality.

Source: eiopa.europa.eu (2014).

the rating does not want to allow small investors to free-ride on the information content of the credit rating. As a result, small investors are at an informational disadvantage because only the paying investor has access to the rating.

An important example of this over-optimism about borrower solvency occurred in the personal finance markets leading up to the financial crisis of 2007–2008, when the prime market for structured finance products, specifically, mortgaged-backed securities (MBSs), collapsed. After the ensuing discussion of the role of consumer credit in the financial crisis, the focus of this chapter resumes on corporate credit ratings.

Traditionally, financiers were careful to separate prime debt from sub-prime debt. *Prime debt* is issued to the most creditworthy borrowers with the lowest risk of default (i.e., prime borrowers). Sub-prime debt has several definitions. One definition is that *sub-prime debt* includes all debt issued to nonprime borrowers, regardless of the closeness of those borrowers' credit rating to the prime rating. Another definition of sub-prime debt is arbitrary and is based on having a credit rating below an endogenously-chosen level such as BBB. This action ensured that prime mortgage securities consisted solely of prime-rated debt, making investors confident of the quality of their investments. However, leading up to the financial crisis, financiers bundled sub-prime debt with prime debt and sold them as prime-rated securities. Investors, who were oblivious of this practice, bought the securities as if they consisted of only prime debt. As borrowers became insolvent, fewer investors received interest and principal payments. Because the type of debt at issue here was a MBS, borrower insolvency meant that people could not afford their homes. Compounding this issue was that some borrowers who could pay their mortgages chose to strategically default if the value of their homes fell below the value of the amount borrowed.

Although the financial crisis involved MBSs, not corporate debt per se, the crisis is relevant to the corporate debt markets because credit ratings exist in both the personal mortgage and corporate markets. In the personal mortgage markets, some loan officers worked with potential borrowers to misrepresent the true ability of the latter group to repay its debts (predatory lending). Part of the incentive for loan officers to engage in this behavior was competitive pressure. If potential borrowers could not obtain a loan from one bank, another bank was willing to satisfy that demand, even if borrowers mispresented their financial position, which is called *predatory borrowing*. This feature is also relevant to corporate debt markets because shopping around also exists in the corporate debt markets, as potential corporate borrowers can request a credit rating from a second lender if they are dissatisfied with the credit rating from a first lender.

Bolton et al. (2012) investigate possible reasons for the collapse of the structured finance market. The authors specify a model that reflects competition among credit rating agencies. Although they present a duopolistic model of the credit ratings industry, the authors model the realistic feature of the ratings process that credit rating agencies rate firms higher than they deserve to be rated, with the goal of attracting more rating business. After all, firms pay the credit rating agencies for ratings ("issuer pays" model) and the payment involves a fee when a rating is issued as well as a fee each year that a debt issue is outstanding. Thus, rating agencies have an incentive to provide a "favorable service" to their clients by issuing favorable credit ratings so as to attract repeat business. If the client firms are dissatisfied with a given rating, they can shop around for a more favorable rating.

Bolton et al. (2012) also model the realistic feature that certain groups of investors could put too much trust in observable credit ratings. Informed investors realize that credit ratings could be inflated, whereas uninformed investors assume the ratings are accurate. The authors also consider the willingness of rating agencies to preserve their reputation. Rating agencies suffer a reputational penalty if the issuer does not repay a debt issue for which they gave a high rating (i.e., goes into default). Furthermore, Bolton et al. consider a distinct barrier to entry into the credit ratings business—namely, the SEC's NRSRO designation. The SEC awards that designation to rating agencies that it believes offer useful ratings for the purpose of making investment decisions.

According to Bolton et al. (2012), a duopoly model, which involves some degree of competition, albeit imperfect, in the credit ratings industry, is less efficient overall than a monopoly model. They explain this result by arguing that the practice of shopping around for a favorable credit rating is the primary driver. Shopping around allows firms to obtain the most favorable credit rating, and the agency that issued such a rating tends to retain its customers as long as the ratings continue to be the most favorable. Also, uninformed investors take the credit ratings as accurate, leading to high returns for the sophisticated investors who know otherwise.

These results are based on a one-period model. Next, Bolton et al. (2012) extend their model to two periods to allow for a rating agency's reputation, which is formed during the first period, to carry over into the second period. They find that a duopolistic model of the credit ratings industry is still less efficient that a monopolistic industry. Their results apply to both the personal mortgage and corporate markets.

Focusing solely on the corporate bond markets, Becker and Milbourn (2011) examine the impact of adding a third credit rating agency—Fitch—to the short list of major players in the ratings industry. Before the emergence of Fitch, S&P and Moody's dominated the credit ratings industry. The authors find that Fitch's emergence as a major competitor to S&P and Moody's is associated with an overall lower quality of ratings from S&P and Moody's. Specifically, they find that credit rating levels increased but that the predictive power of ratings with respect to default decreased. Becker and Milbourn attribute their findings to reputation in that increased competition from Fitch reduces the willingness of credit rating agencies to issue accurate ratings.

Although this explanation has merit, other researchers examine whether the reputational effects that motivate credit rating agencies to generate accurate ratings always do so uniformly. Bar-Isaac and Shapiro (2013) tackle this issue and find that the strength of those reputational effects fluctuates over the business cycle. They find that the strength of reputational effects moves inversely with the business cycle. The authors also find that rating agencies issue lower-quality ratings during economic booms. Bar-Isaac and Shapiro contend that rating agencies behave in this manner because of cost considerations. In boom times, rating agencies are required to pay more to hire top credit ratings analysts. Also, because firms seek debt capital at the lowest cost (i.e., interest rate) during boom times to seize growth opportunities, rating agencies realize that firms need high ratings. As a result, rating agencies issue inflated credit ratings, which likely translate into repeat business. The risk of issuing inflated ratings is low. As Becker and Milbourn (2011) note, corporations rarely default on their outstanding debt.

Kisgen and Strahan (2010) document evidence of the impact of DBMS in the debt markets. As previously mentioned, DBMS was the fourth NRSRO, after Fitch. The authors find that bond yields move positively with ratings issued by DBMS, particularly when its ratings are higher than those of other NRSROs. Kisgen and Strahan find that, when a firm's DBMS rating improves by one notch, the firm's cost of debt capital decreases by 39 basis points. The lower cost of debt capital makes debt even more preferable relative to equity for fund-raising purposes.

Taking a different vantage point, Manso (2013) provides a logical basis for the view that issuing optimistic credit ratings is rational. Noting that rating agencies are frequently vilified for not downgrading ratings quickly enough, the author presents a model that considers bi-directional feedback associated with credit ratings. One of the most important implications of his model is that, when issuing credit ratings, agencies should consider both the accuracy of the rating and the potential effect of a relatively low rating on the client firm's financial well-being. Manso also shows that a firm can immediately default on an issue if a rating agency downgrades that firm's rating. Thus, he suggests that credit rating agencies should be slow to downgrade credit ratings because doing so too quickly can affect an issuer's solvency.

Manso (2013) also shows that competition among firms in the credit ratings industry can actually lead to rating downgrades. This implication conflicts with the aforementioned research documenting that competition in the credit ratings industry provides an incentive to rating agencies to downgrade ratings slowly. According to Manso, the accuracy that comes with rating downgrades comes with costs; firms default on outstanding debt more often and welfare suffers.

The aforementioned analyses are set in issuer-paid settings of credit ratings. Xia (2014) examines the effect of the entry of an investor-paid ratings agency on ratings quality. Founded in 1995, the Egan-Jones Rating Company rated almost 35 percent of U.S. firms that S&P rated in almost 60 industries as early as 1999. In 2007, Egan-Jones became a NRSRO. Xia finds that S&P's ratings quality improved after Egan-Jones started to rate the same firms as S&P. He also finds that the information content of S&P's ratings of those firms is more accurate and that S&P more frequently updates its ratings to reflect changes in credit risk.

Government Regulation and Bond Market Liquidity

As previously mentioned, the financial crisis of 2007–2008 led to the Great Recession in the United States but spread to many countries around the world. Perhaps the main difference from prior recessions was that the losses of individual investors were not confined to paper losses in the stock and bond markets. Along with paper losses, many individual investors either could not afford their homes or chose to default on their mortgages if the appraised value of their homes was below their mortgage balance.

Several factors led to this crisis. Some homeowners took loans that they knew they could not repay. Additionally, banks and underwriters assisted those homeowners in "no documentation" loans (or in extreme cases of forging loan applications) so that they could qualify for prime-rate home loans although many borrowers were sub-prime customers.

To reduce the likelihood of similar occurrences in the future, Congress passed the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (Dodd-Frank). Dodd-Frank proposed several preventive measures. One such measure was to limit the risks that financial institutions, including banks, could take. Another measure was to increase monitoring of financial institutions. A third measure was to increase the reserve requirement for financial institutions. The implications of this provision, termed the *Volcker Rule*, were profound. Increasing the reserve requirement meant that commercial banks had to hold more of their assets in cash. In turn, banks had fewer funds available to invest in marketable securities or lend out. As a result, the ability of banks to fulfill the role of market maker was limited, meaning that liquidity would be reduced and that less-liquid corporate debt markets were in danger of collapsing. Not only would prospective buyers have greater difficulty finding sellers, but perhaps more importantly, prospective sellers would have greater difficulty finding buyers. Going a step further, Blackstone Group CEO Steven Schwarzman believes that this situation could actually cause a future financial meltdown. Several notable finance professionals, including Schwarzman, former Treasury Secretary Larry Summers, Carl Icahn, and J.P. Morgan Chase CEO Jamie Dimon are leading an effort to encourage Congress to roll back the liquidity restrictions in Dodd-Frank.

After banks slashed their inventories of corporate bonds, that market appears to have re-attracted investors. Bloomberg reports that, as of July 6, 2016, investors had invested $2.9 billion in U.S. investment-grade as well as high-yield corporate bond exchange-traded funds (ETFs) during the prior week. Yet, Abramowicz (2016) maintains that the infusion of cash does not signify a rebound in the corporate bond market but rather a settling of that market based on comparable investment alternatives.

Summary and Conclusions

Corporate bond markets have trillions of dollars of outstanding debt. They are important to corporations because they provide a source of funds for managers to invest in growth projects designed to maximize shareholder value. Some bonds are plain vanilla while others have embedded options. Several relations exist between a bond's price and the market interest rate. Perhaps the most important relation is that bond prices and market interest rates move in opposite directions. As market rates increase, bond prices decrease and vice versa.

The yield curve is a graphical representation of the YTMs associated with different times to maturity. Typically, the yield curve is upward-sloping, implying that yields increase with the time to maturity. However, a yield curve can be flat, humped, or inverted.

Duration and convexity are used to estimate the change in a bond's price for a given change in the bond's YTM. Duration provides a linear approximation of a price change while convexity provides a curvilinear adjustment. Duration is used along with immunization to protect the value of a debt obligation from changes in the market interest rate.

Credit ratings are important because they are the transmission channel through which investors learn about the creditworthiness of firms that want to borrow funds. However, credit ratings are often too high because of over-optimism and the ability of firms to shop around for the best rating. These features existed in the personal mortgage markets and contributed to the financial crisis of 2007–2008.

Discussion Questions

1. Discuss several common types of corporate bonds and their features.
2. Identify the key relation between a bond's price and the market interest rate.
3. Discuss several ways to estimate the change in a bond's price.
4. Describe how to protect a debt obligation's value from interest rate movements.
5. Discuss the importance of credit ratings to firms and investors.

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8

Securitized Debt Markets

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Introduction

The importance of global securitized debt markets can be gauged by their size, which have been estimated to be about $10.4 trillion as of early 2018 (Morgan Stanley 2018). Of this amount of outstanding debt, roughly 86 percent is estimated to represent the U.S. securitized debt market.

This chapter explores securitized debt instruments by focusing on their characteristics and various benefits and costs to participants in this market, followed by details of the different types of securitized debt instruments. The terms "securitized debt" and "structured debt" are used interchangeably in the marketplace. Accordingly, this chapter does not draw any distinction between the two terms and treats them as substitutes. The chapter begins by discussing the characteristics of securitized debt. Next, it explains various types of securitized debt products and then discusses recent developments in the non-U.S. securitized debt markets. The final section offers a summary and conclusions.

Characteristics of Securitized Debt

Securitized debt instruments have three main characteristics:

1. The primary source of payments on the instruments is the cash flow from the pool of assets supporting the debt instrument. These assets are typically financial assets that pay a periodic interest and/or principal payment.
2. Cash flows from the underlying assets are paid out or distributed to the securitized debt investors in a predetermined, specific manner. Senior investors in the securitized debt are typically paid before more junior investors.
3. The *credit risk* of the securitized debt, which is the risk of nonpayment of promised interest or principal to the securitized debt investors, is limited to the credit

risk of the underlying asset pool and separated from the credit risk of the originator of the assets.

How Securitized Debt and Secured Lending Differ

Borrowers are typically required to post collateral when taking a loan. Lenders take security over some assets of the borrower to limit their losses in case of nonpayment or default. Mortgage loans or auto loans, for instance, have the property or the vehicle attached to the loan as security thus enabling the lender to sell the collateral and use the proceeds to recoup its loan.

Lenders cannot always liquidate the borrower's assets to recover their claims. In many jurisdictions, insolvency laws allow companies that are facing cash flow constraints or general financial difficulty to reorganize under bankruptcy protection laws. The main reason for the existence of such laws is due to public policy objectives, such as prevention of job loss or adverse spill-over effects on related businesses such as the firm's suppliers. For example, Chapter 11 of the U.S. Bankruptcy Code prevents a firm's creditors from enforcing their claim, unless permitted by a bankruptcy court. A typical provision in these laws permits suspending payments to creditors giving time for the borrower to improve its financial health. Thus, even though a loan is typically secured by collateral, lenders may have difficulty in practice enforcing timely payment on their loans due to existing provisions of the bankruptcy laws.

Securitized debt, however, is structured in a way that minimizes the risk of a moratorium or automatic stay on due payments by a borrower. This situation is achieved by legally isolating the assets in a way that they are "ring-fenced" (protection of assets) from bankruptcy laws. The specific manner in which a securitization transaction is structured to achieve the goal of legally isolating the collateral assets depends on the relevant jurisdiction and commercial laws applicable to the transaction. The most common means of achieving this separation is to structure the securitization transaction as a legal sale of assets by the originator to a special purpose entity (SPE), also known as a special purpose vehicle (SPV) that is arranged to be distant from bankruptcy. In other words, the SPE is unlikely to enter formal bankruptcy proceedings due to a combination of its jurisdiction and limited business activities. The SPE then uses the legally purchased assets from the originator, typically financial assets, as the collateral for issuing the securitized debt. Investors in the securitized debt can liquidate the SPE's assets in the event of nonpayment of a promised interest or principal payment.

Figure 8.1 shows the basic mechanics of the securitized debt transaction. At the initiation of the transaction, the SPE issues securitized notes (i.e., *tranches*), and uses the proceeds to invest in a portfolio of financial assets, i.e. the *collateral pool*. The financial assets produce cash flow streams in the form of interest and principal payments. In the event of an asset defaulting, instead of an interest or principal collection, a one-time cash flow may occur in the form of a recovery amount on the defaulted asset. These cash flows are, in turn, used to service the liabilities of the SPE (i.e., make interest and principal payments to investors of the securitized notes).

The procurement of assets by the SPE from the originator should constitute a "true-sale" so that, in the event the originator enters into bankruptcy proceedings, the sold

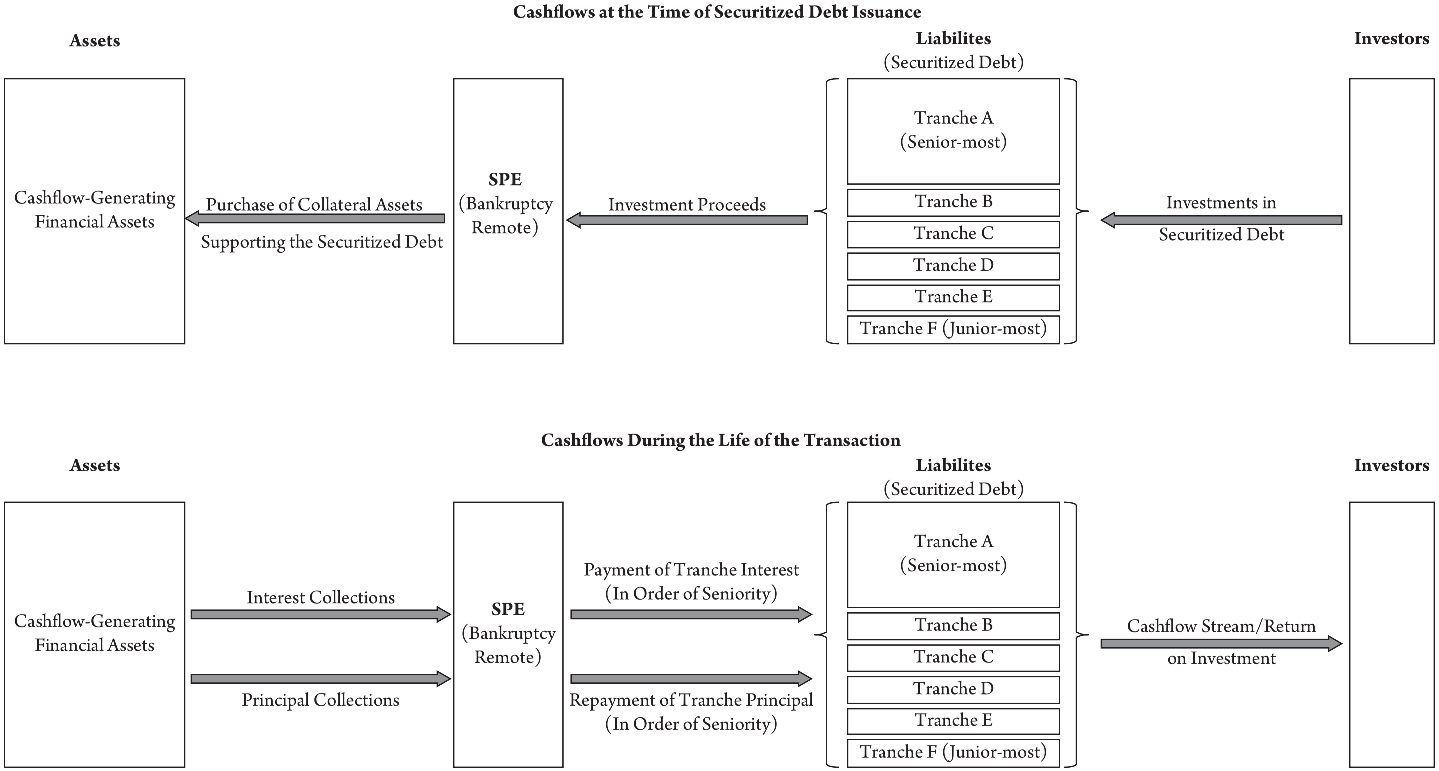

Figure 8.1 A Simplified Securitized Debt Transaction Structure
This figure shows the transaction structure of a simple securitized debt obligation. The figure explains the cash flows both at the time of the securitization and during the life of the transaction.

assets are deemed not to belong to the originator in a court of law. Achieving bankruptcy remoteness is thus a key goal of structuring the securitized debt in the form of an SPE.

Securitization Benefits to the Originator

The originator of the assets that are used in securitization is understood to be the firm that either owned or created the assets before their transfer through a sale to the SPE. For example, in a residential mortgage-backed securitization, the originator is the financial institution that provided mortgage loans to home buyers. From an originator's point of view, the two most important benefits in a securitization are (1) the use of securitizations as a means of bringing forward future receipt of cash flows and (2) a reduction in funding costs. Accelerating payment of future cash flows is especially advantageous for originators who generate profitable revenues in the form of origination fees. Securitization allows for the sale of previously originated loans to an SPE, thus replenishing the lending stock of the originator thereby allowing it to make fresh loans. A related advantage is the ability to re-characterize interest income into servicing and other fee income that may provide a steadier stream of cash flows to the firm.

An equally important advantage of securitization, especially for lower rated or unrated originators, is to achieve more favorable funding costs on the securitized assets relative to what the originator may face in the market. This advantage is particularly important when the assets being securitized are of higher quality than the overall quality of the originator.

As an example, suppose an originator has a B credit rating but has BB credit-rated assets on its balance sheet. If the originator were to raise funds in the market through a new debt issuance, it would face a lending cost corresponding to a B credit rating level of risk. However, the originator has the option of raising funds by securitizing the BB-rated assets, which reduces the funding costs. An associated benefit of securitization is that it allows for a more diverse source of funding options to the originator firm, thus providing more liquidity choices. Recent research on the value of securitization (Lemmon, Liu, Mao, and Nini 2014) indicates that asset securitization by non-financial firms helps firms reduce funding costs by providing an alternative source of financing, particularly for firms with credit ratings corresponding to low investment grade (BBB) or high speculative grade (BB).

For an originator, another use of securitization could be to enhance market recognition. A firm may pursue a strategy of building a track record through a successful securitization program before tapping corporate debt markets. Other firms use securitizations to manage their asset-liability profile. In this case, transactions are structured in a way that the repayment characteristics of the underlying assets more closely match the firm's debt payment schedule.

For financial institutions, securitizations offer other benefits. An important use of securitizations is in the management of their regulatory and/or economic capital requirements. This use may either be achieved by reducing the amount of assets on the balance sheet, through the process of securitization, or retaining the senior tranches that, by the process of securitization, are less risky and require lower (or no) capital to be held. On a related note, securitizations are a risk management tool in which an originator or financial institution can transfer some of the credit risk associated with the assets on its balance sheet to specific investors seeking particular risk-return characteristics.

Research on the benefits of securitization to financial institutions finds that securitization provides better lending ability for banks and shelters banks' loan supplies from the effects of monetary policy (Altunbas, Gambacor, and Marques-Ibanez 2009; Loutskina 2011). Furthermore, Cardone-Riportella, Samaniego-Medina, and Trujillo-Ponce (2010) analyze Spanish banks and find that securitization is not used for regulatory arbitrage but rather as an alternative financing source for banks.

Securitization Costs to the Originator

Although securitizing debt offers many benefits to the originator, securitizations may also be accompanied by offsetting costs. The most common cost of securitization is that it may unfavorably affect the originator's balance sheet. If the originator selects its higher quality assets for the securitization, either by design or due to unfavorable circumstances, a reduction in the quality of the remaining assets on the balance sheet occurs. In certain cases, this situation could have a substantial adverse impact on the originator's creditworthiness and may even lead to downgrades of its credit rating or an equity analyst's view of the company. In either case, the originator's funding costs may increase if the securitization increases the market's perception of the risk associated with the firm.

Another securitization cost may arise if the setup costs associated with the securitization outweigh the benefits of the securitization. This form of a net cost typically arises when the scale of the transaction is small or the transaction structure (or the assets associated with the transaction) is very complex. The originator can minimize some of these costs if the originator intends to have an ongoing program of new issuance using the same framework and documentation. But for one-time or infrequent securitizations, the initial fixed costs associated with the securitization may be simply too high.

Securitization may also add to the originator's operational costs. A frequently observed cost to the originator is if the securitization requires it to modify or update its internal systems in order to administer or monitor the receivables that underlie the transaction. Very often this situation is due to different reporting requirements that investors may impose in the securitization or by market regulators. Other adverse effects include a reduced incentive of lenders to screen borrowers (Loutskina and Strahan 2009; Mian and Sufi 2009) or using securitization as a tool for regulatory arbitrage (Merrill, Nadauld, and Strahan 2017).

Securitization Benefits to the Investor

Securitizations also offer various benefits to investors. First, they give investors access to a new class of asset, thereby providing a direct diversification benefit to their existing portfolios. Depending on the type of assets being securitized, investors can easily gain exposure to assets that have different risk characteristics such as prime or subprime, residential or commercial real estate, auto loans, student loans, and credit card receivables.

Moreover, investing in securitized debt is a more efficient form of gaining exposure to an entire pool of assets as opposed to buying the assets comprising the pool individually. Another important aspect of securitized debt is that it offers investors the ability to invest in a security with a specific risk level. In other words, the process of structuring the securitization through senior/subordinate credit structures or other features such as bond insurance allows the risk of different debt tranches to be tailored in a way that becomes appealing to a broad set of investors who may have different risk preferences or risk tolerances.

Finally, the process of securitization enables the creation of very high quality (i.e., low risk) debt securities from a pool of lower quality assets. For example, the senior-most tranche in a securitization may be rated AAA by credit rating agencies, commensurate with its remote risk of default, even though the average quality of the underlying pool of assets may be of much worse quality such as BB or lower. This feature is important for investors or entities that want to invest in very safe securities equivalent to AAA risk as securitized debt provides more investment options. In its absence, investors would have relatively few AAA-rated corporate debt issuers from which to choose. For example, the number of U.S. firms rated AAA by S&P has progressively declined from 98 firms in 1992 to only two firms in 2016. (Financial Times 2016)

Securitization Risks for Investors

Securitized debt exposes investors to three main risks to investors. The first risk factor is the increased chance of incorrectly estimating the risk of a securitized debt security due to the inherent complexity of structured debt. Cash flows to different securitized debt securities not only depend on the joint or correlated performance of the underlying assets being securitized but also on the payment rules associated with the structured debt, which could feature cash diversion mechanisms. Typical risk analysis of securitized debt requires using models and/or certain assumptions. A misspecified model or a wrong set of assumptions could provide a much distorted risk assessment of a structured debt security. For example, Ağca, Agrawal, and Islam (2008) demonstrate that the standard industry practice of modeling the loss distribution of a collateral portfolio using a Gaussian copula model has inherent shortcomings. More specifically, the authors show that implied correlations extracted from the standard Gaussian copula model produce a consistent skew pattern that is unrelated to true correlations. Implied correlations are analogous to the concept of implied volatility in a Black-Scholes framework. Similarly, Ağca and Islam (2010) highlight misperceptions in the market regarding the relation between asset correlations and the performance of securitized notes.

A second important risk factor for investors is the combination of credit risk in the collateral pool and inherent leverage created in the structure of securitized debt. Senior investors are shielded from “normal” levels of defaults in the collateral portfolio, due to the protection provided by more subordinate tranches. Yet, at the more junior levels, even a few defaults in the collateral pool may result in large disproportionate losses for junior investors, up to and including a complete loss of principal. Realized returns on speculative grade securitized debt could therefore be highly volatile and small changes in the collateral pool performance can have a large impact on the payment profile of the more leveraged tranches. For example, Albertazzi, Eramo, Gambarcota, and Salleo (2011) indicate that banks hold a share of the high-risk, first-loss equity tranche in order to signal the quality of their securitized assets and to boost their reputation on lending standards.

The third main risk factor of a securitized debt instrument from an investor's perspective is *prepayment risk*, which is the likelihood of the underlying assets that support the securitized debt to accelerate their principal payments. A good example of prepayments is a pool of mortgages that start prepaying early due to refinancing. Since refinancing activity typically increases when interest (mortgage) rates decline, investors in a mortgage securitization may receive payment much earlier than expected and precisely at a time when interest rates are low, thus exposing them to reinvestment risk.

Another form of risk generally associated with prepayment risk is the potential for *adverse selection*, which is the deterioration of an asset pool's overall credit quality because more creditworthy borrowers tend to prepay first. Continuing with the mortgage prepayment example mentioned previously, better quality borrowers with relatively higher credit scores such as Fair Isaac Corporation (FICO) scores are usually the first to refinance their mortgage loans. Such refinancing results in higher quality borrowers exiting the pool and the remaining assets progressively deteriorating in terms of average credit quality. As the proportion of less-creditworthy borrowers increases, adverse selection results in higher default rates in the asset pool supporting the securitized debt than the investors' original expectations.

Types of Securitized Debt Products

Since structured debt can be backed by any pool of assets that produces a steady cash flow stream, using different types of financial assets as the collateral pool leads to creating different types of securitized debt. Although examples of securitizations may be traced back to the late eighteenth century (Frehen, Rouwenhorst, and Goetzmann 2013), the modern practice of securitizations commenced with the creation of the Government National Mortgage Association (also known as GNMA or Ginnie Mae) by the U.S. Department of Housing and Urban Development (HUD) in 1968. GNMA launched the first modern-day residential mortgage-backed security (RMBS) by issuing securitized debt backed by a portfolio of mortgage loans. The next section provides more details on RMBSs, which is the largest securitized debt market as measured by the notional value of outstanding debt. As of 2016, the outstanding volume of U.S. RMBSs stood at approximately $7.4 trillion according to the *U.S. Securitization Year in Review 2016*, a research publication by the Securities Industry and Financial Markets Association (SIFMA 2016).

Residential Mortgage-Backed Securities

The U.S. RMBS sector can be divided into two types of securitized bond issuance: agency and non-agency bonds. Agency bonds are issued by a U.S. government agency such as Ginnie Mae and government-sponsored enterprises (GSEs) such as the Federal National Mortgage Association (Fannie Mae), or the Federal Home Loan Mortgage Company (Freddie Mac). The main difference between the bonds issued by Ginnie Mae (government agency) and Fannie Mae/Freddie Mac (GSEs) is that the U.S. government explicitly guarantees securitized debt issued by the former but securitized debt issued by the GSEs has only an implicit backing of the U.S. government. The U.S. government's rescue of the GSEs from insolvency in 2008 gave further credence to the perception of an implied guarantee.

U.S. agency RMBSs are the largest and most liquid securitized asset class, with almost $6.5 trillion in outstanding assets as of the end of 2016 according to SIFMA (2016). The high demand for agency RMBSs are largely explained by the offer yields that are typically higher than U.S. Treasuries for comparable levels of duration and credit risk. Historically, agency RMBSs have also tended to display low correlation with more credit-sensitive securitized debt classes thus making them useful instruments for providing diversification to asset portfolios.

Due to the explicit or implicit backing of agency RMBSs by the U.S. government, credit or default risk is not a primary risk factor for this asset class. The main risk facing an investor of agency bonds is in the form of prepayment risk or extension risk. When the rate of prepayments increases in a declining interest rate environment, early and unscheduled principal repayments to investors expose them to reinvestment risk. On the other hand, if the rate of prepayments declines in an increasing interest rate environment thereby extending the security's expected maturity, investors cannot benefit from the rising interest rates because their investments remain locked at a lower rate for a longer period.

Private institutions are not connected to the U.S. government-issue, non-agency RMBSs. Therefore, the U.S. government neither backs nor guarantees their interest or principal payments. As a result, credit or default risk is generally the primary driver of non-agency RMBS performance. Another major difference between agency and non-agency issued bonds involves the characteristics of the underlying pool of mortgages. Agency bond collateral pools enforce strict borrower credit characteristics such as FICO scores and loan size limits—both in terms of the loan value as well as the absolute amount of the mortgage loan. Non-agency bond collateral pools comprise mortgage loans that may differ from these requirements and could be originated by private institutions with varying underwriting standards. Indeed, Adelino, Frame, and Gerardi (2017) find that mortgages in GSE pools had better performance than those backed by non-GSE pools, and the difference in performance is mainly attributed to the higher quality of loans in the GSE pools.

According to SIFMA (2017), outstanding non-agency RMBSs in the United States stood at about $783 billion in 2017. New issuance of non-agency RMBSs has been muted since the financial crisis of 2007–2008 with only about $96 billion of new U.S. RMBS bonds structured in 2017. By contrast, the issuance level in 2006 was $1.27 trillion. As shown in Figure 8.2, RMBS issuance steadily increased until 2006 where it peaked and went down sharply following the financial crisis.

Non-agency RMBSs typically have 500 to 1000 individual mortgage loans that serve as the underlying collateral pool for the securitized mortgage-backed bonds. The performance of RMBSs depends on many factors. Researchers have explored

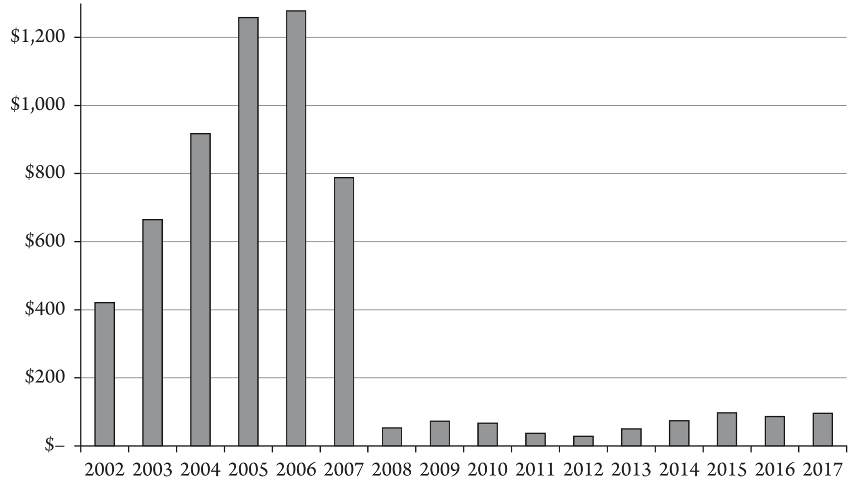

Figure 8.2 Residential Mortgage Backed Securities (RMBS) Issuance
This figure shows the issuance of residential mortgage-backed securities (RMBSs) between 2002 and 2017. The values are in billions of dollars.
Source: SIFMA (2017).

the drivers of the RMBS design (Hartman-Glaser, Piskorski, and Tchistyi 2011; Begley and Purnanandam 2017). The primary factors are the level of delinquencies or foreclosure frequency experienced by the pool of mortgage loans backing the RMBSs and the loss incurred on a mortgage loan if a home is foreclosed. This loss is usually expressed as a percentage of the outstanding loan amount, also known as a *loss severity*. Appreciating home prices, for example, have a positive impact on RMBS performance as they not only lower instances of foreclosures but also reduce the loss severity of the pool in the event that some loans become delinquent and are eventually foreclosed. With respect to interest rate risk, investors in RMBSs may be shielded from rising interest rates if the RMBSs are issued as floating rate notes (FRNs). However, declining interest rates may trigger early prepayments on the RMBS notes as a greater proportion of the underlying mortgage loans are refinanced, accompanied by adverse selection that leads to a decline in the average quality of the remaining mortgage pool.

The introduction of credit risk transfer (CRT) bonds is a recent innovation in the U.S. RMBS market. These bonds can be viewed as a hybrid of agency and non-agency RMBS bonds. CRT bonds issued by GSEs are structured as unsecured obligations of the GSEs with payments on the issued bonds dependent on the performance of a large, diversified reference pool of loans. CRT bond investors are not guaranteed the full principal repayment and receive periodic payments of principal and interest based on the performance (i.e., delinquency and principal payment experience of the reference pool). CRT bonds allow the GSEs to transfer a portion of their credit risk to private investors, thereby reducing the government's credit exposure to the residential mortgage market. However, unlike traditional non-agency RMBS, bond payments come from the GSEs instead of directly from the underlying mortgage loans.

Risk Analysis of Non-Agency RMBSs and CRT Bonds

Since credit risk is the primary driver of non-agency RMBSs and CRT debt performance, the key step in assessing the risk of these bonds involves projecting losses in the mortgage loan pool underlying the RMBS or CRT transaction. Projected losses are in turn based on forecasting, projecting two components: foreclosure frequency and loss severity. The product of foreclosure frequency and loss severity provides an estimate of the projected loss for the mortgage loan pool.

Various techniques can be employed to estimate foreclosure frequencies and loss severities for an RMBS transaction. Analytical techniques use econometric models that are calibrated to historically observed default rates and loss severities. Simulation models build up a loss distribution with certain assumptions about correlated default behavior. On the other hand, non-analytical models incorporate the use of expert judgment in comparing the characteristics of the loan pool being securitized with the attributes of a geography-specific "archetypical" or representative loan pool. These geography-specific pools could be, for instance, based on countries (e.g., United States, Canada, Japan, and Italy) or regions (e.g., U.S. Northeast and Midwest).

The "archetypical" loan pool is usually based on a set of idealized or representative loan characteristics that have been historically observed in the geographic-specific location. The archetypical pool thus acts as a benchmark against which the mortgage loan pool being securitized is compared. Deviations in the characteristics of the loan pool that is securitized from those of the archetypical loan pool lead to modifications in the loss projections, which may be adjusted up to reflect higher risk, or down to reflect lower risk.

As an example, if the region-specific archetypical loan pool has a median (or average) FICO score of 700 while the median (or average) FICO score of the mortgage pool being securitized is 730, the projected losses would be adjusted down. Conversely, if the archetypical pool comprises mortgage loans that were used to purchase primary residences while the actual mortgage loan pool being securitized includes loans that were made to fund purchases of secondary residential properties, the projected losses for the actual loan pool would be adjusted higher, all other things being equal. Once an estimate of future losses on the actual pool has been made, cash-flow analysis can be carried out. This analysis takes into account how losses are allocated to the different securitized debt tranches based on the specific payment rules that govern interest and principal payments to each of the tranches. As a result, it generates an estimate of potential losses on the structured securities themselves.

Asset-Backed Securities

The early success of RMBS securitizations led to the expansion of securitized debt markets as techniques developed in the mortgage market were applied to other types of financial assets. Thus, a general class of asset-backed securities (ABS) was established with a pool of automobile loans becoming the first type of non-mortgage assets securitized in the mid-1980s. Marine Midland Bank originated a $60 million auto loan ABS securitization backed by a Certificate for Automobile Receivables Trust (CARS 1985-1) (Valeo 2010). The first credit card securitization occurred in 1986, student loan securitizations in the mid-1990s, and an ever-increasing variety of assets such as aircraft or shipping container leases in recent years. ABS outside the United States tends to focus on a smaller range of more "traditional" assets such as credit cards, auto loans, and consumer loans.

Evaluating the risk of ABS tranches essentially follows the same set of steps that govern the analysis of any securitized debt transaction. The first step is an assessment of the bankruptcy remoteness of the issuer followed by a systematic examination that the transfer of the financial assets from the originator or sponsor to the issuer constitutes a true sale. The next step is an evaluation of the credit risk of the assets in terms of their propensity to become delinquent and the associated loss severities. This step is followed by an assessment of whether the cash flows and credit enhancement mechanisms in the structure are adequate for paying off the promised interest and principal payments to the securitized debt investors. Finally, a comprehensive review of the legal documents that describe in detail the terms of the transaction is necessary for ensuring no mismatches occur between the legal documentation and the intended deal structure.

Asset-Backed Commercial Paper

A variation of an ABS is a debt security called asset-backed commercial paper (ABCP). ABCP is usually issued as part of a program or conduit where an SPV sells short-term debt notes known as commercial paper (CP). ABCP notes have a maturity of about a year or less with a typical maturity of a month. Assets such as trade receivables, credit card receivables, auto loans and leases, and equipment leases back payments on the ABCP. In other words, financing of medium- to long-term assets is achieved by issuing short-term liabilities that are rolled over on a continual basis via the ABCP conduit.

Major commercial banks initially sponsored and administered ABCP conduits to provide flexible and competitive low-cost financing to their corporate clients. By issuing ABCP notes to investors, sponsoring banks could use the proceeds of the issuance to buy the trade receivable assets on their customers' balance sheets. Using ABCP conduits met two main objectives: (1) Illiquid assets such as trade receivables are converted into more liquid ABCP notes, and (2) longer term assets could be financed through short-term liabilities that normally have a lower funding cost. ABCP conduits were especially attractive to banks' speculative-grade clients as they allowed them to borrow at lower, investment-grade costs provided these clients had portfolios or sub-portfolios of high-quality, cash-generating assets to back the ABCP conduit.

Over the years, ABCP programs expanded to serve a wider variety of objectives such as providing financing for companies that cannot access the commercial paper market directly, off-balance sheet funding of bank assets, or warehousing of assets before issuing new securitized debt. Almost all ABCP notes are structured in a way that they attain high-quality short-term ratings from credit rating agencies. This structure occurs because the largest investors in ABCP notes are money market funds that are generally constrained by mandates, regulatory or otherwise, to invest in highly rated instruments only.

ABCP vehicles vary but a common way of classifying ABCP conduits is by the number of sellers. By far the most common type of an ABCP conduit is a multi-seller conduit that, as the name suggests, has the defining characteristic that the underlying asset pools are sourced from a multitude of unrelated originators or sellers. Therefore, the assets could be sourced from different sectors and comprise varying asset types. The only common, though not necessary, characteristic is that originators of assets are usually customers of the ABCP program-sponsoring entity, which is typically a commercial bank. In rare instances, non-bank entities may also be the sponsors of the ABCP conduit.

For multi-seller ABCP conduits, the sponsoring bank or entity is usually the party that has the responsibility for selecting the assets that comprise the pool backing the ABCP notes. The sponsor is also responsible for structuring the conduit financing mechanics. This structure typically includes the creation and management of any support facilities such as liquidity reserve accounts or the utilization of any hedging instruments to manage any potential interest rate or credit risk. Liquidity facilities need not be funded by the sponsor and could be provided by third-party financial institutions. Additionally, the sponsor may act as the administrator of the ABCP program or delegate this role to a third party. As the name implies, the administrator or administrative agent is responsible for performing the administrative functions of the conduit. These functions include the following: (1) keeping track of impending ABCP maturities; (2) safeguarding the proper movement of asset cash flow collections into collection accounts to ensure timely interest payments or repayment of principal on maturing ABCP notes; and (3) providing notice to the support providers, such as liquidity support providers, in case of a temporary shortfall in funds needed to repay the maturing ABCP notes. The latter case is not uncommon as the frequency of payments on the underlying assets, such as receivable collections, oftentimes differs from the frequency of payments on the ABCP notes leading to transient imbalances between the cash collections and the amounts due.

The other type of an ABCP vehicle is a single-seller ABCP conduit where the program issues CP notes to finance the assets of a single originator. The single originator may be a group of related originators such as a parent and its subsidiary firms. Single-seller conduits are more applicable for originators that have large asset pools on their balance sheets. The main economic advantage of a single-seller conduit over a multi-seller conduit is that the asset originator has substantial control over the associated costs of administering the ABCP pool. On the other hand, it bears these costs alone instead of sharing them with other originators.

One risk unique to ABCP securitized debt compared to other types of securitized debt is in the form of rollover risk. Since the essence of an ABCP securitization is to issue short-term debt instruments to finance longer-term asset pools that typically possess varying repayment terms, payment dates on the underlying assets extend well beyond the dates on which the conduit is obligated to repay its maturing shorter-term ABCP notes. Thus, for the ABCP conduit to remain continuously invested in its asset pools, it strives to issue new short-term notes to repay the maturing notes, which is termed a *CP rollover*. To protect holders of maturing notes against the possibility that the conduit cannot issue new notes to refinance its outstanding CP obligations, most ABCP conduits have one or more committed liquidity facilities that can be used as a source of funds for repaying maturing ABCP notes. As a result, investors of ABCP not only consider the typical risks associated with securitized debt such as evaluating bankruptcy remoteness of the issuing entity, credit risk in the assets, credit enhancement features, but also assess the strength of the liquidity facilities and their providers.

Commercial Mortgage-Backed Securities

Commercial mortgage-backed securities (CMBSs) emerged in the 1990s (Ambrose and Saunders 2003). CMBSs are securitizations backed by a pool of commercial real estate (CRE) loan assets. Although CMBS and RMBS transactions are similar, one important difference between the two types of securitizations is the size of the individual loans that comprise the asset pool, and subsequently the number of loans that back the issued securitized bonds. The typical RMBS pool may have about a thousand individual residential mortgages with each loan size in the low hundred thousand dollars. In contrast, a typical CMBS transaction may be backed by only some tens of individual CRE loans each having a size of a few million. Thus, an inherent "lumpiness" exists in a CMBS collateral pool compared to an RMBS collateral pool, which can result in even a single idiosyncratic default on a CRE loan having a disproportionate impact on the performance of the issued CMBS notes.

CMBS securitizations can be classified into four main categories: (1) multifamily agency CMBSs, (2) conduit CMBSs, (3) single-asset or single-borrower CMBSs, and (4) securitization of single-family rental properties. The main differences among these four types of CMBS are highlighted next.

- *Multifamily agency CMBSs* are multifamily loans that offer low credit risk on senior securities as they are guaranteed by one of the GSEs (Fannie Mae, Freddie Mac, or Ginnie Mae). Thus, they are similar to agency RMBS bonds that have little or no credit risk. Payments on subordinate securities are not guaranteed and therefore have an element of credit risk.
- *Conduit CMBSs* are the most typical form of non-agency CMBS and are usually fixed-rate transactions involving a diversified pool of loans in terms of property locations and property types. Historically, conduit CMBSs have usually offered higher yields from similarly-rated fixed income securities, which lead to their popularity among fixed-income investors.
- *Single-asset* or *single-borrower CMBSs* are collateralized by large single properties or a single borrower who has invested in a portfolio of properties. Although this characteristic makes the analysis of the issued CMBS notes more straightforward because it avoids the need for evaluating the correlations between different borrowers, the lack of diversification increases the concentration risk in the securitization. This lack of diversification is generally offset through higher quality loan underwriting standards compared to conduit CMBS as well as secondary support through large institutional sponsorships.
- *Single family rental property CMBSs* are collateralized by residential home rental properties that are geographically diversified. It represents the smallest segment of the CMBS market and generally offers credit risk exposure to investors similar to non-agency RMBSs.

Risk factors for CMBSs are similar to RMBSs and the performance of CRE securitized debt is closely tied to the health of the commercial real estate market. When commercial real estate prices increase, or occupancy and rental rates improve, as was generally the case after the financial crisis of 2007–2008, aggregate delinquency rates decline. This improvement reduces the risk of nonpayment on CMBS debt. Another reason for the good performance of CMBS securitizations since the financial crisis involves the replacement of some pre-crisis loans in older CMBS transactions with newer loans with stricter underwriting standards. However, not all sub-sectors within commercial real estate have seen an improvement in recent years. More specifically CMBSs backed by CRE loans for retail shopping centers have been under pressure due to frequent store closings by major national retailers such as Sears, Macy's, and J.C. Penney (USA Today, 2017).

Evaluating the risk in CMBS tranches typically begins with an analysis of each loan at the individual property level. Loan-level analysis is crucial because the aggregate cash flow from a mortgaged commercial property is usually the only source of funds available to service the debt on a mortgage loan, which in turn is necessary to make promised payments on the securitized CMBS notes. The main analysis generally focuses on a review of income statements for the mortgaged properties in a loan pool. Further adjustments may be made for current and projected vacancies, normal expenses and reserves for scheduled and unscheduled maintenance expenses or tenant improvements, whether rents are on par with the market or above-market, leasing commissions and fees, replacement of capital items.

The *adjusted net operating income*, also called *net cash flow* (NCF) by rating agencies such as Standard & Poor's, can be expressed as a debt service coverage ratio (DSCR) in which a value greater than 1 indicates an ability to service the outstanding CMBS debt and a value below 1 indicates a potential shortfall. The higher the DSCR, the more secure are the payments to the CMBS noteholders. Another important metric that is considered in the analysis of CMBSs is the *loan-to-value (LTV) ratio* of the mortgage loans. The measure provides an indication of the equity cushion that is available to absorb a decline in the market value of the attached property. From an investor's perspective, a low LTV is desirable because it increases the recovery value of the mortgage loan in the event of a default and reduces the likelihood of default.

Collateralized Debt Obligations

A *collateralized debt obligation* (CDOs) is a generic term for securitized debt that may be backed by a portfolio of bonds, loans, or a combination of both. Since the financial crisis of 2007–2008, CDOs have primarily used speculative grade corporate loans, also called *leveraged loans*, as the main asset type that comprises the collateral pool. CDOs that are backed by leveraged loans, also called *collateralized loan obligations* (CLOs), have seen high investor demand with about $120 billion of new issuance estimated for 2017 (S&P Global Ratings Structured Finance Research 2017).

The first CDOs issued in the late 1980s were securitizations of corporate bonds. Since then CDOs have evolved into three main categories, depending on their type of funding: (1) cash flow CDOs, (2) market value CDOs, and (3) synthetic CDOs.

- *Cash flow CDOs* use proceeds from the issuance of different tranches of liabilities to purchase a pool of financial assets such as corporate loans or bonds. The cash flows generated by the financial assets are then used to pay back investors of the CDO tranches, generally in sequential order from the senior investors that hold the safest least risky) securities, to the junior-most “equity” tranche investors that bear the first-loss risk and generally have claims on residual cash only. Expected returns on the various CDO tranches increase from the senior-most (safest tranche) to the junior-most equity tranche thus reflecting the increasing premium required for bearing the increase in default risk. As assets in the collateral pool mature and pay off their outstanding principal, the proceeds may be used to pay off the CDO tranche investors starting with the senior-most noteholders.

- *Market value CDOs* are structured similar to cash flow CDOs but the main difference is that the CDO or SPV issuing the securitized debt tranches does not issue liabilities based on the par amount of the assets but instead based on an “advance rate” associated with each type of asset in the collateral pool. An advance rate is the equivalent of a “haircut” or required discount that is applied to the value of an asset. For example, an advance rate of 90 percent means a haircut or reduction in value of 10 percent is applied to the underlying collateral. For market value CDOs, advance rates are applied to each asset and to each liability tranche, with the advance rates themselves being functions of the historical price or return volatilities of each of the asset types. If the value of the collateral pool falls below the pool advance rates, the CDO must sell a portion of the collateral via the collateral manager to pay off the senior-most noteholders in order to bring the advance rates back into compliance.
- *Synthetic CDOs* use derivatives to gain credit-risk exposure to the collateral assets without physically purchasing them. Investors in a synthetic CDO are effectively sellers of credit insurance or protection because they bear the risk of losses should the underlying assets default. In its simplest form, the collateral pool of assets comprises a portfolio of credit default swap (CDS) contracts. Spread income generated by the CDS contracts provides the cash flows for making payments to investors of the synthetic CDO tranches. If defaults occur related to any of the CDS contracts, the most junior CDO tranche investors become liable for covering the losses. Synthetic CDOs differ from cash flow CDOs in that the money paid upfront by investors in the synthetic CDO is not used to purchase the pool of credit derivative assets because no upfront payment is required for selling credit protection. The proceeds are instead invested in high credit-quality, but low-yielding investments that are typically held by the CDO or SPV in the form of a reserve account for covering potential future credit losses. The periodic premium paid by the credit-protection buyers to the CDO, together with the interest earned on the investment held by the CDO in the reserve account, is used to pay the promised interest to the CDO tranche investors.

Losses arising due to a reference entity defaulting in the asset pool are covered by liquidating a portion of the investment held in the reserve account and reducing the outstanding balance of the junior-most CDO tranche by an equivalent amount. At the maturity of the synthetic CDO transaction, the entire investment comprising the reserve account is liquidated to pay off the CDO tranche investors starting with the senior-most note investors.

Cash flow CDOs and synthetic CDOs have more similarities with each other than with market value CDOs. For both cash flow and synthetic CDOs, the payment of

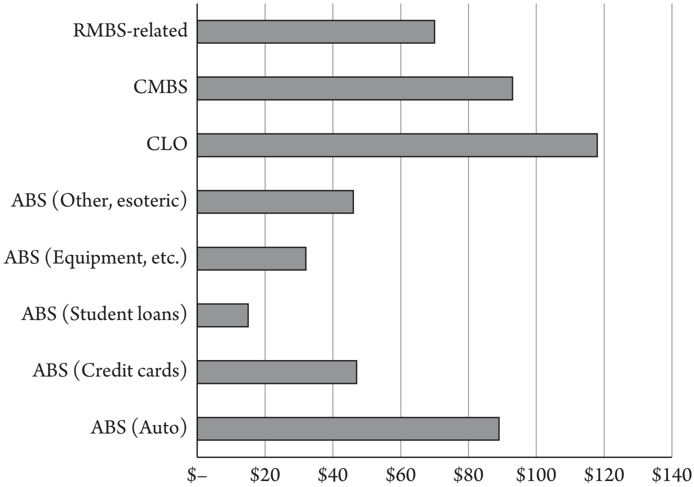

Figure 8.3 Types of U.S. Non-Agency Securitized Debt Issuance in 2017
This figure shows the U.S. non-agency securitized debt issuance for 2017. The figure includes issuances of different types of asset-backed securities, residential mortgage-backed securities, collateralized loan obligations, and commercial mortgage-backed securities. The values are reported in billions of dollars.
Source: S&P Global Ratings (2017).

promised interest and principal to the CDO tranches is a function of the credit risk of the underlying collateral assets backing the two structures. Conversely, the performance of market value CDOs is based upon the market valuations and the ability of collateral managers to engage in profitable trading of the collateral of assets. Given their similarities, a greater overlap exists in the risk analysis of cash flow and synthetic CDOs versus market value CDOs. As shown in Figure 8.3, CLOs constitute the largest share of the non-agency securitized debt issued in 2017, indicating the importance of this asset class in the securitized debt markets.

Non-U.S. Securitized Debt Markets

Securitized debt markets are the largest and deepest in the United States, with more than half of non-agency new issuance in 2017 attributable to U.S. markets. As Figure 8.4 shows, China recently increased its share of the global securitized debt market. Almost a quarter of new issuance in 2017 represented the Chinese market.

Although new issuance in the United States exceeded 2016 levels by an impressive 37 percent ($510 billion in 2017 versus $372 billion in 2016), new issuance in China almost doubled from the equivalent of $116 billion in 2016 to $210 billion in 2017. Whether this trend persists in the future to allow securitized debt markets in China to catch up in size and depth with the U.S. market remains to be seen.

Examination of Figures 8.4 and 8.5 reveals that the share of European issuance of securitized debt in 2017 is around 10 percent of the global market. This market share has been stable for the last several years representing around $80 to $95 billion issuance

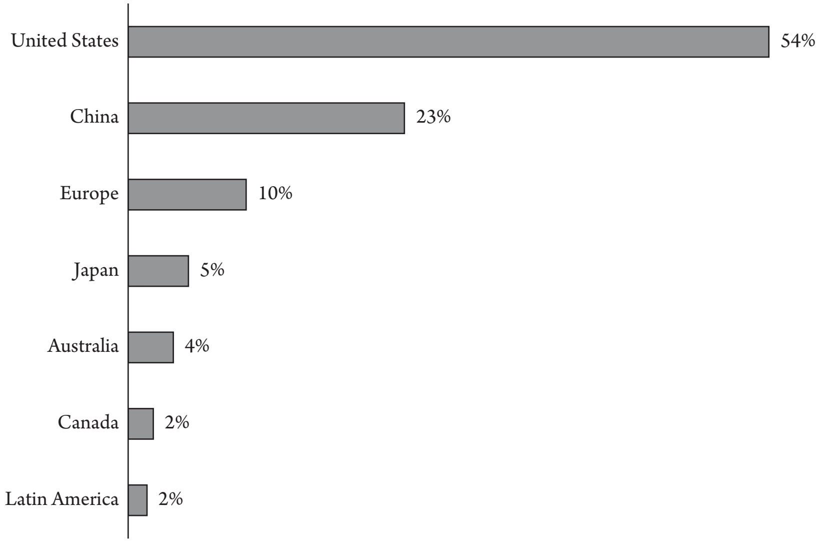

Figure 8.4 Global Share of Non-Agency Securitized Debt Issuance in 2017
This figure shows non-agency securitized debt issuance in 2017 for various countries that are important players in the market: the United States, China, Europe, Japan, Australia, Canada, and Latin America.
Source: S&P Global Ratings (2017).

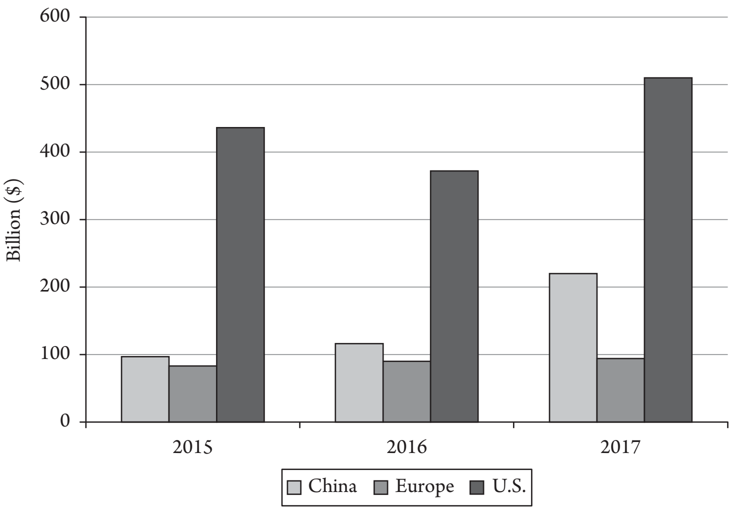

Figure 8.5 Recent Non-Agency Securitized Debt Issuance in the Three Largest Markets
This figure shows non-agency securitized debt issuance in China, Europe, and the United States between 2015 and 2017. The values are reported in billions of dollars.
Source: S&P Global Ratings (2017).

in the securitized debt markets. The other participants in the securitized debt markets, mainly, Japan, Australia, Canada, and Latin America, make up around 5 percent or less of the market issuance.

Summary and Conclusions

Securitized debt markets play an important role in the economy by providing benefits to originators and investors. For originators, they offer new sources of funding at competitive costs, act as an important tool for risk management by transferring risk to external investors, provide an efficient way to monetize illiquid assets, and in some cases build brand recognition in the market. For investors, securitized notes provide alternative investment choices that enable diversification of their investment portfolios, the ability to tailor their investments in accordance with their risk preferences, and easily add exposure to a portfolio of assets. Thus, securitized markets perform the important social role of sharing risk in the economy and recycling capital in the real economy.

Discussion Questions

1. Discuss the three main characteristics of securitized debt instruments.
2. Explain the main differences between securitized debt and secured lending.
3. Describe the importance of a true sale in the context of securitized debt.
4. Discuss the importance of liquidity facilities in securitized debt transactions such as asset-backed commercial paper.
5. Explain how cash flow and synthetic CDOs differ from market value CDOs.

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9

Derivatives Markets

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Introduction

A *derivative security* is a financial instrument whose payoff depends on the value of other, and typically more basic, underlying variables or processes (Hull 2018). Within the scope of debt markets, interest rates usually serve as the primary underlying variable, giving rise to the use of the term *interest rate derivatives*. Under the more general heading of fixed income derivatives, inflation derivatives and credit derivatives are usually included as their underlying variables can be a specific debt security or a debt issuer. As Luenberger (1998) notes, some debt market instruments such as bonds and mortgage-backed securities (MBSs) can also be considered interest rate derivatives because their values are directly dependent on interest rates. This chapter focuses mostly on interest rate derivatives but briefly introduces credit default swaps (CDSs), which are the most common type of credit derivative.

Derivatives provide investors with cost effective and flexible instruments for managing risks or executing arbitrage trades. For example, hedgers can use interest rate derivatives to effectively minimize or transfer interest rate risk. Such risk is the dominant risk factor in debt markets as well as a common source of risk present in almost all financial transactions. At the other end of the spectrum, speculators can potentially enhance portfolio performance by taking on more risk via these instruments. Arbitrageurs are also major users of interest rate derivatives in their attempts to exploit price inconsistencies.

The remainder of the chapter is organized as follows. The next section presents the current state of the interest rate derivatives markets as well as a historical perspective on their development over time. The third section offers an in-depth description of various types of interest rate derivatives. The fourth section provides an overview of the CDS markets. The final section presents a summary and conclusions.

An Overview of Interest Rate Derivatives Markets

The global interest rate derivatives market has grown remarkably since 2000. Figure 9.1 shows the growth of the over-the-counter (OTC) interest rate derivatives markets based on the semiannual survey data maintained by the Bank for International Settlements (BIS 2018). This particular segment of the market has clearly outpaced the rest of the OTC derivatives markets as evidenced by a consistent upward trend for interest rate derivatives as a percentage of all OTC derivatives.

The massive size of the OTC interest rate derivatives market can be recognized by comparing it to the size of global bond markets or global output as measured by the world gross domestic product (GDP). At the end of 2016, the notional amount of OTC interest rate derivatives outstanding was $368 trillion, which was four times the value of the global bond markets at that time (SIFMA 2017) and almost five times the 2016 world GDP (World Bank 2017).

Some contend that the notional amounts are imprecise measures relative to the actual loss than can occur. These notional amounts are increased when either a party offsets its position by entering an opposite position in a new contract or a central counterparty (CCP) is involved instead of bilateral clearing. Conversely, notional amounts are reduced through a process called *compression*, which allows economically redundant derivative trades to be terminated early (O'Kane 2016). Even though the trend toward CCPs in OTC interest rate derivatives has been an important factor, as

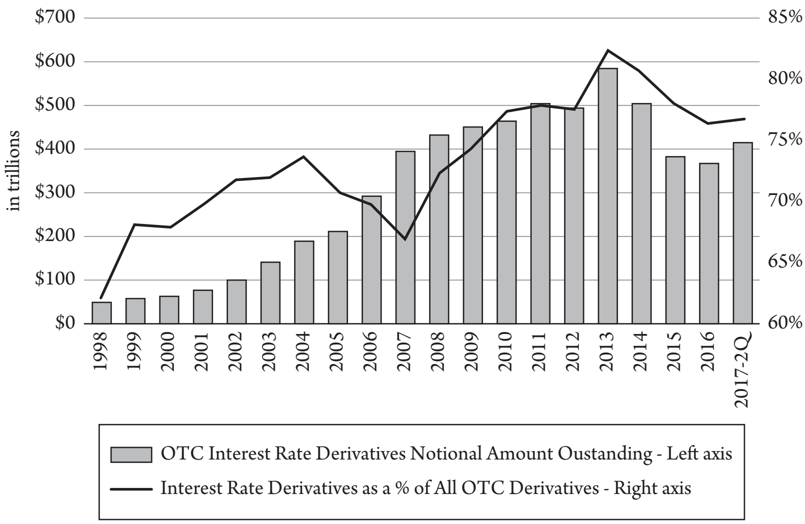

Figure 9.1 Growth of the Over-the-Counter Interest Rate Derivatives Markets
This figure shows in columns (left axis) the growth of the OTC interest rate derivatives market as measured by the notional amount outstanding for these contracts. The black line (right axis) displays the ratio of this amount to the notional amount outstanding for all OTC derivatives contracts maintained by the same database. The right axis starts at 60 percent.
Source: The authors' calculations using data from BIS (2018).

demonstrated by their weight of 75 percent in all existing outstanding contracts at the end of 2016, the compression effect is the dominant element (Schrimpf 2015). As Hull (2018) notes, this latter effect is one reason for the lack of growth since 2007.

An alternative measure for the size of OTC interest rate derivatives markets is the *gross market value*, which represents the maximum loss that investors would incur if all counterparties failed to meet their obligations and the contracts were replaced at the prevailing market prices (BIS 2017). For example, the estimated gross market value of all OTC interest rate derivative contracts at the end of June 2017 was about $8.5 trillion, a much lower figure compared with their notional value of $416 trillion. Based on the former value, the systemic risk posed by these markets does not appear to be as large as what is reflected by the notional amounts. Nevertheless, gross market values depend on many more factors such as interest rate volatility and can be noisier than notional amounts, which purely reflect the sum of outstanding and new market activity.

Turnover is a measure of new market activity in OTC interest rate derivatives markets and is reported by BIS triennially (BIS 2016). As Figure 9.2 shows, this rough indicator of liquidity shows that the daily average turnover during April 2016 was about $2.7 trillion, up from $2.3 trillion in 2013. One well-known advantage of organized exchanges over OTC markets is higher liquidity. The turnover data confirm this advantage as the turnover in exchange-traded interest rate derivatives has been consistently higher than their OTC counterparts. This relation reverses when notional amounts outstanding are considered as demonstrated as will be described in the next paragraph.

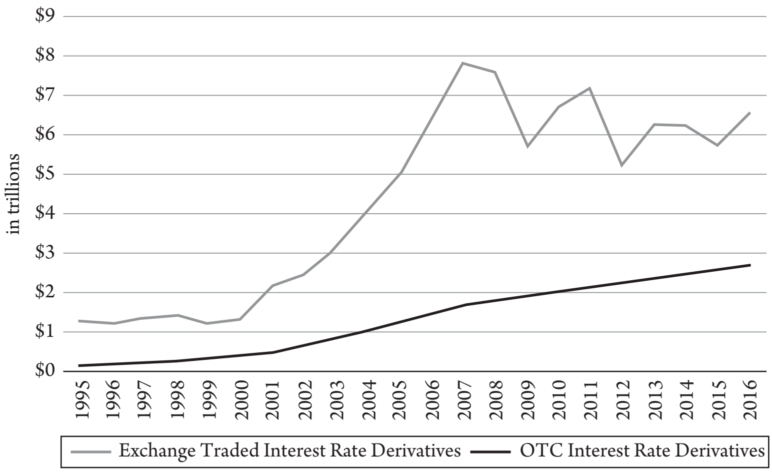

Figure 9.2 Daily Average Turnover for Interest Rate Derivatives
This figure displays the growth in daily average turnover for interest rate derivatives. The black line corresponds to OTC interest rate derivatives and is measured triennially in the month of April only (between 1995 and 2016). The gray line represents the turnover for the exchange-traded contracts as measured annually. The figures are in trillions of dollars measured in notional amount outstanding averaged per day.
Source: The authors' calculations using data from BIS (2018).

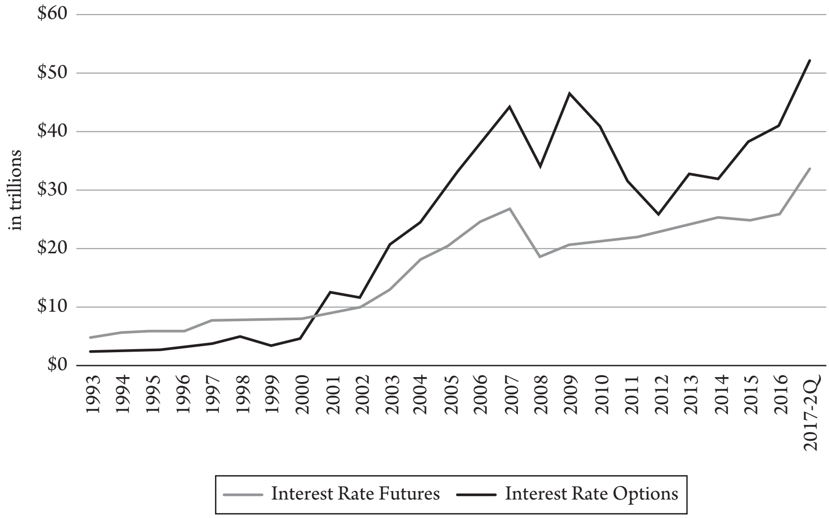

Figure 9.3 Exchange-Traded Interest Rate Derivatives
This figure displays the growth in the notional amount outstanding for interest rate derivatives that trade on organized exchanges. The gray line corresponds to interest rate futures whereas the black line shows the options on interest rate futures. The figures are in trillions of dollars measured in the notional amount outstanding at the end of each quarter between 1993 and 2017-2Q.
Source: The authors' calculations using data from BIS (2018).

Increased popularity of exchange-traded derivatives is evident from the open interest data (BIS 2018). *Open interest* refers to the total number of outstanding derivative contracts that market participants hold at the end of the day. As Figure 9.3 shows, both interest rate futures and exchange-traded interest rate options have enjoyed remarkable growth since 2000. When compared with the notional amount outstanding for OTC interest rate derivatives, these values look much smaller. However, as previously explained, this comparison would be unfair. For instance, with exchange-traded derivatives, offsetting long and short positions are canceled, thereby reducing the open interest.

As this section shows, the interest rate derivatives markets have grown dramatically since the 1990s. This popularity can be attributed to the unique characteristics of various products available in these markets. The next section focuses on understanding some of the most widely used interest rate derivatives instruments.

Types of Interest Rate Derivatives

This section presents a detailed description of interest rate derivatives markets by focusing on four popular types of instruments. Forward rate agreements (FRAs) and interest rate swaps are introduced as the two main instruments of the OTC market, recognizing the former as building blocks for the latter. Futures and options on interest rates are discussed next with an emphasis on the organized exchanges on which they trade. OTC interest rate option types are also presented in the same subsection.

Forward Rate Agreements

A *forward rate agreement* is an OTC contract guaranteeing that a fixed interest rate applies to a given notional principal amount during a predetermined future period of time. An FRA is essentially a forward contract based on a reference interest rate, typically the London Interbank Offered Rate (LIBOR). It can also be viewed as a forward-starting loan with no exchange of principal, so the cash flows exchanged between the counterparties depend only on the difference between the predetermined fixed rate (FRA rate) and the reference interest rate at the settlement date. In this transaction, the party who pays the FRA rate is called the *FRA payer* or *FRA buyer* and assumes the long position. If the FRA rate is lower (higher) than the reference rate, the buyer has a profit (loss). As the notional principal is not exchanged, no actual borrowing or lending is involved per the contract. However, a trader can effectively convert a future loan or investment based on the uncertain floating LIBOR to a fixed rate using an FRA. As a result, FRAs enable investors to hedge future interest rate exposure.

FRAs began trading in the money markets in the early 1980s (Fabozzi, Mann, and Choudhry 2003). At the end of June 2017, the notional amount outstanding in the FRA markets reached $72.6 trillion, with more than half of this amount attributable to FRAs in U.S. dollars (USD) (BIS 2018). The estimated gross market value of these contracts was $53 billion. FRAs trade in an active and liquid market. In April 2016, the estimated average daily turnover was $653 billion (BIS 2016). Table 9.1 presents these numbers along with those for other major instruments in the OTC derivatives market.

Several key dates occur in an FRA's life, beginning with the *trade date* on which the contract is transacted and the FRA rate is set. No payments are exchanged at this time. After this date, the *spot date* is T + 2 for FRAs in most currencies including U.S. dollars. Great British Pounds (GBP) are a notable exception with T + 0. The future period of time (also called the *contract period*) for which the interest rates applies begins on the *settlement date* and ends with the *maturity date*. The value of the reference rate that will be compared with the FRA rate is determined on the *fixing date*, which is two days before the settlement date for contracts in USD (in line with the T + 2 value date convention). Both the *waiting period* (i.e., time between the spot and settlement dates) and the contract period can be up to 12 months. The maturity of the reference rate also matches

Table 9.1 **Size of the Over-the-Counter Interest Rate Derivatives Markets by Instrument Types**

Type of Instrument	*Notional Amount*	*Gross Market Value*	*Daily Average Turnover*
Forward rate agreements	72,584	53	653
Interest rate swaps	306,144	7,683	1,859
Interest rate options	36,970	764	163

This table shows the breakdown of the OTC interest rate derivatives markets by instrument type and reports the market size using three alternative measures in trillion of dollars.

Source: BIS (2016, 2018).

the length of the contract period. Figure 9.4 depicts the timeline for the key dates for an FRA trade.

The terminology for quoting an FRA explicitly identifies the settlement and maturity dates in terms of the number of months from the spot date. For example, a 2 × 5 FRA on USD LIBOR implies that the FRA rate and the three-month LIBOR applies for the three-month period (five minus two) that starts two months from the spot date. Mechanically, this notation means that the FRA rate is locked on the trade date and the waiting period (two months in this example) for the settlement date begins on the spot date. The value of the three-month LIBOR that is observed two days before the settlement date is compared against the FRA rate to compute the settlement sum. The notional principal amount, the difference between the rates, the length of the contract period, and the day count convention determine the settlement sum.

Because interest on loans is generally paid at the end of the period, the FRA payoff computed as the settlement sum should be due at the maturity date. However, FRAs are typically settled on the settlement date. Therefore, the settlement sum must be discounted from the maturity date to the settlement date. Equation 9.1 shows the payoff to the FRA buyer at settlement:

$$N \times \frac{(r_L - r_K) \times (\tau / B)}{1 + r_L \times (\tau / B)} \tag{9.1}$$

where N is the notional principal, r_K is the FRA rate, r_L is the reference rate observed at the fixing date, τ is the length of the contract period in days, and B is the day count basis, which is 360 for USD and most currencies and 365 for GBP.

As the previous illustration demonstrates, an FRA protects its buyer against an increase in the reference rate at a specific point in time whereas the seller is hedged against a decrease in the same rate. In this respect, it is a simple yet effective tool for managing interest rate risk for a single cash flow in the future. Investors with more complex cash flow scenarios would be better off using the instrument explained in the next subsection.

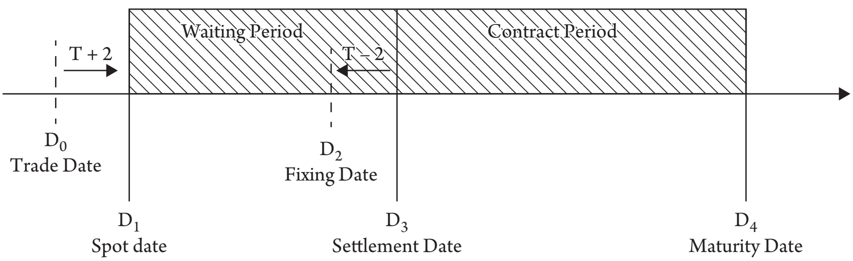

Figure 9.4 Key Dates for an FRA

This figure illustrates the key dates involved with an FRA and its mechanism. The life of an FRA consists of two periods, including a waiting period and a contract period. The five key dates are the trade date, spot date, fixing date, settlement date, and maturity date.

Interest Rate Swaps

An *interest rate swap* is an agreement between two parties to exchange periodic interest payments on a single currency for a predetermined number of periods. These payments are calculated based on a notional principal, which is generally not exchanged. In its most common form, called the *plain vanilla interest rate swap*, one party agrees to make payments based on a fixed interest rate while receiving cash flows based on a floating reference rate such as LIBOR. Furthermore, the notional principal remains constant during the life of the swap and the frequency of the floating rate payments is typically equal to the maturity of the underlying floating rate. For example, if the underlying floating rate is the three-month LIBOR, the floating rate payments are made every three months. Although two payment streams occur (called the *fixed leg* and *floating leg*, respectively), in practice, only the net difference between the two legs would be exchanged on each payment date. Floating leg payments are based on the value of the floating rate at the previous payment date. Due to this structural design, the first net payment is known to both parties.

The party that pays the fixed rate in the swap is called the *swap buyer* whereas the floating rate payer is called the *swap seller*. Li and Mao (2003) find that fixed rate paying corporations generally have lower credit ratings, higher leverage ratios, higher percentages of long-term floating rate loans, and are more likely to use bank loans than fixed rate receivers.

Table 9.2 shows the market quotes on January 11, 2018, for the plain vanilla U.S. dollar interest rate swap, for which the floating rate is the three-month LIBOR rate. Fixed leg payments are made every six months with the 30/360 day count convention. The floating leg's day count convention is actual/360. The *bid rate* is the fixed rate that a market maker is willing pay in exchange for receiving three-month LIBOR. The *ask rate* is the fixed rate that a market maker would expect to receive in order to pay the floating rate. The *swap rate* is the average of the bid and ask rates. Based on these quotes, entering into a three-year swap is possible as a buyer paying 1.15 percent (half of 2.30 percent) of the notional principal every six months and expecting to receive the three-month LIBOR (prorated using the day count convention) multiplied by the notional principal every quarter.

Table 9.2 **Plain Vanilla Interest Rate Swap Rates Quoted in the U.S. Markets on January 11, 2018**

Maturity (Years)	*Bid*	*Ask*	*Swap Rate*
2	2.1490	2.1890	2.1690
3	2.2600	2.3000	2.2800
4	2.3160	2.3560	2.3360

This table presents an example for actual rates quoted in the plain vanilla interest rate swap market in the United States where the floating rate is the three-month LIBOR. The values are percent per annum.

Source: FactSet Research Systems (2018).

An interest rate swap can be recognized as a portfolio of FRAs or a combination of opposite long and short positions in a fixed coupon bond and a floating rate note. These two aspects are typically used in valuing interest rate swaps. The value of an interest rate swap is typically zero at initiation even though the FRAs constituting it have non-zero value.

Another type of fixed-for-floating interest rate swap that recently gained popularity is the *overnight indexed swap* (OIS) where a fixed rate (OIS rate) is exchanged for the geometric average of the overnight rates during a period of one to three months. In the United States, the standard overnight rate is the effective *federal (Fed) funds rate*, which is the interest rate at which depository institutions such banks and credit unions lend reserve balances to other depository institutions overnight on an uncollateralized basis. The geometric average of the overnight interest rates is equivalent to the realized rate for rolling forward the interest and principal for a loan or investment at the overnight interest rate on a daily basis. Therefore, with an OIS, overnight borrowing (lending) for a period can be swapped for borrowing (lending) at a fixed rate for the same period. Due to this structure, the OIS rate is a continually refreshed overnight rate, which began replacing LIBOR as a proxy for the risk-free rate used for valuation of interest rate swaps after the financial crisis of 2007–2008 (Hull 2018).

Market participants often use interest rate swaps to convert the nature of liabilities from fixed to floating rate or vice versa for hedging purposes. They may also appeal to investors who would like to create synthetic assets by combining swaps with bonds or similar securities to enhance returns. Chernenko and Faulkender (2011) show that non-financial services firms' use of derivatives that are usually interpreted as the result of hedging may possibly be due to speculation. Their panel data analysis indicates that the hedging motive is concentrated among high-investment firms, as measured by high levels of capital expenditures as a percentage of assets, due to costly external finance. Firms with more performance-sensitive executive compensation contracts appear to use interest rate swaps to speculate and to manage earnings. Regardless of the purpose, interest rate swaps are required to be recorded on the balance sheet at fair value since the adoption of the Financial Accounting Standards Board (FASB) Statement No. 133 (FAS 133) in June 1998 (Kawaller 2007). Before that time, such swaps were recognized as off-balance-sheet items. FAS 133 has been amended several times since then and is currently part of the FASB Accounting Standards Codification (ASC) 815.

Interest rate swap markets began in the early 1980s. Whaley (2006) provides an early example in 1982 when a $300 million seven-year Deutsche Bank bond issue was swapped for a return based on LIBOR. As shown in Table 9.1, these markets have grown dramatically and constitute the largest segment of the derivatives industry by a wide margin. As of June 2017, the notional amount outstanding in interest rate swaps is estimated to be $306 trillion, which is approximately 56 percent of the OTC derivatives markets (BIS 2018). The gross market value of interest rate swaps is $7.7 trillion, which amounts to more than 60 percent of OTC derivative contracts. The interest rate swap market is also very liquid with bid-ask spreads around four to five basis points. The average daily turnover in April 2016 was $1.86 trillion, corresponding to 69 percent of the OTC derivative markets (BIS 2016).

Many other variations of interest rate swaps exist. For example, both legs of the swap can be based on different floating rates of the same currency (*basis swap*), or notional principal can be amortized according to a predetermined schedule regardless of the level of interest rates (*amortizing swap*). In basis swaps, a fixed spread typically exists over one of the floating rates. The convention is to quote the spread on the shorter maturity leg so that the spread is positive. For example, consider a swap in which three-month LIBOR plus 15 basis points is paid against the six-month LIBOR. This party should pay quarterly three-month LIBOR plus 15 basis points (prorated for the quarter based on the appropriate day count convention) multiplied by the notional and receive semi-annually six-month LIBOR (prorated for six months based on the appropriate day count convention) multiplied by the notional amount. To align the payments on both legs, shorter tenor payments can be compounded.

Interest Rate Futures

Interest rate futures are exchange-traded derivatives, whose underlying instrument is either an interest rate such as three-month LIBOR or a specific debt security such as the 10-year U.S. Treasury note. The Chicago Board of Trade (CBOT) introduced the first interest rate futures contract in 1975 based on mortgage pools, called *collateralized depositary receipts* (CDRs), whose payments were insured by the Government National Mortgage Association (Ginnie Mae). Due to structural issues, this contract was unsuccessful and was delisted in the late 1980s (Johnston and McConnell 1989). Nonetheless, this market continued to grow with several innovations along the way, including the first cash settled interest rate futures contract. In 2016, more than 3.5 billion interest rate derivatives contracts traded or cleared on organized exchanges, comprising almost 14 percent of all contracts (Future Industry Association 2017).

Interest rate futures contracts are typically classified based on the maturity of their underlying instrument. This value is one year or less for short-term interest rate (STIR) futures whereas the long-term interest rate futures have an underlying instrument whose maturity exceeds one year. Table 9.3 lists the top 15 interest rate futures contracts in 2016 based on the number of contracts traded and/or cleared at 76 exchanges worldwide. The relative popularity of the STIR futures is also confirmed by other measures of market size and activity. As of September 2017, the notional amount outstanding in short- and long-term interest rate futures contracts is $31.1 and $2.2 trillion, respectively. Average daily turnover in interest rate futures reached $6.5 trillion and short-term contracts constituted 86 percent of this volume.

As the most popular exchange-traded interest rate derivative instrument, Eurodollar futures on the Chicago Mercantile Exchange (CME) have many desirable characteristics. The underlying instrument is a $1 million Eurodollar deposit with three months to maturity. Therefore, Eurodollar futures are cash settled against the three-month LIBOR fixed two days before the third Wednesday of the contract expiry month. It is quoted as an index, which is equal to 100 minus the implied annualized three-month LIBOR level at the termination date. For example, if a trader expects the underlying three-month LIBOR to be 2 percent, the trader would quote the futures price as 98 as an add-on yield (100 minus 2). As with every futures contract, Eurodollar futures are marked-to-market (MTM) daily and a one basis point change in the futures price results in a $25 change in the value of a single contract (i.e., $1 million times 0.01 percent times 90/

Table 9.3 **Most Popular Interest Rate Futures Contracts in 2016**

2016 Rank	*Contract Name*	*Exchange*	*2016 Volume*	*2015 Volume*	*Change (%)*
1	*Eurodollar Futures*	CME	654,947,336	586,913,126	11.60
2	10-Year Treasury Note Futures	CBOT	350,762,158	328,341,066	6.80
3	*1-Day Inter-Bank Deposit Futures*	BM&F	302,518,177	309,308,981	−2.20
4	5-Year Treasury Note Futures	CBOT	201,904,771	190,707,727	5.90
5	Euro-Bund Futures	Eurex	186,714,728	177,107,346	5.40
6	*3-Month Sterling Futures*	ICE Futures Europe	153,940,833	146,337,942	5.20
7	*3-Month EURIBOR Futures*	ICE Futures Europe	134,881,365	110,151,762	22.50
8	Euro-Bobl Futures	Eurex	130,704,593	118,963,514	9.90
9	2-Year Treasury Note Futures	CBOT	81,874,197	83,040,660	−1.40
10	Euro-Schatz Futures	Eurex	73,660,249	70,279,064	4.80
11	30-Year Treasury Bond Futures	CBOT	70,203,290	71,901,544	−2.40
12	*ID x U.S. Dollar FRA Futures*	BM&F	58,612,981	66,957,541	−12.50
13	Long Gilt Futures	ICE Futures Europe	53,144,942	47,917,051	10.90
14	3-Year Treasury Bonds Futures	ASX 24	51,827,874	49,308,108	5.10
15	10-Year Treasury Bond Futures	ASX 24	40,121,694	31,786,345	26.20

This table shows the top 15 interest rate futures instruments in 2016 based on the number of contracts traded and/or cleared at 76 exchanges worldwide compiled by the Futures Industry Association (FIA). The names of the STIR futures are italicized. The number of contracts traded and/or cleared in 2015 and the percentage change between the two years are also reported.

Source: Futures Industry Association (2017).

360). For example, a long position in one Eurodollar futures contract would lose $250 if the quoted price falls by 10 basis points from 98.2 to 98.1 in one day. A long position in Eurodollar futures is comparable to a short position in an FRA as both suffer from an interest rate decline.

Among all the specifications of the contract, the most unusual one compared to other exchange-traded derivatives is the number of expiry dates available at any given time and its maturity structure. Eurodollar futures contracts have maturities in March, June, September, and December for up to 10 years into the future and an additional four nearest-month other than these four standard maturity months, resulting in a total of 44 contracts (Hull 2018). For example, in January 2018 a trader can use Eurodollar futures to speculate on the three-month LIBOR in February 2018 or hedge against the three-month LIBOR in December 2027. This range creates such versatility that many traders consider Eurodollar futures to be the best hedging vehicle for a wide range of situations. As expected, they can be used to trade the short end of the yield curve or to hedge positions in long-term interest rate swaps.

Within the category of STIR futures, other instruments are based on three-month interest rates of different currencies as listed in Table 9.3. On the short end, some instruments are linked to overnight rates such as the 30-day Fed funds futures contract, which is based on the average daily fed funds effective rate for the contract delivery month.

Among the long-term interest rate futures contracts, CBOT's U.S. Treasury Note/Bond futures is particularly important. As of January 2018, eight versions of this contract were available that only differ with respect to the maturity specifications for the underlying U.S. Treasury security that would be delivered physically. For the Treasury bond futures contract, any government bond that has between 15 and 25 years to maturity on the first day of the delivery month can be delivered. An Ultra version of this contract has been available since 2010, where any U.S. Treasury bond with maturity greater than 25 years can be delivered. In the 10-year Treasury note futures contract, any U.S. Treasury note with a maturity between 6.5 and 10 years can be delivered. Ultra 10-year Treasury note futures are restricted to Treasury notes with a maturity of at least nine years and five months. The five-year, three-year, and two-year Treasury note futures contracts have different restrictions with respect to the remaining maturity but require that the deliverable note must have an originally stated maturity less than 5.25 years.

Given the range of alternatives, the short party chooses which bond or note to deliver. Although the range of alternatives may appear confusing, it is aimed to minimize the possibility of a *short squeeze*, which is a situation in which a lack of supply and an excess demand occurs in the Treasury bond market, by avoiding the market to be cornered in a limited supply Treasury issue. Conversely, the short party would rationally choose the bond cheapest-to-deliver (CTD) among other alternatives. To provide fairness to the long party, CBOT publishes a conversion factor for each eligible bond to convert each to a hypothetical 6 percent coupon bond.

Treasury bond futures are quoted similarly to the way bonds are quoted in the spot market (i.e., as a percentage of the par with points and fractions of one thirty-seconds (1/32) of a point). For example, a quote of 123-4 means 123 and 4/32 or 123.125. Thus, the buyer agrees to pay 123.125 percent of par value and accepts delivery of the bond. Unlike the wide availability of the expiry months for the Eurodollar futures, Treasury futures have only four contract months in March, June, September, and December.

On the delivery date, the short party delivers an eligible U.S. Treasury bond from the deliverable basket to the buyer of the futures contract. In return, the buyer must pay an amount called the *invoice price*, which is computed as sum of the futures price multiplied by the conversion factor of the delivered bond plus the accrued interest on the delivered bond. The conversion factor calculation rules specified by CBOT include rounding procedures and are imperfect in creating an equality across all eligible bonds that can be delivered. Because the conversion factor is not a perfect multiplier, the short party chooses the bond that is CTD by comparing the invoice price against the full (dirty) price of the bond.

Similarly, structured long-term interest rate futures contracts are available in other currencies. For example, in Eurex, EUR-denominated bond futures are available for underlying bonds issued by Germany with the names Euro-Buxl, Euro-Bund, Euro-Bobl, and Euro-Schatz, in the order of decreasing maturity.

Interest Rate Options

A *call option* gives the right to buy the underlying asset whereas a *put option* gives the right to sell the underlying asset for a predetermined price (strike/exercise price) on or before a predetermined future date (expiration). When the underlying asset is a futures contract, a call option gives the right to take a long position in the underlying futures contract whereas a put option gives the right to take a short position.

As of January 2018, all U.S. exchange-traded interest rate options are options on interest rate futures. In 1982, CME and CBOT introduced option contracts on Eurodollar futures and Treasury futures, respectively. As shown in Table 9.4, these futures have been extremely successful and are very popular. As of September 2017, the notional amount outstanding in options on short- and long-term interest rate futures contracts is $51.4 and $0.9 trillion, respectively. Average daily turnover in all options on interest rate futures reached $1.8 trillion.

Table 9.4 **Most Popular Interest Rate Options on Futures Contracts in 2016**

2016 Rank	*Contract Name*	*Exchange*	*2016 Volume*	*2015 Volume*	*Change (%)*
1	Eurodollar Options	CME	168,254,035	112,278,366	49.90
2	Eurodollar/Mid-Curve Options	CME	140,529,194	131,374,348	7.00
3	10-Year Treasury Note Options	CBOT	98,504,626	97,821,923	0.70
4	IDI Index Options	BM&F	50,194,640	31,762,121	58.00
5	Euro-Bund Options	Eurex	34,904,716	45,385,172	–23.10

This table shows the top five options on interest rate futures in 2016 based on the number of contracts traded and/or cleared at 76 exchanges worldwide compiled by the Futures Industry Association. The number of contracts traded and/or cleared in 2015 and the percentage change between the two years are also reported.

Source: Future Industry Association (2017).

Most options on futures are *American style*, which means the option can be exercised any time before the expiration date. The expiration date of a futures option is usually a short period of time before the last trading day of the underlying futures contract (Hull 2018). For example, options on Eurodollar futures expire together with the underlying futures on the second day before the third Wednesday of the contract month. CBOT Treasury bond futures option expires on the latest Friday that precedes by at least two business days the end of the month before the futures delivery month. In contrast, the Eurodollar mid-curve option expires much earlier than the underlying futures contract.

CBOE and the American Stock Exchange (AMEX) have tried to develop options on specific bond issues, but they have been unsuccessful, possibly because of too many debt issues. Conversely, OTC option dealers provide options on specific bonds as well as other types of interest rate options. Among these OTC interest rate options, the most commonly used ones are caps, floors, collars, and swaptions. The seller of a cap agrees to make a payment to the buyer of the contract if a floating reference rate exceeds a predetermined exercise rate of the cap on multiple given future dates. In contrast, the seller of a floor does the same if the reference rate falls below the exercise rate. From the buyer's perspective, caps and floors are like swaps, whose net cash flows are bounded below at zero. Based on the payment conditions specified between the reference rate and the exercise rate, the buyer cannot make a payment. A collar is designed by taking opposite positions in a cap and a floor. Finally, a swaption is an OTC option that gives the holder a right to enter into an interest rate swap contract at a future date.

OTC interest rate option markets are comparable to the exchanges in terms of size and trading activity. As of June 2017, the notional amount outstanding was $37 trillion and the gross value of OTC interest rate options was $764 billion (BIS 2018). Average daily turnover in April 2016 was estimated to be $163 billion (BIS 2016).

Credit Default Swaps

All the derivative instruments discussed up to this point focus on interest rate risk, which is a type of market risk. However, investors in debt securities are also exposed to *credit risk*, which arises because issuers of debt securities (i.e., borrowers) or counterparties in derivatives transactions may default on their obligations.

Debt buyers or investors can protect against credit risk by trading credit derivatives, which are considered a subset of fixed income derivatives. The most commonly used credit derivative is a credit default swap (CDS). JP Morgan engineered the first CDS in 1994 to give Exxon a credit line for the Valdez liability resulting from an oil disaster (Augustin, Subrahmanyam, Tang, and Wang 2016). The CDS market exploded after 2000, reached its peak in 2007 at $58 trillion in notional amount outstanding, and dramatically declined to $9.6 trillion as of June 2017 (BIS 2018). The compression effect, also observed in the interest rate swaps, partly explains this drop. Even though the emergence of CDS indices, which now account for 44 percent of the CDS market compared to only 25 percent in 2010, has prevented the market from shrinking further, the dominant factor in the decline has been the complete collapse of the synthetic collateralized debt obligation (CDO) market that directly fed the CDS originations.

Although its name contains the word "swap," a CDS is more comparable to a put option because it provides protection against the risk of a default by a corporate or sovereign debt issuer. The issuer is known as the *reference entity* and its default is considered a credit event and triggers a payment from protection seller to protection buyer. In the case of physical settlement, the CDS buyer has the right to sell bonds issued by the company or country for their face value to the protection seller when a credit event occurs. The total face value of the bonds that can be sold is known as the notional principal of the CDS. Most standard CDS contracts now settle through an auction process, which lends itself to cash settlement as well as an equivalent of the physical settlement explained above.

The CDS buyer makes periodic payments to the seller until the end of the life of the CDS or until a credit event occurs. The total amount paid per year, as a percent of the notional principal, is called the *CDS spread*. Before April 2009, the CDS premium payments were made in arrears every quarter from the trade date onward using the day count convention of actual/360. Central clearing demands have been so strong in this market that regulatory efforts have been made for product standardization (Markit 2009). Since April 2009, barring a few differences between North America and the rest of the world, the standard CDS contract has fixed coupon payments (e.g., 100 basis points for investment grade credit and 500 basis points for high yield credit in North America) and quarterly maturities that match the International Monetary Market (IMM) dates of March 20, June 20, September 20, and December 20. These dates also coincide with the quarterly coupon payment dates for a given CDS. This standardization implies that a standard CDS requires an upfront payment that accounts for not only the accrued interest between the trade date and the first coupon payment date, but also any potential difference between the conventional CDS spread and the fixed coupon rate. Furthermore, if the CDS spread is lower than the fixed coupon, the buyer of the CDS can potentially receive this upfront cash payment.

For a CDS buyer, if the reference entity does not default during the life of the CDS, nothing is received in return for the coupon payments. If the reference entity defaults, most standard CDS contracts are now hard-wired for an auction, which is used to determine the recoverable value for the bonds in default. This auction takes place about 30 days after the credit event. In the case of cash settlement, the seller of the CDS pays the buyer the difference between the principal and the auction-determined value for the bonds (i.e., the recovered amount).

Summary and Conclusions

Interest derivatives markets have a shorter history compared to other derivatives dating back to mid-1970s and early 1980s. Nevertheless, their growth has been dramatic especially after 2000. OTC interest rate derivatives markets are by far the biggest segment in the world of derivatives led by interest rate swaps. Forward rate agreements, which can be viewed as building blocks for the interest rate swaps, are also used extensively. These very popular products, in their most standard forms, are now cleared mostly via central counterparties. Furthermore, market optimization processes such as compression has given these markets an exchange-like liquidity and effectiveness.

Organized exchanges also introduced very successful and innovative products to meet the demand for efficient means for managing interest rate risk. Eurodollar futures and Treasury bond/note futures, as well as their options, provide investors with liquid and effective tools to gain or reduce exposure to the changes in future interest rates. In the case of Eurodollar futures, volatility of future short-term interest rates as long as 10 years from today can be hedged. More recent innovations, such as Ultra Treasury bond futures, render duration-based strategies more effective.

Participants in debt markets are exposed to both interest rate and credit risk. To mitigate this latter risk, the OTC fixed income derivatives markets provides several credit derivatives of which the CDS is the most popular. This market has survived the troubling events during the financial crisis of 2007–2008 and is more tightly regulated than previously.

Discussion Questions

1. Discuss the size of the interest rate derivatives market in both absolute and relative terms using different measures.
2. Identify the key dates for a forward rate agreement and discuss their role in its trading mechanism.
3. Discuss the characteristics of the Eurodollar futures contract.
4. Discuss the main features of a credit default swap.

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10

Short-Term Funding and Financing Alternatives

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Introduction

Short-term funding is traditionally defined as any financing solution with a maximum maturity of 12 months. It is typically excluded from the long-term debt portion of the capital structure and classified as a current liability on a borrower's balance sheet. Short-term financing is generally used to provide a firm or individual with *working capital* (i.e., cash to fund short-term operations) or sufficient liquidity to achieve a specific near-term business goal such as funding a large customer order. Both the extension of credit by the lender and acceptance by the borrower must be evaluated by balancing the potential risks and returns of the contemplated financial transaction. This chapter explores several prominent short-term financing solutions available in the market today and the key components that participants should consider.

Commercial Paper

Commercial paper is a money market instrument issued by firms requiring short-term funding and can be issued by either financial or non-financial firms. The quality of commercial paper is derived from the issuer's credit rating, the issue's maturity, and whether the security is collateralized using financial or physical assets, which is known as *asset-backed commercial paper*. Because commercial paper is typically unsecured, it is issued by firms with high credit ratings as a lower-cost alternative to short-term borrowing from banks (Hawawini and Viallet 2011).

As lenders can obtain commercial paper directly from issuing firms, the primary market for commercial paper is much more active than the secondary market. Without an active secondary market, commercial paper liquidity is limited; issuing firms typically repurchase the issue directly from the lender before maturity (Ross, Westerfield, and Jaffe 2016).

Although money market instruments typically have maturities of 12 months or less, commercial paper maturities range from one to 270 days in the United States and up to one year in Europe. A firm wanting to issue commercial paper with a maturity greater than 270 days must file a registration statement with the Securities and Exchange Commission (SEC). According to the U.S. Federal Reserve, the average commercial paper maturity is 30 days (Board of Governors of the Federal Reserve System 2017).

Using data from the Depository Trust & Clearing Corporation (DTCC), the Federal Reserve Board publishes information on domestic and foreign commercial paper market activity via its website. These data include aggregate issuance rates and volumes for AA financial, AA and A2/P2 non-financial, and AA asset-backed commercial paper issuances of various maturities, providing market participants with average term structures of interest rates for each type of commercial paper. Within a given category of commercial paper, issuance rates rise with increasing maturity to compensate investors for accepting additional risk by providing financing over a longer time horizon.

The yield earned by lenders (commercial paper investors) is typically 10 to 20 basis points (bps) above Treasury bills (T-bills) with the same maturity. This additional yield is necessary because gains on commercial paper are not exempt from state and local taxes (Council of UC Faculty Associations 2017). From the borrower's perspective, the short-term funding obtained from issuing commercial paper can be used to finance working capital or other investments. The profit earned by commercial paper issuers (borrowers) is the difference between the yield on investments earned with the short-term funding obtained from commercial paper issuance and the lower yield paid to commercial paper investors (lenders).

A common practice with commercial paper issuers is *rollover* or paying off lenders of maturing issues with cash received from new issues. This practice introduces one potentially major risk with commercial paper known as *rollover risk*. A change to the issuer's credit prevents the firm from issuing new commercial paper and renders it unable to pay off maturing issues. To mitigate this risk, issuers should secure their commercial paper issues by obtaining backup lines of credit in exchange for a fee paid to the bank (Stojanovic and Vaughan 1998).

Letters of Credit

A *letter of credit* (LC) is a conditional commitment from a bank or financial institution to make a payment to a party on behalf of a second party if certain requirements are met. Many types of LCs are available for different business purposes, but fundamentally an LC's purpose is to provide a guarantee of payment. The predominant use of commercial LCs is to support international trade between parties unfamiliar with each other. For a fee, a buyer's bank guarantees payment to the seller's bank upon completion of the buyer's and seller's transaction, which is typically the delivery of goods. A *standby letter* *of credit* is another type of LC used as a form of insurance against failure to complete an agreement. Under these LC structures, payment only occurs if the transaction does not go as planned. Standby LCs might be issued as a backup payment guarantee in the same transaction where a commercial LC is issued as the primary payment mechanism. Standby LCs are more commonly used as security for commercial property leases or collateral for bonds issued to investors. LCs are governed by the Uniform Customs and Practice for Documentary Credits (UCP600 as of 2007), which are established by the International Chamber of Commerce (Dolan 2007).

LCs can be an effective commercial tool because their payment assurance allows business transactions to occur between parties that would otherwise lack the security or mutual trust required (Seeruwani 2012). In new business relations, particularly between foreign parties, buyers are often reluctant to make advance cash payments to sellers who have not demonstrated their ability to deliver quality goods in a timely fashion. Likewise, a seller hesitates to invest its own capital in providing goods to a buyer who lacks an established payment history or cash for a deposit payment. Buyers can request that their bank provide a commercial LC guaranteeing full payment to sellers if all documented conditions are met without exception. Banks require the LC to include a detailed list of conditions such as dollar amount, delivery date, LC expiration date, and legal names and addresses of involved parties. Required documents often include bill of lading, packing list, proof of insurance, and certificate of inspection.

For banks to remit payment, all requirements must be met under the precise language of the LC. If the smallest detail is not met, including an altered delivery date or misspelled name, a bank can refuse to make payment until a new, revised LC has been issued. The LC-issuing bank considers the agreement's terms fulfilled once all required documents are presented. Satisfaction of the parties plays no role in the bank's decision to release funds. Buyers and sellers should therefore ensure that all key commercial terms are documented properly in the LC. Savvy buyers include the inspection certificate among the documents to be presented to the bank before payment to ensure that the goods delivered are satisfactory before the seller is paid (Vishny n.a.).

Four different parties are typically involved in an LC transaction: (1) the buyer, (2) the buyer's bank issuing the LC (the issuing bank), (3) the seller, and (4) the seller's bank coordinating receipt of payment via LC (the advising bank). Once a buyer and seller agree on transaction terms, the buyer issues a purchase order to the seller for the value of the purchased goods. The buyer then approaches its bank to issue an LC for the transaction. The LC-issuing bank completes its due diligence before agreeing to issue the LC. This action normally includes verifying the potential order and reviewing the buyer's creditworthiness and business history. The bank often requires cash collateral for the LC, resulting in the buyer pre-funding the purchase in an issuing bank–controlled account until the transaction is completed and payment to the seller is due. In other instances, a bank might extend credit to the buyer rather than require cash collateral. Banks only extend such credit to borrowers with strong credit backgrounds, and the fees to the borrower would be higher because the bank is putting its own capital at risk.

Once the LC is approved, the seller engages its own bank as the advising bank in the transaction. The advising bank must also be approved by the issuing bank to act as intermediary for the transfer of funds. The advising bank inspects all LC documents for accuracy and informs the seller when shipment of goods can occur. Upon shipment, all shipping documents are forwarded to the issuing bank for inspection. If all requirements documented in the LC are met, the issuing bank transfers funds to the advising bank to hold in escrow until further authorization. Once the buyer receives the goods, the buyer remits payment to the issuing bank. After this step, the issuing bank authorizes the advising bank to release funds to the seller and the transaction is complete. An LC's tenor varies by business transaction. The maximum tenor is typically one year with the option to renew annually, but the tenor can be as short as the predetermined period required for a seller to produce and deliver goods to a buyer (Federal Financial Institutions Examination Council 2015).

Although LCs help to mitigate the risks inherent in international business transactions, risks still exist for the involved parties. Buyers and sellers bear some degree of counterparty risk and must have confidence that the issuing and advising banks they select will follow through on the payment once the seller has fulfilled its obligation and is entitled to draw down on the LC. Sellers also risk delayed payment or nonpayment if the issuing bank rejects a draw on the LC due to the seller's inability to produce the required documents or an error during the documentation process. The buyer risks delayed or damaged goods without recourse if it failed to include appropriate documentation in the LC's requirements. The issuing bank assumes the largest risk in the transaction. Buyers could default on their payment or go bankrupt, leaving the issuing bank obligated to pay the seller and incur a loss of capital. Sellers could submit fraudulent documentation to the banks and receive payment without having fulfilled all of their obligations. Additionally, potential legal and political risks are inherent in transactions involving countries in unstable environments. Issuing banks will seek to obtain adequate security during the due diligence process. If cash collateral is infeasible, the issuing bank often files a first priority lien against the buyer's assets. This lien is lifted once the transaction is complete and all parties are made whole. The advising bank does not incur financial risk unless it agrees to such a role in advance. Its role is traditionally administrative in nature, and it does not employ its own capital in the transaction.

Because the bulk of the risk in an LC transaction lies with the issuing bank, it seeks to charge fees sufficient to earn a risk-adjusted return. Longer tenor LCs are more expensive for buyers because of the perceived higher risk. Buyers can expect to incur LC fees in at least three categories: (1) up-front issuance fees, (2) administrative fees, and (3) interest fees. Banks generally charge a minimum issuance fee on LCs below a predetermined amount. This fee converts to a percentage of the LC amount as its size increases. Traditionally, this charge has been 1 percent, though it is a market-driven rate and varies accordingly. Because LCs have a maximum tenor of one year, any LC outstanding longer than 12 months must be renewed before its one-year anniversary and incurs the same issuance fee again. Various administrative fees are charged on each LC, which increase the buyer's cost of funds by an immaterial amount. Additionally, the issuing bank charges the buyer a pre-determined interest rate on the total LC amount for its duration. Interest rates are typically pegged to a common benchmark such as the London Interbank Offered Rate (LIBOR) or the federal (Fed) funds prime rate, with a spread added to increase the bank's overall return. The advising bank also charges its own fees, though these are often a low dollar amount or small percentage of the total LC amount. The seller traditionally bears these fees rather than the buyer because the advising bank represents the seller. When used judiciously between reputable parties, LCs can be an effective method for expanding businesses both commercially and geographically.

Repurchase Agreements

Repurchase agreements, also known as repos, are sales of securities by a bank or securities dealer with an agreement to repurchase them back at a higher price on some future date as specified in the agreement. Although repos are formally an agreement of sale and repurchase, they are treated as collateralized loans for accounting and tax purposes. The borrower provides securities to the lender in exchange for cash, which gives the borrower a source of short-term financing for operations or investing. For the borrower, the difference between the initial sale price and the repurchase price is called the *repo rate* and is effectively the interest paid to the lender on an annualized basis. The lender receives collateral in the form of securities typically valued in excess of the loan amount. The difference between the collateral value and the loan amount is known as the *haircut*. From the lender's perspective, the agreement is called a *reverse repurchase agreement* or *reverse repo*.

The collateral used in repurchase agreements can be virtually any financial security, ranging from lower-yield U.S. Treasury securities to asset- or mortgage-backed securities. The risk associated with a repo is based on the credit rating of the borrower (i.e., the ability to repay the loan at maturity), quality of the collateral (i.e., its value over the life of the loan), and the maturity, or tenor, of the agreement. Repurchase agreements can be classified as either *term repos* with an established repurchase date, typically overnight or within a few days, or *open repos* with no established repurchase date. As the tenor of the agreement increases, the counterparty risk to the lender also increases.

Bilateral repos involve two parties—the borrower and the lender—establishing the agreement directly with each other. Typically, bilateral repos are interdealer or interbank agreements. The Fixed Income Clearing Corporation (FICC) processes about $400 billion in overnight settlements of bilateral repo transactions collateralized with U.S. Treasury securities (Bowman, Louria, McCormick, and Styczynski 2017). By comparison, tri-party repos involve the borrower and lender along with a third-party bank that provides both parties with accounts to manage cash and collateral exchanges, and collateral valuation and settlement services. The Federal Reserve Bank of New York detailed the following benefits of the tri-party repo market to the health and stability of U.S. financial markets: (1) increased market liquidity and price transparency for government and corporate securities, (2) the two tri-party clearing banks (Bank of New York Mellon and JP Morgan Chase) operate other payment clearing and settlement services central to U.S. markets, and (3) provide critical funding for broker-dealers who make markets in government and corporate obligations (Federal Reserve Bank of New York 2017).

Central banks set monetary policy and can indirectly influence the money supply by setting the repo rate. When the central bank lowers the repo rate, financial institutions are encouraged to act as borrowers. These banks enter into repos and sell securities to the government in exchange for cash, which increases the money supply. Conversely, when the central bank moves to increase the repo rate, financial institutions are less motivated to use repos as a source of short-term cash. With fewer banks entering into repos with the government, the available money supply effectively decreases. Central banks can also use reverse repos to raise target interest rates without selling large amounts of securities. By acting as a borrower from financial institutions and repaying the lender overnight, the central bank allows lenders to effectively hold an interest-earning reserve deposit. Those lenders would have no incentive to issue loans at rates below what the central bank offers them, which allows the reverse repo rate to function as a lower bound for the federal funds rate. Therefore, central banks can increase short-term interest rates by increasing the reverse repo rate (Wessel and Sastry 2015).

Asset Based Loans

This section discusses accounts receivable factoring and purchase order financing, which are two types of short-term funding that are secured by a firm's assets.

Accounts Receivable Factoring

Accounts receivable factoring is a form of secured lending whereby a borrower sells its accounts receivable to a lender (the factor) at a discount from face value in exchange for an advance cash payment of the company's invoices. Often associated with the negative connotation of "lenders of last resort," accounts receivable factoring has a long history as an effective business financing tool. The earliest verified examples of factoring date back to fourteenth-century England merchants who financed the manufacturing and sale of clothing and textiles (Flaxman, Tatge, and Tatge 2009). Present-day factoring is used within a range of industries, including medical, trucking, and manufacturing. The majority of factor financing still occurs within the fashion and textile industries due to their long collection cycles.

Factoring remains a useful short-term financing resource for several reasons. First, accounts receivable factoring allows a business to improve its liquidity by converting its invoices into cash faster than customers pay their invoices. Sellers and manufacturers of goods often lack the cash or credit required to purchase goods from suppliers. Sales to customers subsequently slow and the ability to meet customer demand is impeded. Accelerating collections and renegotiating supplier payment terms can improve cash flow, but these solutions are sometimes unavailable or insufficient to address a company's working capital needs. Factor financing can help address these needs.

Second, factors historically have a larger appetite for lending to borrowers that traditional banks consider "un-bankable." This term is characterized by businesses that lack a pristine financial history or are currently in a challenging financial position. Because a borrower's accounts receivable are the underlying assets in a factoring arrangement, factors base their credit decisions primarily on the financial strength of a borrower's customers, such as their ability and willingness to pay their outstanding invoice obligations, rather than the borrower themselves.

Third, a borrower can structure the sale of its accounts receivable to a factor as either *full-recourse* where collection risk stays with the borrower or *non-recourse* where collection risk transfers to the factor. In a non-recourse structure, the cash advanced by the factor to the borrower is not recorded as a liability on the borrower's financial statements. Accounting professionals refer to this as “off-balance sheet debt” because it allows a borrower to access short-term financing without increasing its amount of total debt (KPMG 2014).

Finally, a factor can provide valuable services to a business beyond access to working capital. Factors perform credit analysis on the borrower’s customer base and share insights with the borrower during the due diligence process. The factor also provides back office support to the borrower by monitoring the aging of a borrower’s accounts receivable and collecting outstanding invoices, as well as pursuing delinquent customers for past due payments.

The mechanics of accounts receivable factoring are straightforward yet possess some distinctions from traditional bank financing. A typical financing structure involves two parties: (1) the borrower (seller of the goods) and (2) the lender (financial institution, generally a bank). A factoring structure involves three separate parties: (1) the borrower (seller of the goods), (2) the debtor (buyer of the goods), and (3) the lender (financial institution, which in this case is a factor). The seller seeks short-term funding for its business and sells its accounts receivable to a factor at a discount from face value of between 75 and 90 percent in exchange for cash. The factor assumes ownership of the seller’s invoices, as well as the risk and responsibility for collection. The factor holds back the 10 to 25 percent invoice balance as a reserve until the invoices have been fully collected. The seller then receives the balance, less the agreed factor fees. The factor determines this discount percentage up front based on the debtor’s creditworthiness, collectability of the invoices purchased, stability of the seller’s industry, and the factor’s required risk-adjusted return. The reserve amount can also offset any returned or damaged merchandise that might reduce the invoice’s value (Saulnier and Jacoby 1943). Once the collection cycle is completed, it starts again with new invoices from the seller.

Because factoring is considered an alternative form of financing, it can often be more expensive than traditional bank financing. Factors generate their returns by charging an administrative fee, usually 1 percent minimum, on the factored invoice’s face value, as well as a daily interest rate on the invoices until they have been collected. The seller agrees to pay these fees to the factor in exchange for the cash advance and the transfer of collection risk. The interest rate charged is typically floating and based upon a spread to prime or LIBOR. A common practice is for a borrower to pay between 5 and 10 percent in interest. Different factoring institutions have different pricing models and rates charged are market driven.

Both the seller and the factor must consider the risks of factor financing. Before entering into a factoring arrangement, a seller must complete its own internal analysis to ensure that it can bear the financing costs. Businesses with high gross profit margins and the ability to generate excess earnings beyond the cost of funds are typically the most successful with factoring. Sellers also want to ensure that the factor they engage has an established reputation of integrity and professionalism because factors require access to confidential financial information and reasonable control over financial operations during the financing arrangement. The factor is often a visible third party in a seller’s business relationship with its customers and the seller must consider the impact of this dynamic before proceeding.

A successful factor completes a rigorous due diligence process of a seller and its debtors before providing funding. Debtor default on invoices purchased by a factor can result in a major loss of capital investment. Failing to identify seller fraud (e.g., issuing fake invoices or collecting invoices already sold to a factor without remitting the funds) can be a mistake that often leads to costly and time-consuming litigation without the guarantee of recouping funds. Factors must also complete a Uniform Commercial Code (UCC) search to ensure that the purchased invoices have no prior ownership claims from other parties (Clark 2004). Directing all debtor payments into a factor-controlled bank account can provide additional security for the factor. Factors seek to mitigate risk by focusing on industries in which they have expertise. This attention allows them to make informed decisions when seeking new opportunities to deploy available capital and earn the highest risk-adjusted return.

The tenor of a factor financing can last as short as the collection cycle on a single batch of factored invoices, but typically a factor seeks a minimum 6- to 12-month commitment from a seller. Successful factor financing relationships can last for decades between the right partners. Although accounts receivable factoring may not be a household name in finance, it can be a useful form of short-term funding for those in need of working capital augmentation.

Purchase Order Financing

Purchase order (PO) financing is similar to factoring but takes place earlier in a company's sales cycle. Businesses eligible for PO financing are limited to sellers of physical goods and hence exclude service providers and wholesale manufacturers because the products in question are part of the collateral for PO financing companies. The funding mechanics work as follows. A seller first receives a PO from its customer for goods to be delivered. The seller must then fund the purchase of these goods. Sellers typically use PO financing when they lack either the up-front capital to buy the goods or the ability to obtain credit from a supplier. After receiving the PO, the seller contacts the financing company and requests funding to fulfill the purchase order. The PO funder then contacts the seller's customer to verify that the order is legitimate and noncancelable. The financing company will not fund an order that may be canceled because this could result in a loss of its invested capital. At the same time, the PO funder engages a factoring institution to underwrite the transaction. The factor agrees to advance funds on the anticipated invoice and remits them directly to the PO funder rather than the seller.

Before a factor finalizes the underwriting, it completes due diligence on all key parties—the borrower who sells the goods, customer who buys the goods, and initial supplier of the goods. Review of financial statements and operating history is standard, as well as physical inspection of the goods sold. Like factoring, the crux of the lending decision is based on the creditworthiness of the borrower's customers. Lenders that deem a particular funding request higher risk might require a personal guarantee from the borrower as security. A *personal guarantee* is a legally binding commitment that gives a lender recourse to pursue a borrower's personal assets if a business defaults on its obligation and cannot make the lender whole. These agreements are common with newer or less stable businesses, but borrowers with established business histories generally avoid them.

Upon completion of due diligence, the PO funder issues an LC to the supplier's bank and authorizes the supplier's access to funds after confirming satisfactory delivery of goods to the customer. PO funders recover their capital outlay and required return via the funds remitted by the factor's advance. If the advance amount exceeds the amount owed to the PO funder, the balance is paid to the seller. Once the customer pays the invoice for goods delivered, the factor remits the balance due to the seller, less the factor's required fees. Figure 10.1 illustrates the mechanics of the PO financing process.

Similar to factoring, many of the businesses using PO financing lack the stability to be considered "bankable" and are required to pursue higher cost capital. PO financing can be cost prohibitive for many sellers, with annualized interest rates sometimes exceeding 15 to 25 percent. Borrowers should clearly understand the advertised interest rates for PO funding because some lenders refer to a weekly interest rate versus a monthly rate. This difference can materially affect the borrower's cost of capital. The borrower may incur additional administrative fees and approval fees, but these are a small component of the total expense. Because of the high overall cost involved with PO financing, the borrower is required to maintain a 20 to 30 percent gross profit margin to qualify for funding. PO funders also often require a minimum funding amount to lock in a minimum guaranteed return on their invested capital. The tenor of a PO financing is usually less than 90 days, with an average of 45 days per transaction (TFG Finance Limited 2017). Table 10.1 illustrates the economics and timing of a PO financing.

As Table 10.1 shows, the borrower pays fees to both the PO funder and the factor. Including a factor in the transaction can reduce the borrower's cost of capital, as the factor provides less expensive financing than the PO funder and allows the PO funder to be "taken out" of the transaction earlier than if the PO funder waited to collect the customer's invoice. In this example, the PO funder charges the borrower a daily interest rate of 0.03 percent on the amount of funds advanced. Over a period of 45 days, this earns the lender a return of 1.5 percent (annualized return of 12 percent). Repeat

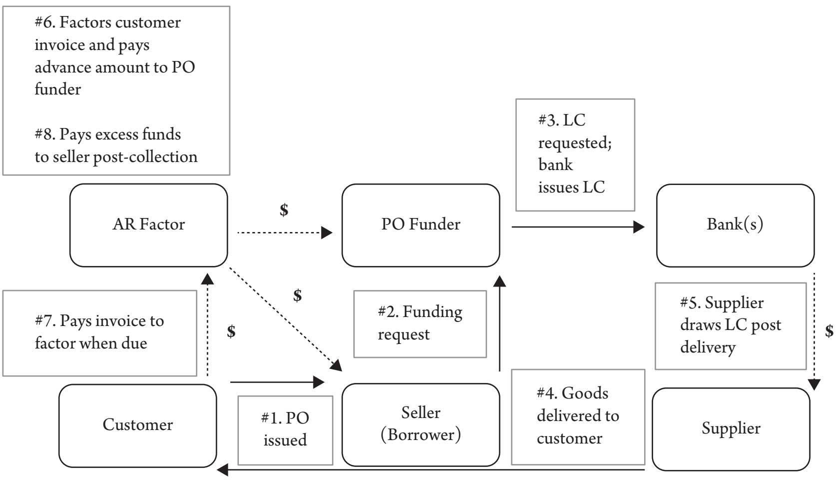

Figure 10.1 Purchase Order Financing Mechanics Illustration
This figure shows the mechanics of a PO financing between the various parties.

Table 10.1 **Example of Purchase Order Financing**

(Units in $s)		
Customer purchase order amount (future invoice amount owed to the seller)	$65,000	(a)
Seller's cost of goods sold (amount owed to the seller's vendor)	$50,000	(b)
Seller's initial gross profit margin (29 percent is within target 20 to 30 percent range)	$15,000	(c) = (a) – (b)
Letter of credit/cash amount required to pay the seller's vendor	$50,000	(d) = (b)
Daily PO financing interest rate of 12 percent annually or 1 percent per month	0.03%	(e)
Number of days for goods to arrive from the vendor to the end user (seller's customer)	45	(f)
Seller's financing cost on purchase order	$740	(g) = (d)(e)(f)
Invoice amount owed by the customer to the seller	$65,000	(h) = (a)
Factor's advance rate on invoice	85%	(i)
Value of advanced portion of invoice from the factor to the seller	$55,250	(j) = (h)(i)
Amount available for the seller's working capital (less PO amount plus fees)	$4,510	(k) = (j) – (d) – (g)
Daily invoice factoring interest rate of 6 percent annually or 0.5 percent per month	0.02%	(l)
Number of days for the end user (seller's customer) to pay invoice	60	(m)
Seller's financing cost on factored invoice	$545	(n) = (j)(l)(m)
Total financing cost to seller	$1,285	(o) = (g) + (n)
Seller's gross profit margin before financing costs (23 percent)	$15,000	(p) = (c)
Seller's gross profit margin after financing costs (21 percent)	$13,715	(q) = (c) – (o)

This figure shows the economics of a sample PO financing transaction and its impact on a borrower's profit margin.

transactions between borrowers and lenders can be mutually beneficial. As the parties develop a track record, lenders can earn their target annual return by redeploying capital in progressively less risky transactions. Borrowers who establish a positive track record with a PO funder can benefit from having access to reliable sources of working capital to fund future transactions, and their businesses can grow as a result.

Revolving Credit Facilities

Revolving credit facilities, often referred to as *revolvers*, are secured forms of financing that provide commercial borrowers with access to short-term liquidity on an as-needed basis. Businesses pursue these facilities because they allow for uninterrupted operations during periods of tight cash flow, as well as the ability to pursue time-sensitive business opportunities (i.e., funding a large customer purchase order) that might not otherwise be feasible. Because banks are the most common providers of revolving credit facilities, this review focuses on the prevalent terms in a traditional bank revolver.

Revolvers act similar to a credit card whereby the borrower is granted a maximum amount of credit at inception and may continue to borrow up to this maximum amount if the borrower makes regular payments toward the outstanding balance due. Unlike a credit card, a commercial line of credit has a predetermined tenor and limitations on using the proceeds, which are generally only for working capital purposes to support business operations. A revolver's tenor can vary from 12 months to five years to "evergreen," which is an automatic renewal structure. Conservative lenders prefer to extend credit of one year with the ability to renew before maturity. Cognizant borrowers should seek a longer commitment when possible to secure longer-term working capital stability.

Before issuing credit, banks perform due diligence to determine the maximum facility size, pricing terms, and credit enhancements required for the borrower to secure the loan. The bank completes a physical audit of the borrower's assets to ascertain the collateral's adequacy for the financing. Banks seek a first priority lien on all of the borrower's assets if such a position is available. Various security structures can be devised based upon the lender's risk appetite, but at a minimum, borrowers are generally required to pledge a security interest in their accounts receivable. Reviews of financial records are standard, as well as an analysis of the borrower's projected performance throughout the tenor of the credit facility. A revolver's borrowing availability can also be determined by an advance rate against the value of the borrower's eligible accounts receivable. The advance rate is similar in concept to the one employed in factoring, but under the revolver's structure the borrower merely pledges its accounts receivable as collateral while retaining ownership of the assets. The assets remain on the borrower's balance sheet, along with the balance due on the revolver. This repayment obligation is recorded as a current liability and increases the borrower's total leverage. Finally, banks require ongoing reporting of operating and financial performance. The borrower must submit audited or reviewed financial statements along with proof of compliance with financial covenants imposed by the bank. These covenants require the company's performance to meet certain liquidity and profitability thresholds in order to maintain access to the credit facility (Clifford Chance LLP 2014).

A borrower's cost of funds under a revolving credit facility are lower than nontraditional funding sources such as factoring or PO financing for several reasons. First, banks have stricter lending requirements and extend credit only to borrowers with several years of profitable operations. Stable projections for the borrower's enterprise and overall industry also affect pricing. Second, the interest rate is market driven. More competition from lenders can drive down the cost for the borrower. Finally, revolvers are commonly provided to borrowers as a complementary piece of a larger overall banking relationship. Banks often offer working capital revolvers to borrowers who have also secured a larger term loan with the bank or are using the bank for its ancillary services such as treasury or investment management. These additional earnings allow banks to keep the borrower's revolver costs competitive while still earning their own overall target return.

When a bank extends revolving credit to a borrower, it is committing its own funds in an amount equal to the facility's limit. Because borrowers can draw down on the line as needed, the borrower's interest costs and the lender's interest income fluctuate. This situation may cause banks to encounter periods where their committed capital earns a sub-optimal return when considering their own borrowing costs and opportunity costs (foregone interest earnings). Banks therefore charge a borrower an unused commitment fee on the undrawn portion of a revolver (Clifford Chance LLP 2014).

Consider the following example as shown in Table 10.2. In Scenario 1, a borrower obtains a $10 million credit line with three cost components: (1) 5 percent annual interest rate on borrowed funds, (2) 0.30 percent up-front commitment fee on total facility size, and (3) 0.30 percent annual unused commitment fee on the facility's undrawn portion. On day 1, the borrower pays $30,000 to the bank as an up-front commitment fee and fully draws down the $10 million without servicing the debt until maturity at day 365. Although traditional bank structures accrue interest daily and require monthly or quarterly interest payments, this example assumes only annual interest payments. Under this structure, the borrower would make an interest payment of $500,000 on day 365 and repay the $10 million borrowed for a total payment of $10.5 million. The borrower incurs no unused commitment fee because it fully drew the $10 million credit line. The lender's annual rate of return on its $10 million of invested capital would therefore equal 5.30 percent.

In Scenario 2, a borrower obtains the same $10 million credit line with the same terms as Scenario 1, including the 0.30 percent up-front commitment fee ($30,000) charged on day 1. This time, however, the borrower draws down only $5 million on day 1 and does not borrow the remaining $5 million during the credit line's 365-day tenor. Because the bank is not earning interest income on half ($5 million) of its committed capital ($10 million), it seeks at a minimum to recoup its own cost of funds by charging the borrower 0.30 percent on the undrawn $5 million ($15,000). Assuming annual payments, on day 365 the borrower would make a $265,000 interest payment ($250,000 for the funds borrowed and $15,000 for the funds not borrowed) and would repay the $5 million borrowed for a total payment of $5.265 million. The lender's annual rate of return on its $10 million of invested capital is now only 2.95 percent due to the diminished interest earnings on the total facility. Had the lender not charged an unused commitment fee for the line's undrawn portion, the lender's annual return would have been 15 basis points lower at 2.80 percent. In Scenario 2, the $10 million size of the credit line is likely larger than the borrower actually needed to support its working

Table 10.2 **Example of a Revolving Credit Facility**

(Units in $s)

	Scenario 1	*Scenario 2*	
Committed revolver size	$10,000,000	$10,000,000	(a)
Up-front commitment fee percent due on day 1	0.30%	0.30%	(b)
Up-front commitment fee dollar amount due on day 1	$30,000	$30,000	(c) = (a)(b)
Less amount drawn and outstanding for 365 days	($10,000,000)	($5,000,000)	(d)
Available revolver balance	–	$5,000,000	(e) = (a) – (d)
Annual interest rate on drawn amount of revolver	5.00%	5.00%	(f)
Dollar cost of funds drawn from revolver due on day 365	$500,000	$250,000	(g) = (d)(f)
Annual interest rate on undrawn amount of revolver (unused commitment fee)	0.30%	0.30%	(h)
Dollar cost of funds undrawn from revolver due on day 365 (unused commitment fee)	–	$15,000	(i) = (e)(h)
Total dollar cost of funds on revolver (drawn + undrawn) due on day 365	$500,000	$265,000	(j) = (g) + (i)
Total funds to be paid on day 365 (accrued interest + revolver drawn down)	$10,500,000	$5,265,000	(k) = (d) + (j)
Total fees charged by the lender	$530,000	$295,000	(l) = (c) + (j)
Annual percent return to the lender without unused commitment fee	5.30%	2.80%	(m) = [(c) + (g)] / (a)
Annual percent return to the lender with unused commitment fee	5.30%	2.95%	(n) = (l) / (a)

This table shows the economics of a revolving credit facility and standard lender fees.

capital needs. Thus, a lender should properly size a credit facility to ensure that the borrower has sufficient liquidity and the bank can maximize its own return on invested capital.

Lenders seek to provide revolvers to businesses with a strong operating and financial history. Because banks do not extend credit to potential borrowers already experiencing a cash crunch, a general rule for borrowers is to "get the credit line before you need it." For those who can obtain credits lines, a revolving credit facility can be a cost-effective and reliable source of liquidity to fund working capital needs.

Summary and Conclusions

Several short-term funding options are available to generate cash required by borrowing firms to meet current liabilities, provide working capital, or support other financing or investment opportunities. These options have maximum maturities of 12 months, are classified as current liabilities on the borrower's balance sheet, and typically have no impact on a firm's capital structure. As with any financial transaction or investment, the borrower must consider the potential return objectives and risks, along with other factors such as collateral quality, credit worthiness, liquidity, time horizon, and taxes.

Commercial paper is a money market instrument issued by firms in need of short-term funding. Borrowers with excellent credit ratings can generate cash by issuing commercial paper to lenders, and the borrowers pay off expiring issues from available cash or by rolling over to new commercial issues. Issues have maturities ranging from one to 270 days, with average maturity of 30 days; firms wanting to issue commercial paper with maturity greater than 270 days must register with the SEC. The longer the time horizon to maturity, the higher is the risk of default. Therefore, the interest rate borrowers must pay to commercial lenders increases. Borrowers can expect to pay a yield of 10 to 20 basis points above Treasury bill yields with the same maturity. Therefore, cash generated from commercial paper for fixed income investing must earn a return greater than the interest rate paid to commercial paper lenders at maturity.

Banks may issue letters of credit as a commitment to make a contingent payment if both parties, typically a buyer and seller of physical goods, meet certain conditions. This form of payment guarantee can have a tenor of up to one year. It can be deployed as a source of short-term funding to support international trade between unfamiliar parties or as insurance against the risk that an agreement will not be fulfilled. The bank typically requires cash collateral to be posted for the letter of credit, with terms dependent on the buyer's creditworthiness and operating and financial history. The buyer issues a purchase order backed by a letter of credit from the buyer's bank to the seller in the amount of the value of physical goods, effectively pre-funding the financial transaction in a controlled account until all terms have been met and payment to the seller is due. Therefore, buyers transfer default risk to the issuing bank, buyers face the risk of losses from delayed goods or incorrectly accepting damaged goods, and sellers face the risk that the payment will be delayed or denied from the issuing bank if required documentation is not provided or in cases of administrative error.

Participants can expect to pay sufficient interest (i.e., floating interest based on prime rate or LIBOR plus spread) and fees to compensate their banks commensurate with the level of risk incurred.

Firms with financial securities on the balance sheet can generate short-term funding through repos. The borrower sells the securities to the lender and agrees to repurchase them for a specified amount on some future date (term repos) or without a specific date (open repos). The borrowers can use the cash received to purchase fixed income securities. To profit from the transaction, the yield on those investments must exceed the effective interest rate owed to the lender (i.e., the difference between the agreed repurchase price and the initial loan amount provided to the borrower). Prospective borrowers should also provide collateral with value exceeding the initial loan amount. A borrower's credit worthiness is the source of counterparty risk in the agreement with lenders, who also bear collateral risk as the value of the collateralized securities may decrease over the life of the agreement.

Two types of asset-based loans can also provide short-term funding sources at different stages of a company's cash cycle: purchase order financing and accounts receivable factoring. Firms that sell physical goods are eligible to use PO financing with a maturity up to 90 days and terms dependent upon the borrower's creditworthiness, financial health and operating history, and quality of the physical goods. Accounts receivable can be sold at a discount to lenders, allowing borrowers to receive cash earlier than collecting from its customers. In accounts receivable factoring, the perceived collectability of outstanding customer accounts can also influence the lending decision and terms. PO financing borrowers may face (annualized) interest rates of 15 to 25 percent, while accounts receivable factors may charge daily interest (i.e., floating interest based on prime rate or LIBOR plus spread) on outstanding accounts until they are collected. Because these asset-based loans are typically associated with a higher cost of capital relative to traditional sources of debt, borrowing firms may face stricter covenants such as maintaining a minimum gross profit margin or providing a personal guarantee to lenders in case of default. Further, successful PO financing and accounts receivable factoring agreements may be continued in the future, providing borrowers with a reliable source of short-term funding.

Commercial borrowers may also obtain short-term funding from revolving credit facilities, most commonly from banks. Revolving lines of credit provide borrowers with a maximum amount of credit on a specified tenor, with predetermined requirements to make regular payments toward the amount owed and limitations on how the funding can be used. A prospective borrower considering revolvers should expect a thorough audit of physical inventory, financial statements and projections, and the lender has a first-priority claim on the firm's assets in case of bankruptcy. As with other loan-based financing options discussed in this chapter, the lender's due diligence also determines the revolver's terms and what covenants and security enhancements would be required to compensate the lender for the level of risk incurred. The longer the revolver's tenor, the more stable and secure the funding source. The terms are also more likely to be favorable for borrowers with higher credit ratings. Finally, revolvers are a reliable and cost-effective form of short-term borrowing, but they can be difficult to obtain for borrowers with weaker operational and financial performance.

Discussion Questions

1. Discuss three key differences between traditional bank financing and accounts receivable financing.
2. Explain why letters of credit are primarily used within international trade.
3. Explain how collateral risk and counterparty risk can change over the life of a repurchase agreement.
4. Explain why a lender should size a borrower's revolving credit facility properly.

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11

Private Debt Markets

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Introduction

Companies can raise debt from a range of bank and non-bank financial intermediaries. Throughout the twentieth century, listed companies traditionally issued bonds on public markets in a similar fashion to governments issuing public debt. Companies typically raised debt through investment grade issuances although "high yield" or "speculative grade" issuances were not uncommon (Basile, Kang, Landon-Lane, and Rockoff 2015). Private companies had fewer options, restricted to a banking relationship for short-term debt to provide working capital or longer-term debt secured by the company's assets. Companies usually financed acquisitions or expansion of production facilities with retained earnings or new equity issues. In Europe and Asia, intercompany loans or loans from family networks complemented and sometimes replaced bank debt. Since the 1980s, financial innovations and the deregulation of markets have resulted in fixed income markets opening to new financial providers, and private debt has become a viable source of finance for both public and private companies (Carey, Prowse, Rea, and Udell 1994; Yago and McCarthy 2004). Private placement of bonds, syndicated loans, and direct lending provide a flexible array of debt securities to finance mergers and acquisitions, expand facilities, restructure a balance sheet, or facilitate a management or leverage buyout.

This chapter is organized as follows. It begins by describing the key features of private debt markets and the types of debt securities followed by a discussion of why companies issue debt privately, terms and conditions, and performance (i.e., returns and defaults). The final section examines the suppliers of capital to the private debt market.

Types of Private Debt

Private debt markets cover a continuum of debt securities issued and initiated by public and private companies to banks, insurance companies, money market funds, alternative asset managers (e.g., hedge funds and private debt funds), and institutional investors (e.g., pension funds, sovereign wealth funds, foundations, and endowments). Several key features of private debt markets are that the securities are unregistered and unrated by credit agencies, terms and conditions are kept private, and are typically less liquid than public debt. Entrepreneurial firms use private debt more often than all other sources of capital, even venture capital or angel financing, in the United Kingdom (Cosh, Cumming, and Hughes 2009) and the United States (Robb and Robinson 2014). Information asymmetries between borrowers and lenders mean that lenders with resources to undertake research on borrower credit quality are more likely to invest in less liquid private debt markets. Figure 11.1 illustrates the relation among firm size, information availability, and types of private debt.

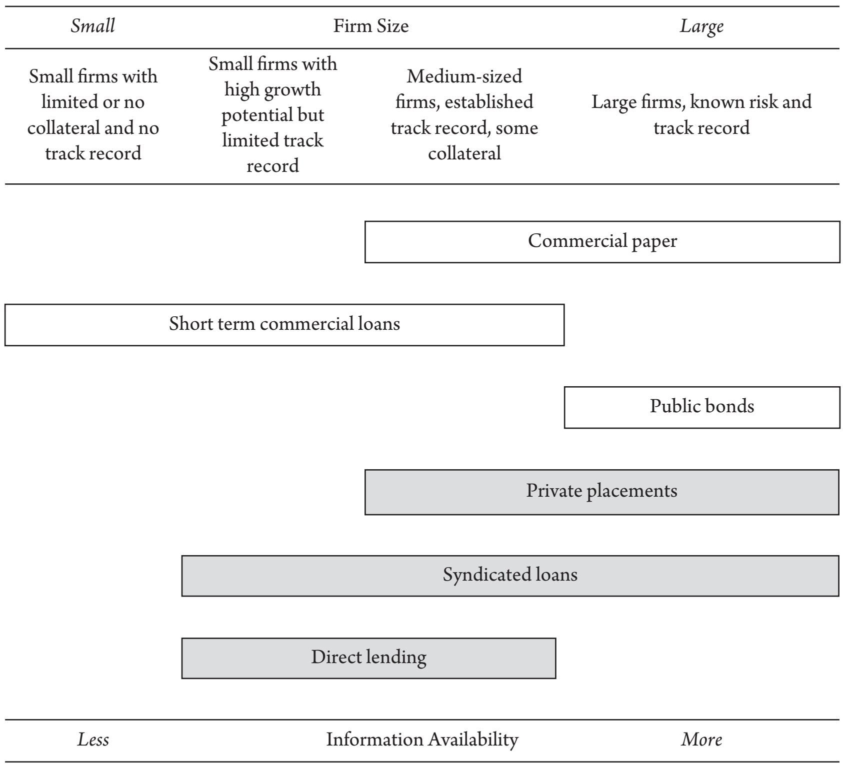

Figure 11.1 Firm Size, Information Availability, and Types of Private Debt
This figure shows the relation among firm size, availability of firm information, and types of private debt.
Source: Adapted from Carey et al. (1994), p. 41.

Large firms can raise short-term debt through commercial paper and long-term debt via public debt markets or through a private placement. By contrast, medium-sized and small firms may only be able to obtain short-term commercial loans (secured or unsecured) from a bank but rely on private debt for longer term borrowing. In both cases, the banks or private lenders incur costs in information collection and due diligence to determine credit quality and monitor borrowers closely over the life of the loan. Depending on firm size, debt could be issued by private placement, syndicated loan, or a direct (private and bilateral) loan.

Private Placement Bonds

Private placement bonds are unregistered corporate bonds issued by public or private companies directly to an investor or small group of investors (Kwan and Carleton 2010; Arena 2011). In the United States, private placements are conducted under the Securities Act of 1933, which requires companies to adhere to rules around the type of investor ("accredited") and the number of "sophisticated" investors. Companies can also issue private debt under the Securities Exchange Commission (SEC) Rule 144A introduced in 1990 to facilitate foreign participation in United States debt markets (Chaplinsky and Ramchand 2004; Arena 2011). The seminal research on private placements by Carey et al. (1994, p. 2) defines private placements as "fundamentally an information-intensive market" where private market lenders must gather or produce information about borrower quality. The fixed costs associated with due diligence on a borrower means that economic efficiency dictates that only one or a few lenders lend to an information-problematic borrower.

Syndicated Loans

Syndicated loans are structured, arranged, and administered by one or more investment or commercial banks (arrangers) and sold (syndicated) to a group of investors. Since the 1980s, the syndicated loan market has been the dominant source for public and private companies to access private lenders (Standard & Poor's 2017). Syndicated loans comprise various debt securities ranging in seniority, term, amortization schedule, covenant protection, and security in case of default. Table 11.1 provides examples of the type of syndicated loans companies can issue.

Term Loans

Banks originally provided term loans and held them on their balance sheets. Over time, term loans have been tranched (or broken up) into amortizing and non-amortizing components (Term Loan A and Term Loan B, respectively) as syndication allowed banks and other arrangers to satisfy non-bank lenders' desire for longer term, non-amortizing fixed income investments. Term loans are secured, maintain seniority in the capital structure, and have a full set of covenants to which a borrower must adhere (e.g., maintaining a particular ratio of debt to earnings or a level of interest coverage). Covenant-lite, second lien, and mezzanine loans are subordinated to term loans in the

Table 11.1 **Types of Syndicated Loans**

Type of Loan	*Term in Years*	*Seniority*	*Security*	*Amortization*	*Covenants*
Term Loan A	5–7	Yes	Yes	Yes; Highest	Full
Term Loan B	7–8	Yes	Yes	Some with bullet	Full
Covenant-lite	8–10	Yes	Yes	Some with bullet	Light
Second lien	8–9	Yes	Yes	Bullet payment	Full
Mezzanine	10+	No	Sometimes	Bullet payment	Light
Payment-in-kind	10+	No	Often	Bullet payment	Light
Unitranche	5–7	Yes	Yes	Bullet payment	Often

This table presents examples of different types of syndicated loans. Key characteristics of the loan include term, seniority in the capital structure, and whether the loan has collateral, amortizes, and has covenants.

Source: Adapted from Rizzi (2016) Table 5.

Table 11.2 **Private Debt Investors by Type**

Type of Investor	*%*
Pension funds	33
Foundations and endowments	22
Insurance companies	9
Wealth managers	7
Family offices	7
Fund-of-funds	6
Other	16

This table reports the portion of investors by type investing in private debt funds in 2016.

Source: Preqin Private Debt Online.

capital structure, meaning that holders of these loans have a claim over this class of security posted for the loan and any repayments only after term loans have been repaid. Each type of loan is provided by investors who are willing to trade off seniority and safety coverage for additional return, and only receive repayment of the loan at the end of its term (i.e., as a single or "bullet" payment). *Covenant-lite loans*, as the name suggests, typically have fewer or no covenants, providing borrowers with flexibility to maintain high debt levels during a time of a decline in revenue or earnings and therefore serviceability. Mezzanine loans often have no security collateral and few covenants.

Payment-in-Kind Loans

Payment-in-kind (PIK) loans combine many of the characteristics of subordinated loans as previously described, with the additional feature that the borrower potentially pays no cash coupon until the term of the loan expires (maturity date). These loans allow borrowers the option to cease interest payments on the loan by issuing new loans as payment and/or accruing interest to be paid at maturity. Private equity firms have frequently used both PIK and covenant-lite loans in leveraged buyouts (LBOs) to increase debt levels and reduce cash interest expense. PIK loans also allow lenders and the borrower to agree on a certain proportion of the loan's interest rate to be paid regularly in cash (e.g., quarterly) while the remainder of the interest payment is paid "in kind." Finally, unitranche loans combine features of senior and subordinated loans into a single security tailored specifically to the borrower's requirements. Such an approach reduces inter-creditor conflicts that may arise when a company's capital structure comprises a range of loan types.

Direct Lending

Direct lending is a privately negotiated loan between a company and a small group of lenders, generally led by a private debt fund. Although direct lending has perhaps the longest history in fixed income markets with bilateral loans pre-dating traditional banks, a more formal direct lending market developed in the 1990s and 2000s. Early investors in direct lending focused on providing specific types of loans for LBOs (e.g., mezzanine loans) or buying loans in defaulted or underperforming companies with a view to "swapping" debt for equity (e.g., distressed debt funds) (Cumming and Fleming 2015, 2016). The direct lending market provides highly customized loans to public and private companies, with each loan containing many, if not all, the features described for syndicated loans.

A direct loan is not commonly secured over the following sources: (1) company assets and potentially personal assets of the company's owners, (2) share pledges where the borrower can take ownership of the shares of the company's owners, corporate and personal guarantees, and (3) control over bank accounts and/or rights to particular revenue streams. Banks face increased prudential regulation (regulation on financial firms to control risks and hold adequate capital) and restrictions over the amount and type of loans they can hold on their balance sheets. As such, direct lending and other forms of shadow banking have increased to fill a gap in the private debt market (Allen, Qian, and Qian 2005; Allen and Qian 2010; Ayyagari, Demirguc-Kunt, and Maksimov 2010; Allen, Chakrabarti, De, Qian, and Qian 2012; Acharya, Khandwala, and Oncu 2013; Allen, Qian, Tu, and Yu 2015; Kidd 2015; Cumming, Rui, and Wu 2016; Preqin 2016).

Why Firms Borrow Privately

Debt financing primarily originates from banks, non-bank private lenders, and public debt offers. Publicly placed debt is largely dependent on public information, whereas privately issued debt uses both public and private information, and information arising from monitoring. The credit quality of the issuance firm, which is driven by the borrower's information environment in terms of the transparency of its financials, primarily influences the choice of firms borrowing privately. In a study on 1,560 new U.S. debt financings between 1995 and 1996, Denis and Mihov (2003) show that firms with the highest (lowest) credit quality chose to borrow from public (non-bank private) sources, whereas the ones with intermediate credit quality use banks. Their findings are largely supportive of previous literature on information asymmetry, borrower reputation, and efficient renegotiation. Furthermore, they show that the source of non-bank private debt plays an important role in complementing other public sources of borrowing by accommodating firms with low credit quality.

The classic literature including Leland and Pyle (1977) and Fama (1985) hypothesizes that "arm's-length" investors are not as efficient and effective as banks and other private lenders in monitoring loan performance. This view implies that firms with higher information asymmetry prefer private debt. Having a diverse array of debt holders monitor a borrower with higher levels of information asymmetry is inefficient. This problem arises because each individual debtholder does not have a strong incentive to properly monitor the borrower. Therefore, private debt is more appropriate for informationally problematic firms as debt holders are more concentrated and therefore have a strong incentive to incur costly monitoring expenses. As Diamond (1991) shows, borrowers shift from private to public debt as the information environment and reputation of the company improves.

As Lin, Ma, Malatesta and Xuan (2013) discuss, if public debt is diffusely owned, then the free-rider problem (of one party not expending effort and/or costs, given the other party incurs those costs) may deter individual bond holders from engaging in expensive monitoring costs because of the limited incentive for any individual to ensure borrowed funds are not expropriated (Diamond 1984, 1991). Regardless of whether individuals are willing to collectively monitor borrowed funds, the result would likely be inefficient because monitoring efforts and costs are duplicated.

In contrast, banks have a superior ability to efficiently monitor borrowers because they have an information advantage over public debt holders due to their role as an inside lender (Fama 1985). Given that debt held by banks is more concentrated, and banks have superior access to information, this makes banks more effective at monitoring borrowers and preventing losses via expropriation of funds. With respect to the shareholders of the indebted company, the probability for corporate insiders or entities with controlling interests to extract private benefits is lessened under bank monitoring. Berger and Udell (1990) find that banks with riskier portfolios are those with a lower proportion of secured loans. This finding is consistent with the notion that banks have superior access to information to assess the borrower's risk levels.

Bradley and Roberts (2015) find that including debt covenants on corporate debt has a negative relation with yield on the underlying loans. Additionally, they find that the covenant structure on corporate debt is dependent on both firm idiosyncrasies and macroeconomic factors. For example, lenders require stricter debt covenants when the borrower is small, high growth, and/or highly leveraged. Additionally, lenders such as investment banks and syndicated loans are more likely to include covenants, while borrowings during recessionary periods or periods with large credit spreads also increase the tendency to include protective covenants.

Berger and Udell (1990) also report that risker firms tend to acquire debt financing on a secured basis with the average secured loan deemed less risky compared to unsecured loans. Their results suggest that banks have an ability to produce information on a borrower's risks.

The conventional wisdom suggests that riskier firms are more likely to pledge collateral. However, less risky firms may pledge collateral in practice, particularly when borrowers have private information about the riskiness of the business. The private information can lead to an equilibrium where the lower risk borrowers typically pledge collateral. This idea is inconsistent with the notion that banks holding riskier debt are more likely to pledge collateral.

Because stockholders bear the agency costs of debt, they have an incentive to minimize such costs by aligning the interests of managers and bond holders. As long as the costs of the constraints imposed by the covenants are less than the benefits (including the interest rate and proceeds in capital raises), firms include covenants in their debt contracts. Because agency costs of debt are inversely related to a firm's financial condition, the expectation is that the poorer the firm's financial condition, the more likely the firm will include a covenant in its debt contract. Given that renegotiating covenants with public bond holders is virtually impossible due to coordination problems, firms including covenants in their debt contracts would issue primarily private as opposed to public debt. In fact, Malitz (1986) finds that the presence of covenants is negatively related to firm size and positively related to a firm's existing leverage ratio.

Arena (2011) suggests a pecking order, dependent on credit quality, for traditional private debt. Firms with high credit ratings favor public debt, but small firms with good credit scores tend to use private debt. Firms with moderate credit quality typically use bank loans and poor credit rating firms prefer 144A debt. Rule 144(a) is a SEC rule modifying a two-year holding period requirement on privately placed securities to permit qualified institutional buyers to trade these positions among themselves. Firms with an inferior information environment (e.g., lower quality of financial reports) struggle to obtain longer term financing in the bond market because buyers of publicly offered bonds generally do not devote resources to the credit analysis required. In contrast, private lenders have developed the necessary capacity for due diligence and monitoring and achieve economies of scale enabling them to offer favorable borrowing terms.

Smaller firms typically have inferior information environments compared to larger firms. Firm size is also highly correlated with firm age. The cost to younger firms is typically higher because they are yet to develop the same reputation as mature firms. Additionally, younger firms are typically considered higher risk because they are generally less stable and established, creating uncertainty for the lender. The level of information asymmetry may also cause concerns for adverse selection risk (Stiglitz and Weiss 1981). That is, riskier firms may expropriate wealth from their lenders.

Legal environments that protect creditors have a strong influence in explaining international differences in the overall use of debt (La Porta, Lopez-de-Silanes, Shleifer, and Vishny 2002; Djankov, McLiesh, and Shleifer 2007; Qian and Strahan 2007; Djankov, Hart, McLiesh, and Shleifer 2008; Bae and Goyal 2009; Qi, Roth, and Wald 2010), the use of tranching (Cumming, Lopez de Silanes, McCahery, and Schwienbacher, 2015), and private debt markets (Cumming and Fleming 2013). In general, where creditor rights are stronger, debt markets are much larger. In the case of private debt markets, Cumming and Fleming show that creditor rights are positively related to private debt investment size, since higher creditor rights efficiency implies less risk.

Cao, Cumming, Qian, and Wang (2015) find similar evidence on international LBOs. They show that LBOs are more active and premiums are lower in countries with stronger creditor rights. Cross-border LBOs originate from private equity funds in countries with stronger creditor rights to target investee companies in countries with weaker creditor rights. The intuition is that the stronger legal protection for creditors enables LBO sponsors to access external debt financing. Better protection for creditors reduces premiums associated with LBOs because creditor protection mitigates expropriation by private equity investors and results in less wealth transfer from debt investors to equity investors.

Private Debt Investors

The deregulation of the banking industry and broader financial deregulation in the 1970s and 1980s was a major impetus for the growth in private debt markets. Traditionally, banks and non-bank institutions such as life insurance companies were the major providers of financing for private placements and syndicated loans. Private debt investors now include a range of institutional investors such as loan mutual funds, collateralized loan obligations (CLOs), finance companies, hedge funds, private equity funds, and fiduciaries such as pension funds, foundations, endowments, and family offices.

Life insurance companies have dominated the supply of financing to the private placement market since the 1980s due in large part to their willingness to incur costs associated with evaluating borrowers and their ability to take on liquidity risk associated with longer term loans. As Carey et al. (1994) note, insurance companies financed 83 percent of all private placements between 1990 and 1992. The authors postulate that life insurance companies had distinct advantages over other suppliers given that they had long-term liabilities with which to match private placement loans and bonds, had large volumes of capital to invest regularly, and therefore were willing to incur costs in due diligence on information problematic borrowers. Pension funds, by contrast, were not equipped with mandates to invest in non-investment or unrated debt and/or did not have requisite internal investment skills to evaluate placements.

In a similar fashion to private placements, a wide range of institutional investors and traditional participants such as banks supply funds for syndicated loans. The standardization of documentation, the establishment of the Loan Syndications and Trading Association (LSTA) in the United States, and the decision by rating agencies to start rating CLOs (e.g., Standard & Poor's rated its first CLO in 1996) enabled the commoditization of syndicated loans in the 1990s (Culp 2013). At this time, banks also began changing their business model from an historical role as an originator and holder of syndicated loans to an "originate-and-distribute" model, whereby banks underwrite and fund the loans and then sell large portions to non-bank lenders. As Yago and McCarthy (2004) note, banks held 71 percent of primary leveraged loans in 1994, but non-bank institutions held 78 percent of such loans by 2004.

In their study of more than 20,000 leveraged loan facilities between 1997 and 2007, Lim, Minton, and Weisbach (2014) find that banks are increasingly likely to syndicate loans, and that 31 percent of all syndicates include at least one non-bank lender. These syndicate members include finance companies (23 percent of the time), hedge funds and private equity funds (14 percent), and mutual funds (5 percent).

The increase in the supply of funds for syndicated loans has resulted in an opening of syndicated loans to firms previously excluded and an increase in credit to lower credit quality borrowers (Cumming et al. 2015). CLOs hold and manage pools of leveraged loans that are tranched according to credit quality and then sold to investors with different risk preferences including regional banks, pension funds, foundations, endowments, and sovereign wealth funds. Loan mutual funds and exchange-traded funds (ETFs) provide small institutions and retail investors with access to investments in pools of syndicated loans. As Table 11.1 shows, the syndicated loans market has debt "products" with different duration, level of seniority and collateral, amortization, and covenants matching more closely the demand for loans from companies with the risk appetite of investors.

As Cumming et al. (2015) show, the number of tranches in syndicated loans both publicly traded and privately held significantly increase in markets with better creditor rights and enforcement of legal rights. Tranching is particularly important to investors to be able to spread the risk of issuing a loan to various types of investors with different appetites for risk. By tranching, investors are made better off by accessing more complete capital markets, and firms are made better off as the size of debt markets increases substantially.

Because the types of investors in syndicated loans have changed, commentators and researchers began focusing on how information on essentially private syndicated loans has become more public, and whether this change results in conflicts of interest and/or insider trading by lenders. Most attention has been directed toward hedge funds, which sometimes have mandates to invest in equity and debt and which may possess information as a private lender that could be used to their advantage as an equity holder. Bushman, Smith, and Wittenberg-Moerman (2010) find that price discovery in equity markets is faster for firms that have borrowed in the syndicated loan market, suggesting that institutional investors such as hedge funds exploit confidential information from their lending activities in equity trading. Massoud, Nandy, Saunders, and Song (2011) find that hedge funds are more likely to lend to lower quality borrowers. Additionally, the amount of short selling of a borrower's equity is higher before the announcement of a leveraged loan or an amendment of a loan when the loan involves a hedge fund. The authors conclude that hedge funds likely trade on insider information gleaned as a lender before public announcements on equity markets.

Pension funds, foundations, and endowments primarily finance direct lending through allocations of capital to private debt funds. Similar to many alternative asset fund managers, private debt fund managers manage capital on behalf of investors on a fully discretionary basis and are responsible for origination of loans, due diligence, monitoring, and exiting. The allocation of assets by institutional investors to direct lending is based on research showing that direct lending provides attractive risk-adjusted returns driven by market inefficiencies and the ability of private debt fund managers to exploit such inefficiencies. Private debt exhibits higher Sharpe ratios than traditional fixed income, but private debt has the potential for higher volatility of outcomes given the importance of manager selection in capturing the return premia. Private debt also provides exposure to illiquid fixed income investments, diversifying an investor's portfolio profile away from interest rate risk, credit risk, and equity risk.

Towers Watson (2015) finds that global alternative credit is negatively correlated to sovereign investment grade credit, although positively correlated to corporate investment grade credit and equities. Furthermore, private credit tends to be concentrated in smaller companies, providing diversification to a fixed income portfolio typically dominated by sovereigns and larger, listed corporations. For these investors, an allocation to private debt could be made from an investor's fixed income allocation (increasing returns and diversifying interest rate and credit risk) or from an alternatives/private equity allocation (shortening the average duration of a private equity portfolio and diversifying equity risk).

Performance of Private Debt

The main avenues to investing in the private debt market are twofold. First, the investment is made by providing credit to privately owned firms to generate a fixed income return with acceptable risk. Second, opportunities also exist in purchasing nonperforming loans on the secondary market, usually at a discount, and receiving returns from borrowers who repay all or part of the original loan. The literature on the performance of private debt can be categorized into two streams examining (1) investment returns that are measured by internal rates of return (IRR) and return on investment (ROI) and (2) bond yields.

Cumming and Fleming (2013) examine debt investments in private companies that are made by professional fund managers. By focusing on how private debt securities are packaged and invested by specialist fund managers, the authors study important determinants for investment returns (IRR and ROI) including market conditions, legal conditions, investee firm-specific risk, and investor-specific risk. Their sample comprises 311 debt investments spanning 25 countries between 2001 and 2010 and is derived from two institutional investors, each of which invested in some but not all of the funds, which mitigates selection bias from only reporting the most profitable deals. The authors measure the IRR and ROI to private debt generated either by buy-and-hold strategies (e.g., purchase and holding of a mezzanine loan) or trading strategies (e.g., buy a portfolio of loans on the secondary market). Private debt investments in the Cumming and Fleming sample generate 14.4 percent average annualized returns, which is impressive relative to the world MSCI equity index that produced average annual returns of 5.2 percent over the same period between 2001 and 2010.

Cumming and Fleming (2013) document that private debt returns show little sensitivity to changes in market conditions or international differences in legal environments. The more important determinants to the level of returns are lender and borrower characteristics. As the portfolio size per fund manager increases, the return decreases. This evidence implies a positive relation between time spent on due diligence on the debt-issuing private firm and private debt returns. Private firm-specific risk, such as asset intangibility, priority structure, and past nonperformance at the time of investment, also affect private debt returns.

Figure 11.2 graphically depicts the evidence in Cumming and Fleming (2013). Among the different factors affecting the returns to private debt fund investments, the authors find that portfolio size per manager is the most statistically robust and economically significant factor. They also find that the economic significance is such that the data indicate that a one standard deviation increase in portfolio size per manager is associated with a reduction in returns by about 8 percent on average. These findings are robust even after controlling for other fund manager characteristics, borrower characteristics, market conditions, and legal conditions. The evidence is consistent with the view that fund manager expertise in due diligence, structuring private debt investments, and adding value to bring the investment to fruition is important and should ideally not be diluted by having fund managers work on too many competing projects at the same time (Kanniainen and Keuschnigg 2003, 2004; Keuschnigg 2004; Cumming 2006).

Cumming and Fleming (2013) explain that portfolio size per manager among private debt funds is an even more important factor in explaining portfolio returns than portfolio size per manager among private equity funds. Cumming and Walz (2010) among others find that more investments per manager in the context of private equity funds are a robust negative predictor of future returns. But the economic significance of the effect of portfolio size per manager on IRRs is roughly 30 percent less pronounced in the case of private equity than in the case of private debt. The comparative importance of fund manager value added for private debt funds relative to private equity funds was unanticipated. However, private debt fund deal structures do involve substantial amounts of equity incentives, and deal structuring is complicated involving many covenants in the case of private debt. Further research is warranted directly comparing the activities of private equity fund managers to private debt fund managers.

Cumming, Fleming, and Liu (2019) compare private debt returns between secondary purchases and buying and holding primary issuances. Primary issuances are more likely higher quality insofar as the original lender of the loan probably does due diligence and would likely find higher quality private companies. Conversely, sale prices of secondary issuances can be abnormally depressed from adverse selection and seller illiquidity. Thus, the returns from secondary purchases should differ from buying and holding primary issuances. By studying investments made by private credit fund managers on 443 private companies in 13 Asian countries between 2001 and 2015, the authors document a strong presence of superior returns (IRR and ROI) in secondary transaction strategies, after controlling for country and industry factors, legal and economic system, and size and age of credit markets.

Cumming, Fleming and Liu (2018) examine rates of returns for domestic versus offshore small and mid-sized private real estate credit funds. Based on pan-Asian data, they find evidence that offshore private credit funds issue smaller and subordinated loans to residential projects. Offshore lenders prefer projects in developed Asian markets and obtain higher rates of return even after controlling for such variables as loan size, seniority, and borrower location. Their data suggest real estate lending markets in Asia are segmented and offshore lenders are not a substitute for domestic capital.

Carey, Post, and Sharpe (1998) show that financial institutions specialize in private debt. They also find that both finance companies and banks are equally likely to finance forms with poor information environments (i.e., no difference exists in business lending between finance companies and banks). This finding suggests that intermediaries in general may have valuable information, not just banks. Additionally, their findings show that finance companies specialize in lending to companies with higher levels of risk.

Carey (1998) finds that riskier levels of private debt, on average, perform better than public debt. Specifically, private debt that is classified investment grade performs better than investment grade public debt, with performance improving in riskier debt classes. An implication for these findings is that monitoring provides substantial value to lenders.

Private Debt and Entrepreneurial Firm Growth

Are entrepreneurial firms better off obtaining private debt or private equity in order to facilitate their growth? Certainly, most firms use debt, and debt is substantially more common than private equity or venture capital (Cosh et al. 2009; Robb and Robinson 2014). Some evidence exists that shows private debt can help entrepreneurial firms grow (Cole and Sokolyk 2018). Very few studies directly compare the impact of venture capital and private debt. One exception is Cole, Cumming, and Li (2016) that compares U.S.-state level evidence and shows that entrepreneurial growth is more closely associated with venture capital than private debt.

The growth of crowdfunding is an important new development in private lending. Private companies can now obtain private lending via crowdfunding platforms bypassing intermediaries. This source of capital is relatively understudied. Evidence to date shows the market is growing rapidly and a pronounced adverse selection is not present in these markets as one might expect (Cumming and Hornuf 2017). However, relatively little is known about the impact of this source of capital on the subsequent success of entrepreneurial firms.

In contrast, Tykvova (2017) shows that private debt through venture lending can complement the use of venture capital, and at times can be very important for entrepreneurial exit. The types of firms that seek debt versus venture capital differ. Many firms end up with their desired level of financing, albeit not in the form that they had initially desired (Cosh et al. 2009). Accounting for these types of selection issues is difficult with respect to measuring the impact of the financing source on entrepreneurial firm growth. Further research is needed to better understand the role of different sources of finance in combination with one another.

Summary and Conclusions

This chapter reviewed evidence on private lending markets. It explained that private debt can be structured in different ways and the debt structures can be adjusted to mitigate expected agency problems depending on the investee and investor characteristics. Private debt markets are growing rapidly around the world and substantial incentives exist for entrepreneurs and investors to participate. Additionally, returns to private debt have been impressive in recent years.

The results from research surveyed in this chapter highlight the importance for private debt financing for investors and investees alike. Although institutional investors typically supply financing through sovereign, investment grade, and listed high-yield debt markets, the evidence from private debt markets shows a strong financial and economic case for institutional investors to also establish and maintain private debt investment allocations in private firms around the world. Evidence shows that private debt investments yield higher investment returns among fund managers who possess specialist skills and expertise in borrower selection, and do not undertake too many concurrent deals so as to lower the time allocation to due diligence and monitoring. Private debt investments are subject to country risks associated with the legal conditions, particularly creditor rights, under which the issuing firm issues debt securities. Creditor rights influence the choice of private debt contracts, location, and investment amounts, and can affect returns in various private debt settings and deals involving private debt, including but not limited to LBOs.

Unlike private equity markets, private debt markets have been relatively understudied. However, the growth and success of private debt markets is likely to attract much scholarly and practitioner interest in the future.

Discussion Questions

1. Discuss why a company might borrow from the syndicated loan market rather than from a bank.
2. Explain why companies are motivated to issue private versus public debt.
3. Discuss whether a private debt investor is better off buying and holding a primary issuance or a secondary issuance.
4. Discuss why institutional investors such as pension funds, foundations, and endowments allocate capital to private debt investments such as syndicated loans and direct lending.

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PART III

YIELD CURVES, SWAP CURVES, AND INTEREST RATE MODELS

12

Yield Curves, Swap Curves, and Term Structure of Interest Rates

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Introduction

The yield curve is the foundation of fixed income security pricing, hedging, and risk management. It also plays a central role in economic decision-making, from a micro setting (e.g., a corporate treasury deciding to issue a bond) to a macro setting (e.g., a central bank setting the short-term interest rates in an economy). The term has various meanings in quantitative finance and economics, which despite being of central importance, can be ambiguous.

Interest rate markets offer a variety of instruments such as government or corporate bonds, different types of swaps, futures, options, and more. Typically, instruments from the same asset class are traded at different maturities, and a collection of the market quoted rates of these instruments is referred to as the *term structure* of that market. The yield curve in its simplest form is a graphical representation of this term structure—the curve that arises by plotting the quoted rates as a function of their respective maturities.

Originally, the term *yield curve* was used to designate the plot of the term structure of the sovereign bond market—a curve that passes through the yields of zero-coupon government bonds of different maturities. A *zero-coupon bond* is an obligation to deliver one unit of account on a fixed date in the future without paying coupons before maturity. Historically, this curve was used to understand the dynamic behavior of yields over time, and to ascertain the interdependence of yields of different maturities.

With the development of the swap market in the 1980s, the term *swap curve* came to denote the term structure of *swap rates* as a function of swap maturities. Simultaneously, advances in quantitative finance led to a new understanding of the yield curve as the curve that represents the cost of money for investors (i.e., the dependence of the *risk-free* *rate* of interest on maturity). Asset pricing theory relies on the assumption that one can borrow and lend at a single risk-free rate. In practice, different risk-free rates appear in different markets, leading to the development of separate curves for the swap market and sovereign bond markets.

The financial crisis of 2007–2008, also known as the global financial crisis (GFC), has made the situation even more complex by forcing the market to revisit the notion that the *London Interbank Offered Rate* (LIBOR) represents the risk-free rate of interest. LIBOR is determined by the interbank market and the Lehman Brothers collapse demonstrated that this market is not default-free. These events caused a reexamination of the entire foundation of quantitative finance whereupon the market at large began to understand an important link between funding and discounting. Fully collateralized swaps are funded at the collateral rate of the margin account, and therefore this understanding led to the notion of a yield curve as the term structure of collateralization rates. As a result, currently the term yield curve is used to designate the dependence of various rates on maturity. For example, the Bank of England states that they estimate three yield curves on a daily basis that are based on: (1) yields of U.K. government bonds, (2) sterling interbank rates (LIBOR), and (3) sterling *overnight index swaps* (Sterling Overnight Index Average [SONIA] or more generally OIS).

This chapter examines the underlying differences between these curves and explains the basic principles for their construction. It is organized as follows. The first section defines the term yield curve, followed by a discussion on arbitrage freedom and why this concept is important when considering curves. Equilibrium and market curves are then explored followed by a general discussion of curve construction techniques. These techniques are illustrated using the examples of curve construction for the U.S. Treasury bond and interest rate swap markets. The chapter concludes by examining the major changes in the swap curve construction methodologies due to the GFC.

No-Arbitrage Requirements and Yield Curve Construction

For those only interested in the behavior of quoted rates, viewing the yield curve as a graphical representation of the term structure of rates is sufficient. However, for those who want to use the curve for pricing and other applications, a simple collection of rates becomes insufficient for the task. For example, to project bond yields with maturities not quoted on the market requires defining an appropriate *interpolation method*. The simplest such method is linear interpolation, which involves drawing straight lines between all the quoted yields. Because of its simplicity, this type of curve is widely used when the task does not require precise computations of bond yields or prices. However, linear interpolation does not work well if the curve is very convex. Therefore, other, more complex, interpolation methods must be used to better capture this convexity. The most widespread method of building these curves is cubic spline interpolation of the quoted yields. Clearly, different interpolation methods provide different estimates for rates, so, from this point of view, a yield curve has to be viewed as a combination of quoted rates and an interpolation algorithm.

The next step after estimating intermediate yields is to use the curve to compute the price of a given fixed income security that is consistent with the quoted rates. To understand why any interpolation method is inadequate for this task requires looking at how to price a simple fixed income security, say a non-callable fixed coupon bond. The yield curve itself, even with interpolation, cannot produce this security's price or yield. However, it can provide the discount factor on each cash flow date to calculate the price via the sum the present value of all the cash flows. How can one be sure that this price is consistent with the market? In other words, are these discount factors arbitrage-free?

In absence of arbitrage opportunities, long rates are risk-adjusted expectations of future short rates. As a result, movements in the cross-section of rates are strongly tied together and the shape of the yield curve is not arbitrary but is defined by the market price of risk and the degree to which the arbitrage is absent in the market. Given that interest rate markets are large and liquid, market participants would quickly exploit any mispricing that would arise between different securities. Hence, any reasonable equilibrium characterization of rates should exclude the presence of arbitrage opportunities. A given interpolation algorithm used to construct the simple yield curve is as likely to conform to the no-arbitrage requirements as it is not. A method more advanced than interpolation is required to join a set of market rates into a continuous yield curve that can be used to price market securities.

An *arbitrage opportunity* is any trading strategy with no initial investment that guarantees a positive payoff in some future state of the world with no possibility of a negative payoff in all other future states. Assuming the absence of arbitrage opportunities is the fundamental underlying concept in asset pricing and yield curve construction theory and practice. Harrison and Pliska (1981) show that this assumption is equivalent to the statement that the price at time t of any future claim X_T paid at time T must be equal the expectation of that claim normalized to a cash accumulation process B_t taken under a risk-neutral measure $\mathbb{Q}$ as shown in Equation 12.1:

$$P_t = E_{\mathbb{Q}}\left[\frac{B_t}{B_T} X_T\right] \tag{12.1}$$

Equation 12.2 defines the value of the cash accumulation process $B(t)$ (cash account or money-market account) at time t written in terms of the short rate process $r(t)$.

$$B(t) = e^{\int_0^t r(s)ds}, \tag{12.2}$$

The *short rate* is the interest rate that is earned on a cash investment of instantaneously short duration. In practice, the overnight rate serves as a proxy for the *short rate*, which is the rate of return of the overnight investment.

Because a zero-coupon bond that matures at time T pays a unit of cash at that time, Equation 12.3 defines its price at time t as:

$$Z(t,T) = E_{\mathbb{Q}}\left[e^{-\int_t^T r(s)ds} \right]. \qquad (12.3)$$

Thus, to be arbitrage-free, all market prices of bonds should be equal to the theoretical prices computed using Equation 12.3. The no-arbitrage requirement for a yield curve essentially means that the price of any zero-coupon bond computed using that curve must be equal to the price computed using Equation 12.3.

At the same time, the price of a bond that pays a coupon C at times t_i and returns the face value of one unit of account at maturity T is shown in Equation 12.4, according to the main pricing Equation 12.1:

$$P(C,t,T) = \sum_i^N E_{\mathbb{Q}}\left[\frac{B_t}{B_{t_i}} C \right] + E_{\mathbb{Q}}\left[\frac{B_t}{B_T} \right] = \sum_i^N Z(t,t_i)C + Z(t,T) \qquad (12.4)$$

Comparing this result with the statement that the price of any bond is the discounted sum of its cash flows shows that the discount factors are arbitrage-free prices of zero-coupon bonds maturing at the time of the cash flows. Thus, a yield curve that is capable of producing arbitrage-free prices of zero-coupon bonds of any maturity can be used to compute arbitrage-free prices of any coupon-bearing bond. The question is how to create such a curve.

One method of constructing the yield curve is to use the zero-coupon bond pricing equation itself. Suppose that one has collected market quotes for a set of zero-coupon bonds of different maturities, and that the market is frictionless enough so that these quotes can be assumed to represent arbitrage-free prices. Thus, a model for stochastic short rate $r(t)$ under a risk-neutral measure can be developed that is calibrated by computing expectations in Equation 12.1 and making sure that they are equal to the corresponding arbitrage-free market quotes. This process results in a yield curve parameterized by the variables in the chosen short rate model, which is arbitrage-free by construction. This yield curve can now be used to compute the no-arbitrage price of a zero-coupon bond at any maturity T, and thus compute an arbitrage-free price of any coupon-bearing bond. Note that the yield curve has evolved from a graphical representation of a collection of yields to the combination of a stochastic short rate model and a set of calibrations based on arbitrage-free market quotes.

Such *stochastic short rate models,* also known as *models of term structure of interest rates,* make explicit how the yields of different maturities relate to each other at each given point in time. Using these models to build the yield curve as opposed to other statistical and interpolation models that do not impose no-arbitrage condition has advantages. First, the no-arbitrage restriction ensures that the yield dynamics are consistent. Most rate markets are very liquid, arbitrage opportunities are traded away fast, and dislocations from no-arbitrage equilibrium are small. The assumption of no-arbitrage thus is natural for rates, whether LIBOR rates or sovereign yields. No-arbitrage models allow recovering, in a consistent way, any "missing" rate from a limited set of market quoted rates. A good multifactor model can predict yields that were not included in the calibration set within a few basis points. This property is very important for studies of emerging markets where bonds and swaps trading only occur for a few maturities at any given point in time.

The short rate models use the well-studied fact that a limited number of driving forces of yields exist, which means that a good short rate model only requires relatively few variables. Principal component analysis of historical yield changes by Litterman and Scheinkman (1991) shows that three principal components can explain more than 90 percent of the variance of the yields: the level, slope, and curvature of the yield curve. This interpretation of the driving forces of yields seems to be stable across model specifications, estimation samples, and types of interest rates; low-dimensional models work well in approximating true yield dynamics. True yield dynamics is unobservable. What is observed on the market is the "true" yield dynamics plus considerable noise. The idea is that principal component analysis and corresponding short rate model cut through that noise and provide a good approximation to the systematic components of yield movements. The latent factors implied by short rate models typically behave like principal components of the yield curve.

Thus, one way to think about the yield curve is as of a stochastic term structure model calibrated to market quotes that are arbitrage-free. Although this representation has many advantages mentioned previously, it still suffers from several deficiencies. Most importantly, short rate models are not very good at computing the discounted expectations of securities with optionality, mainly because creating a short rate model that would be consistent with the observed volatility surface is virtually impossible. For example, computing the arbitrage-free price of a simple callable bond requires knowledge of a yield curve that starts at a future call time, conditional on the value of rates at that time. Although some simple short rate models provide an analytical solution to the problem, in case of more complex models finding even a numerical solution that would be sufficiently stable and precise is very difficult. Overall, short rate models are not very suitable to compute no-arbitrage prices of any option-bearing instrument. A resolution to this issue is to use models of forward rates designed specifically to be calibrated to the market volatility surface.

However, even in case of a simple coupon-bearing bond, using a stochastic, short rate model as a representation of the yield curve requires computing many mathematical expectations each time one wants to compute a bond's price. Despite one-to-one mapping between yields and prices, this mapping is generally not present for short rates. Yet, an instantaneous rate is convenient to use because its natural representation is a continuous curve as a function of maturity that provides a one-to-one mapping among short rates, prices, and yields. This discussion leads to viewing a yield curve as a curve of instantaneous forward rates.

Instantaneous Forward Rates

Implied forward rates provide the most useful information set that can be derived from a given interest rate market. They not only reflect the market expectations about the future path of interest rates, but also provide building blocks for other types of information, such as zero-coupon yields and swap rates.

The *forward rate* $F(t,T,T+\Delta T)$ is the rate of interest specified over a future period of investment between times T and $T+\Delta T$ as determined by a contract entered into at time t ($t<T$). The forward rate agreement can be replicated by a portfolio that is short a zero-coupon bond that matures at T and long a zero-coupon bond that matures at time $T+\Delta T$. The initial value of such a portfolio is $\Pi(t)=Z(t,T+\Delta T)-Z(t,T)$.

At time T the portfolio holder needs to borrow one unit of account to cover the matured short bond position. At time $T+\Delta T$, the matured long bond position brings the portfolio holder one unit of account, and at the same time the holder needs to return the loan of $1+\Delta T\cdot R$, where R is the interest rate paid on the loan from time T to time $T+\Delta T$. Thus, this portfolio's value at time $T+\Delta T$ is $-\Delta TR$. A portfolio with an identical payoff can be constructed by selling at time t the same amount of zero-coupon bond that matures at $T+\Delta T$. The absence of arbitrage requires that the values of these two portfolios at time t be equal, implying Equation 12.5 holds:

$$Z(t,T+\Delta T)-Z(t,T)=-\Delta T\cdot R\cdot Z(t,T+\Delta T) \quad \textbf{(12.5)}$$

Thus, the forward rate in Equation 12.6, defined as the rate that fulfills the no-arbitrage requirement, is:

$$R=F(t,T,T+\Delta T)=-\frac{1}{Z(t,T+\Delta T)}\left(\frac{Z(t,T+\Delta T)-Z(t,T)}{\Delta T}\right) \quad \textbf{(12.6)}$$

As the time interval over which the borrowing is done decreases, the rate converges to the instantaneous forward rate for borrowing at time T as shown in Equation 12.7:

$$f(t,T)=\lim_{\Delta T\to 0}F(t,T,T+\Delta T)=-\frac{1}{Z(t,T)}\frac{\partial Z(t,T)}{\partial T} \quad \textbf{(12.7)}$$

The instantaneous forward rate for borrowing now, at time t, is equal to the short rate as shown in Equation 12.8:

$$f(t,t)=r(t) \quad \textbf{(12.8)}$$

Given the rates $f(t,T)$ for all maturities T enables recovering the prices of any zero-coupon bond via Equation 12.9:

$$Z(t,T)=e^{-\int_t^T f(t,s)ds} \quad \textbf{(12.9)}$$

Representing the yield curve as the instantaneous forward rate $f(t,T)$ allows computing the bond prices with Equation 12.9 without resorting to complex stochastic computations.

At a given fixed time t, the instantaneous forward curve as a function of maturity T forms a smooth deterministic curve. Conversely, as a function of time t the instantaneous forward curve's evolution is governed by a stochastic process. By focusing on this process, a term structure model can be created that is capable of computing arbitrage-free prices of complex contingent claims consistent with the market volatility surface. Any arbitrage-free short rate model can be represented as a stochastic model of instantaneous forward rates (Heath, Jarrow, and Morton 1992). This process allows for the consideration of the yield curve construction as two separate steps. The first step is to create an instantaneous forward rate curve $f(0,T)$ at the current time $t=0$ by ensuring it prices the chosen market instruments correctly. The second step is to evolve the curve stochastically according to a specific stochastic model that is consistent with the Heath-Jarrow-Morton framework (HJM) calibrated to the current market volatility surface.

The first step allows pricing any instrument that pays a deterministic cash flow, or a series of deterministic cash flows, by using Equations 12.4 and 12.9 and computing zero-coupon yields directly from the forward curve. The continuously compounded yield $y(t,T)$ of a zero-coupon bond maturing at T (also known as a *spot rate*—the rate of borrowing between today and the maturity of the bond) is defined as Equation 12.10:

$$Z(t,T)=e^{-y(t,T)(T-t)}. \tag{12.10}$$

Thus, a simple, one-to-one relation exists between instantaneous forward rates and spot rates as shown in Equation 12.11:

$$f(t,T)=y(t,T)+(T-t)\frac{\partial y(t,T)}{\partial T}. \tag{12.11}$$

Equation 12.11 points to one of the very important features of the forward curve—its shape depends on the first derivative of the yield curve. Any discontinuity of the constructed yield curve, any sharp features in it that result from a chosen yield interpolation algorithm translate into spikes or jumps in the forward curve. But the instantaneous forward rates represent market expectations for the future short rates, which must be a continuous process. Therefore, because the forward curve must be smooth and continuous, the only way to guarantee these characteristics is to build a yield curve starting from a smooth and continuous function $f(0,T)$.

In general, the yield curve can be represented using either forward rates, or spot rates, or discount factors as a function of maturity. No one representation contains more information than another. In fact, all three can be derived from any other one. Both the precise numerical value of the spot and forward rates depends on two conventions: compounding frequency and day count. These conventions need to be specified before a spot or forward rate can be correctly interpreted. A benefit of the discount factor is that it is a convention-independent representation.

Thus, a *yield curve* can be defined as a smooth, continuous, arbitrage-free instantaneous forward rate curve $f(0,T)$ constructed at the current time $t=0$ by ensuring it prices the chosen market instruments correctly. This curve can be used to price fixed coupon bonds, to compute discount factors to be used in pricing fixed and floating legs of a swap, or it can be evolved stochastically in the HJM framework to price contingent claim securities. Given the instantaneous forward rate curve, the zero-coupon yield curve and the discount factors curve both result from using Equations 12.10 and 12.11. When such curves are created from a short rate model calibrated to a set of market instruments, they are arbitrage-free by construction.

Yield Curves That Are Not Arbitrage-Free

The assumptions of arbitrage-freedom impose strong restrictions on the joint behavior of yields. However, some of the problems that require yield curve construction are addressable without demanding the absence of arbitrage. As an example, think of forecasting the impact of a central bank intervention on long-term yields, or modeling and forecasting the time series of individual yields. In fact, most sovereign yield curves used by central banks in the developed market countries are not arbitrage-free (Bank for International Settlement 2005). In practice, the fitting method depends on the intended use of the resulting curve: no-arbitrage pricing and valuation of fixed-income and derivative instruments versus information extraction for analytical investment and monetary policy purposes.

When the absence of arbitrage is unnecessary, the curve-building algorithm is free of any constraints on joint yield dynamics and is typically easier to fit than the arbitrage-free curves. Moreover, when the goal of the curve construction does not include pricing of complex instruments or hedging, building the curve as a smooth function of yields or discount factors is possible without worrying about the characteristics of the resulting instantaneous forward rate curve. Different estimation algorithms are available to derive a yield curve based on observed market prices as smooth graphs of yields or discount factors as a function of maturity. These algorithms broadly fall into two categories: spline-based and function-based. The decision concerning which method to use depends on the desired level of flexibility in the term structure estimation. Although spline-based methods are very flexible in the shape and smoothness of the curve estimates, they generally result in considerable variability in yields and forward rates. In contrast, functional methods impose smoothness while potentially introducing mispricings for the chosen market securities. The choice depends on the purpose, intent, and ultimate use of the curves.

Because spline-based methods do not assume a particular functional form, they exhibit greater flexibility by fitting many kinds of term structure curves with very small fitting errors. That flexibility, however, comes at a cost of curve stability. The shape of the resulting curve in spline methods is very sensitive to the location and number of interpolation points (nodes of the spline) and their values. As a result, a small change in the price or yield of one of the bonds may result in large instabilities in the fitted curve.

Figure 12.1 illustrates this feature using an example of a simple spline fit to five quoted yields. It shows the result of the fit to quoted yields (thick solid line) and the corresponding

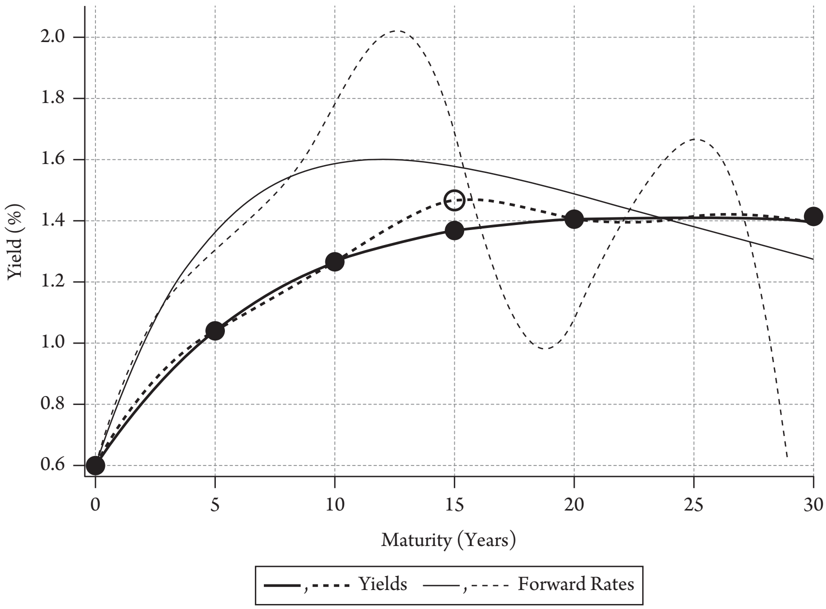

Figure 12.1 Spline Instability
This figure shows the result of the fit to quoted yields (thick solid line) and the corresponding instantaneous forward curve (thin solid line), and the distortion of the spline fit resulting from a small shift in the yield of one of the bonds.

instantaneous forward curve (thin solid line). The quoted yields appear as filled circles. The dashed lines show what happens to the curve when one of the yields is raised by 10 basis points (bps) (an open circle at 15-year maturity). The thick dashed line represents the result of the new fit to the shifted yields, and the thin dashed line shows the shape of the forward rates. A simple spline function is nonlocal in nature (i.e., a change of the functional form between two nodes propagates to the neighboring nodes, and further along the spline). This process results in characteristic *ringing* of the curve—when one section of the curve becomes convex, the neighboring sections must become concave. This ringing is clearly seen in the spline fit itself (dashed curve) but is especially pronounced in the shape of the resulting instantaneous forward curve. This feature renders spline fit unacceptable in cases when a reasonable forward curve is required.

The relative simplicity of the spline-based method led to development of various algorithms that attempt to overcome the problem of instability. A classic cubic spline fit (Vasicek and Fong 1982) was extended to a smoothing spline technique (Fisher, Nychka, and Zervos 1995), which, in turn, serves as a foundation for a broad range of spline-based models (Hagan and West 2006). The main difference between the various approaches lies in the method by which smoothing criteria are applied to obtain a more stable fit (Bank for International Settlement 2005).

The function-based method imposes a particular functional form on yield curve expressed as the dependence of yields $y(0,T)$, discount factors $Z(0,T)$, or forward rates $f(0,T)$ on maturity T. The advantage of a specific functional form is that it can be used directly to control smoothness of the shape of the estimated curve in all its representations such as yields, discount factors, or forward rates. Moreover, the curves in this form are relatively easy to fit—having usually only a few parameters that can be estimated by simple regression techniques. The Nelson-Siegel functional method (Nelson and Siegel 1987) and its extension, the Svensson method (Svensson 1994), are the most widely used among practitioners. According to the Bank for International Settlement (2005), at least nine out of the 13 main central banks of the world use the parametric methods of Nelson and Siegel or Svensson, with the Svensson method being the most popular. These models are relatively easy to estimate and their functional forms combine smoothness of the shapes with flexibility sufficient to provide a good estimate of most of the sovereign yield curves. The original Nelson-Siegel model represents the instantaneous forward rate as a function consisting of three components as shown in Equation 12.12:

$$f(0,T)=\beta_0+\beta_1 e^{-\frac{T}{\tau}}+\beta_2\frac{T}{\tau}e^{-\frac{T}{\tau}} \tag{12.12}$$

The components resemble closely the level, slope, and curvature principal components of the yield curve (Litterman and Scheinkman 1991). The first term, β_0, is a constant level; the second term is exponential term monotonically increasing (if β_1 is negative) as a function of time to maturity T; and the third term generates a hump as a function of T, with the location of the maximum of the hump determined by the parameter τ. When time to maturity increases, the forward rate approaches the constant β_0. Thus, the Nelson-Siegel model always predicts flat instantaneous forward rates for long maturities. This feature results in a poor curve fit for steep curves. To increase the model flexibility and improve the fit, Svensson adds a fourth term, a second hump, with two additional parameters, β_3 and τ_2, as shown in Equation 12.13:

$$f(0,T)=\beta_0+\beta_1 e^{-\frac{T}{\tau_1}}+\beta_2\frac{T}{\tau_1}e^{-\frac{T}{\tau_1}}+\beta_3\frac{T}{\tau_2}e^{-\frac{T}{\tau_2}} \tag{12.13}$$

Equilibrium Versus Market Curves

In the chapter thus far, zero-coupon bonds have been the basis for constructing sovereign curves. However, true zero-coupon bonds are not readily available in the market. For example, the U.S. Treasury issues zero-coupon bonds with maturities up to one year, but all the Treasury notes and bonds of longer maturities (from 2 to 30 years) pay semi-annual coupons. Further, the yields of coupon bearing bonds themselves will not fit along a smooth curve. Bonds with the same, or very similar, maturities can have different yields if they were issued at different times. Any attempt to fit a smooth curve that prices all the bonds on this market exactly will most definitely fail.

Thus, the no-arbitrage assumption does not hold for this market. Arbitrage freedom dictates that two bonds with the same maturity and the same coupon payment dates must have the same yield. However, in practice, the yields can and do differ due to a mixture of supply and demand factors as well as liquidity and transaction costs. Although building a no-arbitrage curve that prices all the instruments in this market exactly is impractical, such a curve is needed to be able to price or hedge these instruments.

The solution in this case is to define a subset of instruments that represents, as close as possible, the arbitrage-free market, to build the curve in such a way that it prices all the chosen securities exactly. Building such a curve is possible using an arbitrage-free short rate model, in which cases it represents, by default, the prices of all the bonds on the market as if they were arbitrage-free. Another way of creating such a curve is by using a functional form of the instantaneous forward rate such as Nelson-Siegel or Svensson in which case it will not be arbitrage-free by default but can be made as close to the arbitrage-free curve as is desirable by a judicious choice of the functional form of the forward rates. In fact, evidence shows that both the Nelson-Siegel and Svensson models can be interpreted as multifactor short rate models (Diebold and Li 2006), and a class of arbitrage-free dynamic term structure models can be constructed that approximate the Nelson-Siegel and Svensson yield curve specifications (Christensen, Diebold, and Rudebusch 2010). In both functional forms and short rate models, any deviation of the observed prices from the prices computed using that curve quantifies the amount of friction in the market—existing theoretical arbitrage opportunity that cannot be exploited because of the liquidity, transaction costs, and other restrictions. In other words, this curve represents a *market equilibrium*, which is the state that would be achieved if all, even the smallest possible, arbitrage opportunities could be exploited and traded away (i.e., if the market was completely arbitrage-free).

A different situation occurs in the LIBOR market, in which the market quotes are *par swap rates*, which are set to exclude any arbitrage between the floating and fixed coupon legs of the swap and are, by definition, arbitrage-free. Because every day a well-defined homogenous set of par swaps exists with distinct maturities (usually spaced by one year), the yield curve in the LIBOR market can be represented by a smooth instantaneous forward curve that prices every par swap exactly.

The issue here is the number of instruments to price. A low-dimensional time-homogenous short rate model that consists of three or four stochastic components is perfect for producing an *equilibrium curve*, which is a set of theoretical equilibrium prices for bonds that will match precisely only the market quotes of a select few securities. However, it is not flexible enough to price all the quoted swaps exactly. This situation led to development of time-inhomogeneous models such as Ho and Lee (1986) that use deterministic functions of time as loadings on stochastic short rate factors that are calibrated in a way that gives a precise match between all theoretical and observed prices.

Another solution would be to construct a smooth, continuous forward rate function $f(0,T)$ that is defined by as many parameters as there are instruments to fit. Such a function can be calibrated to price all these instruments exactly at market. A widely used approach to building such a function is to represent it as a weighted sum of the basis functions. In mathematics, a basis function is an element of a particular basis for a function space in which every continuous function can be represented as a linear combination of the basis functions. In this case the weights are playing the role of free calibration parameters. In order to find a unique solution, the number of basis functions must be equal to the number of market input securities. The Nelson-Siegel and Svensson models are actually the simplest examples of this type of approach, as they define the smooth forward curve as a sum of three and four basis functions, respectively.

The key to a good curve is in the judicious choice of basis functions, which can be as simple as quadratic functions with maximums around maturities of the fitted bonds or swaps, and the choice of boundary conditions on the functional form of the curve at $T=0$ and beyond the last known maturity point. Using the basis functions with domains encompassing the entire range of maturities of interest instead of using splines that are collections of piecewise functions produces a function that satisfies various generic requirements to the form of the yield curve.

Because both these models involve calibration of the curve to observed prices, no arbitrage opportunity exists at the outset. This type of curve correctly prices all the market instruments, and thus can be described as a *market curve*.

Curve Construction Methodologies

Accurate security pricing is at the core of any yield curve construction. Market data represent more than a number. Such data represent a tradeable security that, if transacted, can alter a portfolio's characteristics. Instead of simply connecting the dots between market data points, the process of curve fitting must treat each market quote as a bona fide security, together with all of its terms and conditions as well as its computational conventions. Terms and conditions for over-the-counter (OTC) derivatives are analogous to the legal details contained in a bond prospectus.

Once the functional form of the curve is chosen via economic considerations, such as Nelson-Siegel and Svensson models, or a time homogenous short rate model for equilibrium curves, or via a time inhomogeneous model or a specific parametric function for market curves, the curve can be constructed using two distinct methodologies: *bootstrapping* or a *global fit*. Both methods result in a curve that is guaranteed to match the price of every input security. At the same time each method produces a curve with slightly different properties, and the choice of the method depends on the curve's ultimate use and its desired characteristics. Both methods share the basic steps for constructing the curve. The first step involves choosing the set of securities that will be used to fit the curve (i.e., that have market prices closest to the arbitrage-free values, according to some criterion such as liquidity). The second step is purely technical converting the market prices into a continuous curve of instantaneous forward rates. This step is completed by solving a set of equations that link security prices to the functional form of the yield curve through the set of discount factors such as Equation 12.4. The equations to solve are nonlinear and must be solved numerically using one of the readily available numerical libraries that implement Quasi-Newton numerical methods (Nocedal and Wright 2006).

Bootstrapping proceeds sequentially, building sections of the curve based on the information provided by the market input securities sorted by maturity (Ametrano and Bianchetti 2013). The algorithm starts with a discount factor of 1.0 at $T = 0$, and determines, through interpolation, subsequent discount factors at each point required to price the subsequent market input security. Thus, bootstrapping can be viewed as a combination of *pricing* and *interpolation* in one of the representations of the yield curve: spot rate, forward rate, or discount factor. The interpolation method must be chosen carefully in order to produce curves with desirable financial properties.

The global fit algorithm constructs the curve by solving pricing equations simultaneously for all securities that are chosen as curve fit targets. If the number of the target securities is the same as the number of parameters of the chosen functional form of the curve, the global fit can be performed by exactly solving the system of pricing equations. In the case where more target securities are available than curve parameters, the curve can be estimated using a nonlinear least squares regression, the most widely used algorithm is Levenberg-Marquardt (Press, Teukolsky, Vetterling, and Flannery 2007).

To be useful for pricing and hedging applications, the curve must not only be arbitrage-free, but also have some specific generic properties. Among those, the three most important are continuity, locality, and stability. Each of these properties will be discussed briefly in the content that follows.

A local curve is one in which a slight change in a market price input results in a curve that is only different in a localized region near the changed input. This aspect is important when assessing the risk of fixed income securities and portfolios. For instance, *key rate durations* (KRDs) are an important measure of risk exposure for different maturity points along the curve. The definition of a KRD involves changing the market data inputs and re-deriving the curve. The relative difference between the prices from these two curves gives a measure of the risk at that maturity. Nonlocal curves, such as the one displayed by cubic spline interpolation in Figure 12.1, exhibit "curve ringing"—a change at almost every maturity point of the derived curve based on the change of a single input. Therefore, discount factors along the entire curve are different—the change in the discount factors does not just arise from the region of the curve being shocked. Curve ringing results in a lower reported risk around the shocked region, and an increased risk in regions of the curve completely disconnected with the curve shock.

The curve also must be stable day-over-day. As the market moves, the curve should not show drastic changes. This property is closely linked to locality; typically, curve construction techniques that are local are also stable. An unstable curve gives rise to fluctuations in an intermediate rate (i.e., one not included in the set of market inputs) that are not explicitly exhibited by the market movements.

Continuity of the curve is particularly important when using the curve as a foundation for constructing stochastic models for derivative pricing. A discontinuous curve that has the instantaneous forward rate jump over a decreasingly small time period may produce an unstable modeled distribution of rates at derivative expiration, resulting in incorrect derivative pricing.

In both bootstrapping and global fit methods of curve building, the desired properties are achieved by an appropriate choice of the functional form of the yield curve. Bootstrapped curves are by construction more local, as changing one input point in the curve potentially results in the change of only the sections of the curve at longer maturities. With a good choice of a bootstrapping function, the locality of the curve is virtually guaranteed. At the same time, the bootstrapping method can result in a curve with discontinued first derivative of the instantaneous forward rates. Conversely, the global fit uses a predefined functional form for the whole curve at once, and as such guarantees continuity of the instantaneous forward rates and their derivatives. Because of the global nature of the fit, achieving as high degree of locality with it is more difficult than with the bootstrapping method.

Government Bond Curves

The sovereign bond market for both local currency-denominated and foreign currency-denominated instruments includes both traditional, stable issuers with investment-grade ratings, and more volatile emerging markets issuers. Many bonds, notes, and short bills that differ from each other by their issue dates, remaining time to maturity, liquidity characteristics, and specific supply and demand characteristics typify each government bond market. Therefore, for sovereign curves, choosing the instruments to fit the curve is a task that requires detailed knowledge of the government bond market and understanding of the specifics of both bond issuance and their trading on the secondary market. Consider, for example, the construction of the U.S. government curve.

Currently, the U.S. Department of the Treasury offers Treasury bills (T-bills), notes, and bonds at regularly scheduled auctions. Each Treasury auction effectively creates a supply shock to the market. Substantial trading activity results from investors attempting to hedge the uncertainty in the supply and to absorb the supply shock. Thus, the process of auctioning Treasury securities is an important determinant for the choice of the target securities used in curve fitting. Studies show that despite the fact that Treasury auctions are announced in advance, significant temporary price effects occur in the secondary market both before and after the auctions (Krishnamurthy 2002; Fleming and Rosenberg 2007; Duffie 2010; Lou, Yan, and Zhang 2013).

The current auction issue (so-called *on-the-run issue*) experiences significant price deviations from an equilibrium arbitrage-free price for a period following the auction. This situation makes the on-the-run securities unsuitable for curve fitting, if one is trying to estimate a curve that is as close as possible to the "ideal" arbitrage-free curve. Conversely, the first and second *off-the-run* issues (i.e., the securities that were issued at the auction immediately preceding the most recent auction and at the auction before that) still demonstrate sufficient liquidity, while the effect of the supply shock that their prices experienced around their auctions has very likely dissipated. This situation makes these issues ideal candidates for target securities for curve fit. The choice of the first and/or second off-the-run issue depends on multiple factors, including availability of data and specific purpose of the resulting curve.

Using only the first off-the-run securities results in the most suitable method for curve construction providing a direct solution of the system of pricing equations with the number of target securities equal to the number of the parameters in the curve function. Another possibility is to use both first and second off-the-run instruments. In this case, the least square fitting technique that minimizes the sum of squares of the differences between the theoretical and market yields of the target securities is preferable. This approach might be a slightly better solution because the resulting curve represents "average" yields of the securities with similar maturities and, assuming market friction results in random price fluctuations, is closer to the true arbitrage-free curve.

In both cases, the choice of actual maturities of the target instruments depends on the flexibility of the functional form of the fitted curve. If, for example, one uses a time homogenous model that represents the short rate as a composition of three stochastic processes (i.e., a three-factor model), using only the two-, 10-, and 30-year securities might make sense because such a model is likely not flexible enough to capture the smaller scale dynamics of the prices between two-, three-, five-, seven-, and 10-year maturities. Regardless, the choice of the target securities must balance concerns about quality and availability of input pricing data and the desired characteristics of the resulting curve.

Another important consideration is the modeling of the front-end of the curve (maturities shorter than two years) and the choice of the first point of the curve $f(0,0)$ that must represent the actual short rate at the current time $t=0$. Short-maturity yields are often used as proxies for the short rate. However, evidence shows that various "seasonality" effects influence short maturity instruments. Hamilton (1996) and Balduzzi, Bertola, and Foresi (1996) use the federal (Fed) funds rate and Piazzesi (2005) uses the repo rate. This situation leads to an argument that the target rate set by the Federal Reserve is a cleaner measure of the short rate (He 2000; Piazzesi 2005). Another possibility would be to use the short T-bill rates as short-rate proxies (Chapman, Long, and Peterson 1999). However, studies show that short T-bill rates behave differently from other short rates (Duffee 1996). More specifically, T-bills with maturities less than three months do not share much variation with other short-term yields such as Eurodollar rates or Fed funds rates.

Studies also demonstrate significant differences between the behavior of T-bills and longer maturity Treasury notes and bonds (Simon 1991, 1994). Thus, the dynamics of the front-end of the curve is generally different from longer maturities. This behavior will not be captured by a low-dimensional short rate model calibrated to the longer maturity notes and bonds, or by a functional form of the forward rate curve that is built consistently with the empirical latent factors that drive the curve (i.e., level, slope, and curvature).

Figure 12.2 shows an example of the USD Treasury curve fitted with both a three-factor short rate model (solid line) and functional forward rate models (Nelson-Siegel, dashed line, and Svensson, dash-dot line), together with actual market quotes of all Treasury notes and bonds traded for that date on the secondary market excluding T-bills. The curve is estimated as the instantaneous forward rate curve as described previously. The resulting yield curves are calculated from forward rate curves as constant maturity yields on a grid of evenly spaced maturities. All the curves are fitted using non-linear least squared regression techniques to the set of first and second off-the-run two-, 10-, and 30-year maturities. A one-day general collateral repo rate is used as a short rate proxy for the starting point of the curve. This curve is based on the closing market bid yields on actively traded Treasury securities in the OTC market (quotes captured at 3:30pm Eastern Standard Time).

Since the Treasury does not issue bonds with maturities between 10 and 30 years, all the points on the graph between these maturities represent previously issued 30-year

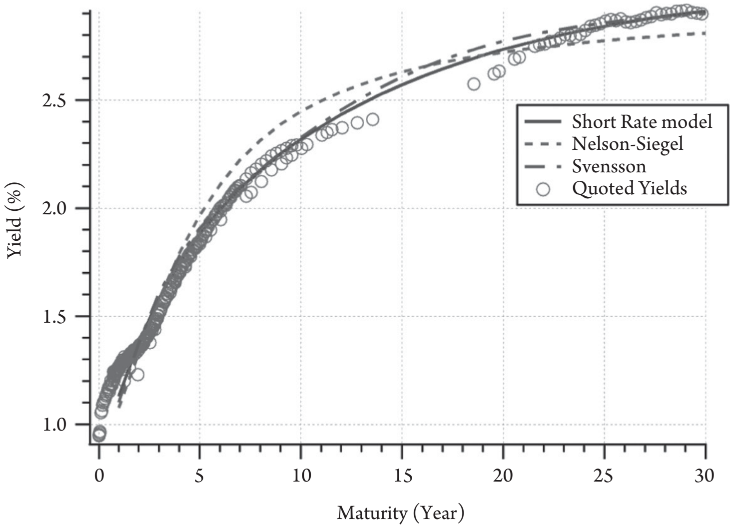

Figure 12.2 Fitted U.S. Treasury Curve for June 8, 2017, Together with Market Quoted Yields for All Traded Notes and Bonds

This figure shows an example of the USD Treasury curve fitted with both a three-factor short rate model (solid line) and functional forward rate models (Nelson-Siegel, dashed line, and Svensson, dash-dot line), together with actual market quotes of all Treasury notes and bonds traded for that date on the secondary market excluding T-bills.

bonds. The gap between the maturities of 14 and 18 years represents the period between 2002 and 2006 when U.S. Treasury discontinued the issuance of the 30-year bond. The distance between the fitted equilibrium curve and the quoted market yield increases with maturities decreasing from 30 years, reflecting diminishing liquidity of the off-the-run 30-year issues. However, as the time to maturity of the original 30-year bond approaches 10 years, the yields are pulled back toward the curve because of the arbitrage between the old 30-year bonds and newly issued 10-year notes. Between 5 and 10 years of maturity there are two clear distinct strings of quoted yields—a set that is closely following the no-arbitrage curve and the set that has yields several basis points below the curve. The former set represents the older issues of the 10-year bonds, while the latter consists of the 30-year bonds issued more than 20 years ago. Insufficient liquidity prevents these bonds from being pulled closer to the newer 10-year bonds of similar terms.

All three fitted curves are able to reproduce the market yields of all the traded Treasury instruments within 10 bps. Clearly, the Nelson-Siegel model is not flexible enough to follow the shape of the curve in both the two- to 10-year segment and at the long end. Because the curve is fitted using least-square regression, the Nelson-Siegel model attempts to minimize the sum of the distances in two-, 10-, and 30-year prices, which leads to underpricing of the 10-year instruments (i.e., the curve shows higher than quoted yields around 10-year maturities), and overpricing of the long end of the curve.

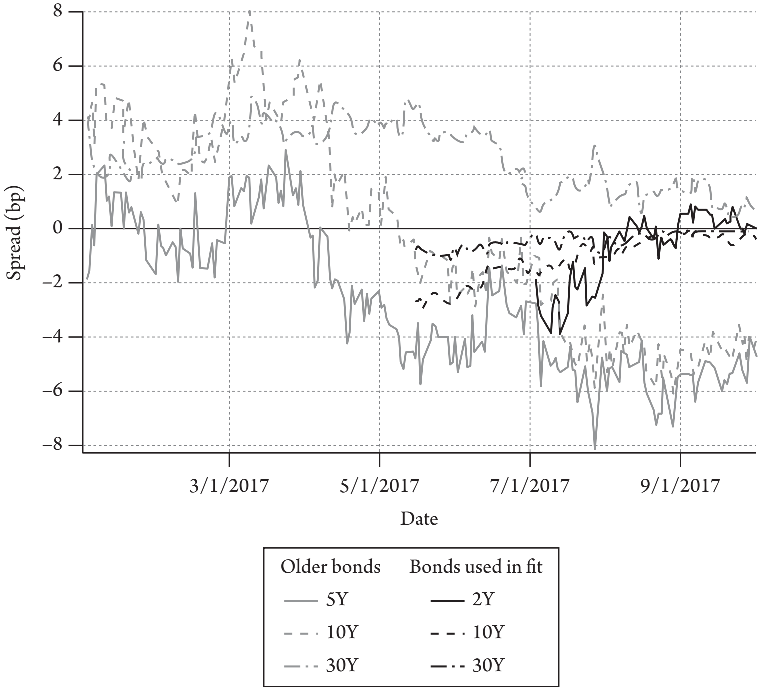

Figure 12.3 Time Series of the Spreads to a Fitted Curve
This figure shows the time series of the spreads of several Treasury instruments to the fitted short rate yield curve.

With the Nelson-Siegel functional form, the first parameter β_0 is effectively defined by the $t = 0$ short rate, leaving only two degrees of freedom (β_1 and β_2) for the function to fit three given points on maturity axis. The Svensson model, by virtue of incorporating two more additional parameters, is more flexible and is capable of fitting closely all given maturities. The result is a curve that is overall much closer to the universe of the quoted yields.

The best performance is achieved by using a time-homogenous three-factor short rate model that, by definition, produces the arbitrage-free curve. That curve reprices all traded liquid securities between two- and 30-years within less than five bps. The two notable exceptions are the old, illiquid 30-year bonds that can deviate from the equilibrium curve by approximately 10 bps, and the old notes with remaining maturities less than two years that are strongly affected by the dynamics of the T-bill market.

Figure 12.3 shows the time series of the spreads of several Treasury instruments to the fitted short rate yield curve. The spreads are computed by shifting the instantaneous forward curve fitted for each date until the price given by the shifted curve becomes equal to the market quoted price of the security. The figure shows the time series of the first off-the-run two-, 10-, and 30-year instruments that were used as targets for curve fitting (black solid, dashed, and dash-dot lines), as well as times series for older securities (gray solid, dashed, and dash-dot lines).

Not surprisingly, the instruments that are used as targets for the curve fit are repriced to within one basis point (bp). What is more important, because it testifies to a true equilibrium nature of the fitted curve, is that the spreads of the other bonds are concentrated, on average, within ±5 bps, and are mean reverting in the long run.

Swap Curves

A *swap* is a legal obligation between two counterparties to exchange one set of future cash flows for another. Swaps can come in many forms. This section focuses on two specific types of swaps: a plain vanilla interest rate swap (IRS), in which one party pays a fixed coupon (the fixed leg) and the other party pays a floating coupon indexed to a specified observable interest rate in the same currency (the floating leg); and (2) basis swaps, where both parties pay floating coupons indexed to different interest rates in the same currency. The magnitude of the cash flows depends on a *notional principal value* (simply referred to as the *notional*). This value plays the same role as a bond principal value, except the notional is never exchanged because it has no economic impact.

The nomenclature of an IRS is defined from the point of view of the fixed leg. A *payer's swap* is a swap where the counterparty is long (receiving) the floating leg and short (paying) the fixed leg, whereas a *receiver's swap* is a swap where the counterparty is long (receiving) the fixed leg and short (paying) the floating leg. Furthermore, the notion of "long" and "short" a swap refers to the fixed leg: the counterparty is long the swap if the counterparty receives the fixed leg.

The interest rate index used in the majority of swaps is a trimmed average of the results of a poll, where an administering body polls a set number of contributing banks for what they could borrow unsecured for a specified amount of time, known as a *tenor*, such as three or six months. For example, the Intercontinental Exchange (ICE) queries between 11 and 17 major banks in London to produce daily LIBOR quotations for five currencies (Swiss franc, Euro, British pound, Japanese yen, and U.S. dollar) and seven tenors (spot/next, one week, one month, two months, three months, six months, and 12 months). Other governing bodies produce indices in a similar manner. For example, the European Money Market Institute (EMMI) polls 20 contributing banks in the Eurozone to determine the daily quotations of the EURO interbank offered rate (EURIBOR).

In some economies, the British Bankers Association (BBA), who administered LIBOR before ICE discontinued quoting LIBOR in certain currencies including Denmark, Sweden, Canada, Australia, and New Zealand. Therefore, each country had to decide how it would set the floating leg of an IRS in their currency. Most countries decided to follow the same mechanism by appointing an administrator and conducting polls of major institutions. However, Australia and New Zealand decided to take a different course and opted not for an index set by a poll, but rather by averaging quotes of actual market traded securities—the Australian Bank Bill Swap Rate (BBSW) and the New Zealand Bank Bill Rate (BKBM), respectively.

Before the GFC, many perceived a swap yield curve as very similar to the government bond curve. The no-arbitrage condition assures that a replicating portfolio can be setup that uniquely determines the implied rate between two times through appropriate discount factors, in exactly the same way as the forward rate was defined by Equation 12.6.

If zero-coupon, a discount factor is defined at time t has the value of one unit of currency to be paid at time T as $D(t,T)$, then the implied (simply compounded) rate between the time T and $T+\Delta T$ is shown in Equation 12.14:

$$L(t,T,T+\Delta T)=\frac{1}{\Delta T}\left(\frac{D(t,T)}{D(t,T+\Delta T)}-1\right) \quad \textbf{(12.14)}$$

Here the discount factor is defined as $D(t,T)$ as opposed to $Z(t,T)$ of Equations 12.3 and 12.6 to distinguish between bond and swap discount factors.

The definition of LIBOR involves three important time points: (1) the time at which the rate is observed, t; (2) the start of the accrual period T, representing the start of the lending period over which the rate is in effect; and (3) the length of the accrual period ΔT, equivalent to the *tenor* defined previously. To ease notation, the shorthand $L_{\Delta T}(t;T)$ is often used, defined as the LIBOR rate observed at time t for borrowing between T and $T+\Delta T$. For example, in this notation the current LIBOR rate for lending in three months for a period of three months is written as $L_{3m}(0;0.25)$. The initial observation time is not important for curve construction but becomes very important when considering models of the evolution of the term structure of interest rates.

Equation 12.14 implicitly contains the usual compounding relationship, in which the appropriate average of shorter-term rates also uniquely determines the value of longer-term rates is reflected in Equation 12.15:

$$(1+\Delta T\cdot L_{3\text{m}}(t;t))(1+\Delta T\cdot L_{3\text{m}}(t;t+3\text{m}))=(1+\Delta T\cdot L_{6\text{m}}(t;t)) \quad \textbf{(12.15)}$$

Intuitively, this result is nothing more than asserting that credit risk is not present in the interbank market—all participants have equal utility between borrowing for two three-month periods and borrowing for a single six-month period. Equation 12.14 provides the LIBOR rate projections and hence the curve $L_{\Delta T}(t;T)$ is known as the *projection curve*.

The only difference from the previous discussions of the bond curve is that, instead of an instantaneous forward rate curve, the curve is represented by a finite tenor forward rate. However, if the compounding relation in Equation 12.15 holds, switching to an instantaneous forward representation and computing each tenor rate as compounded instantaneous rates over the tenor period $[T,T+\Delta T]$ is straightforward.

In this case the (pre-crisis) price of an interest rate swap that matures at T_N is the sum of the present value of all incoming (receive leg) cash flows, less the sum of the present values of all the outgoing (paying leg) cash flows, with discounting calculated using the same discount curve that the floating leg coupon is projected via Equation 12.14 in Equation 12.16:

$$S(c,t,T_N)=\sum_{i}^{N}D(t,T_i)Nc\tau_i-\sum_{j}^{N}D(t,T_j)L_{\Delta T}(t;T_j)N\tau_j \quad \textbf{(12.16)}$$

where c is the fixed coupon, τ is the accrual fraction, and N is the swap notional. Equations 12.14 and 12.16 jointly explain why floating rate notes price to par at coupon dates.

The market quotes for plain vanilla IRS provided from market data vendors are par swap rates, which are the unique value of the coupon c in Equation 12.16 that makes both legs have equal value, and therefore the present value of the swap is zero. The par swap rate can be viewed as a weighted average of future LIBOR projections as shown in Equation 12.17:

$$c = \sum_{j}^{N} \omega_j L_{\Delta T}(t;T_j) \tag{12.17}$$

where the weights are given by Equation 12.18:

$$\omega_j = \frac{D(t,T_j)\tau_j}{\sum_i^N D(t,T_i)\tau_i} \tag{12.18}$$

Pricing a basis swap follows the same process, replacing the fixed leg in Equation 12.16 with a second floating leg with a different tenor produces Equation 12.19.

$$S(t,T_N) = \sum_{i}^{N} D(t,T_i) N (L_{\Delta T_1}(t;T_i) + \delta)\tau_i - \sum_{j}^{N} D(t,T_j) L_{\Delta T_2}(t;T_j) N \tau_j \tag{12.19}$$

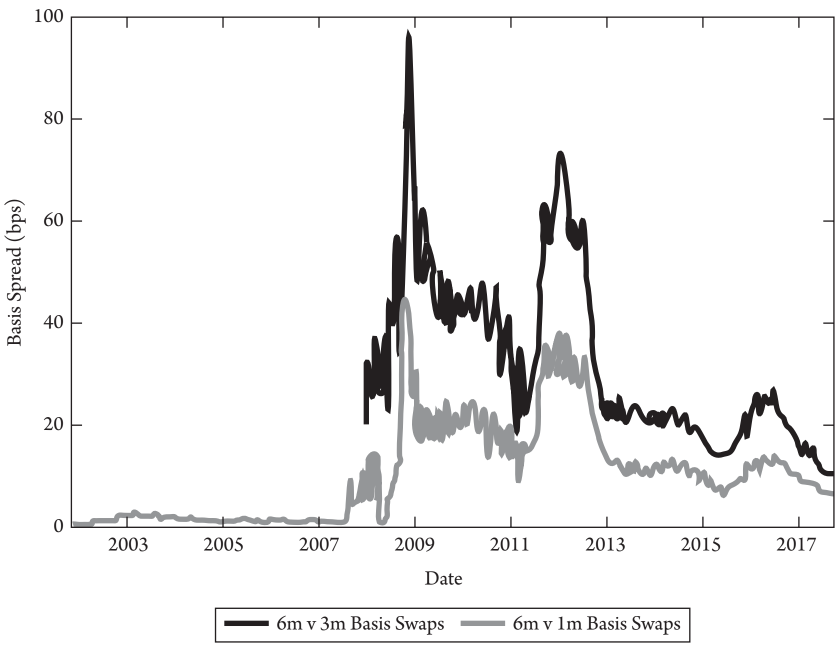

Figure 12.4 European Basis Spreads Before and After the Global Financial Crisis
Figure 12.4 shows the data for swapping different tenors of EURIBOR for six-month EURIBOR.

The spread δ is added to the leg with the shorter tenor in this case the receiving leg. The market data quotes for basis swaps are the basis spreads δ that produce an equal value on each leg, resulting in a par (zero) value for the swap. In the single curve paradigm, this spread should be identically zero and before the GFC, the market quotes were indeed very small, as evidenced by Figure 12.4.

Impact of the Financial Crisis on the Swap Market

The default of Lehman Brothers shows that credit risk clearly exists in the interbank market, a violation of previous model assumptions. Consequently, the implicit assumption that a twice-compounded three-month LIBOR is economically equivalent to a six-month LIBOR is no longer valid. In other words, Equation 12.15 no longer holds. If a borrower can default, the lender must add a spread to the lending rate for longer tenor loans to compensate for possible losses.

The signal that proved this situation emanated from the basis swap market. Figure 12.4 shows the data for swapping different tenors of EURIBOR for six-month EURIBOR. Around 2008 the basis spreads spiked, increasing from near zero to hundreds of basis points. Recall that this is the spread on the shorter tenor floating leg required to enter this swap at par (zero) value. Therefore, the interbank market signaled that the projections of longer term LIBOR based on compounding were too low based on compounding alone, as they now believed a credit component will be present in the future LIBOR fixings.

The impacts of this are pervasive. First, each LIBOR tenor now needs its own projection curve as shown in Equation 12.20.

$$L_{\Delta T}(t;T) = \frac{1}{\Delta T}\left(\frac{D_{\Delta T}(t,T)}{D_{\Delta T}(t,T+\Delta T)} - 1\right) \tag{12.20}$$

Second, and more importantly, given a family of curves, identifying which of these underlying discount curves $D_{\Delta T}(t,T)$ to use for discounting future cash flows is unclear. The resolution came from a surprising place: collateral agreements.

The LIBOR rate now contains a credit risk component and therefore it is no longer a valid proxy for the risk-free rate—the rate singled out in arbitrage-free pricing theory as the rate to use for discounting. This situation prompts the question of which rate to use as the risk-free rate when pricing derivative securities. As Hull and White (2012, p. 84) contend, "The best proxy for the risk-free rate is the overnight index swap (OIS) rate." In an overnight index swap, one counterparty pays a fixed rate and receives the daily compounded overnight rate in the economy. For instance, in the United States, this rate is the Fed funds rate, and in Great Britain, it is the Sterling Overnight Index Average (SONIA).

Conversely, swap traders maintain that the OIS is the correct rate, but for a different reason. To understand their reasoning, consider a fully collateralized swap that is marked-to-market daily with one remaining cash flow. The mechanics of collateral accounts dictate the counterparty for whom the swap is a liability has to pay into the collateral account and pay interest at the overnight rate. This counterparty wants to reduce capital tied up in collateral, and therefore puts in enough money today that, given that interest is accruing daily at the OIS rate, exactly equals the obligation on the future cash flow date. In other words, the amount today of the liability is the future value discounted by the overnight rate.

This link between discounting and funding is controversial. However, what is not controversial is that the swap market now embraces overnight discounting. Today, the London Clearing House (LCH), Chicago Mercantile Exchange (CME), and major accounting firms all discount swaps using the overnight rate for determining their present value. The most compelling evidence came from a numerical study of forward starting interest rate swaps conducted by Bianchetti and Carlicchi (2011). They find that the current market practice to price securities quoted in the swap market is to use the OIS curve, which bootstrapped a discount curve based on the standard EURIBOR six-month curve and the European Overnight Index Average (EONIA) curve. The authors then demonstrate that market quoted forward starting swaps are only consistently priced (to par) using the EONIA curve for discounting.

Thus, the ultimate goal of modern swap curve building is to produce a family of projection curves for commonly traded tenors (one-month, three-month, and six-month) together with the OIS discounting curve. Figure 12.5 shows the result of this process for the EONIA and EURIBOR curves. Most swap markets are homogenous in that they have a single standard tenor quoted for the entire set of data. This standard tenor is typically six months, except for the United States, Hong Kong, New Zealand, and South Africa, which use a three-month tenor. The only economy that is not homogenous is Australia, whose market quotes represent three-month swaps up to three years and six

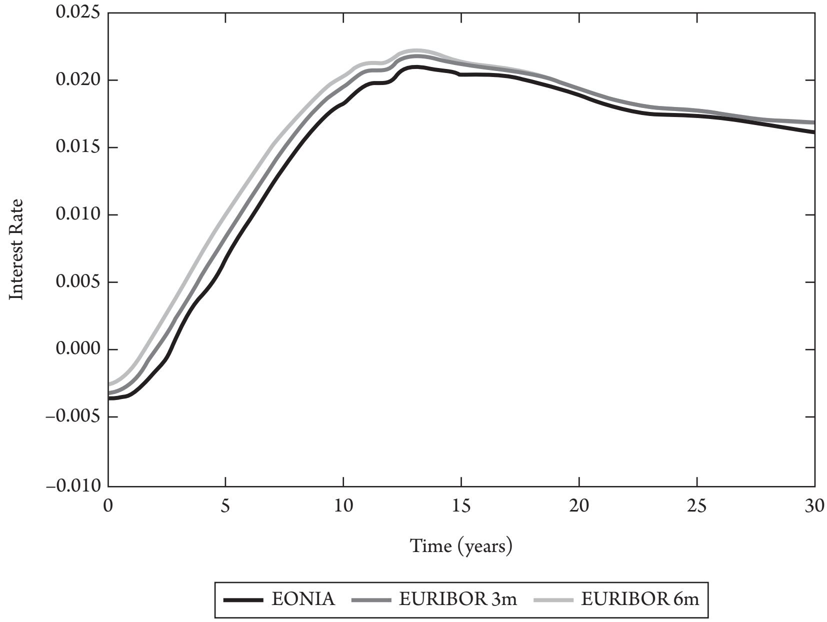

Figure 12.5 EURIBOR Projection Curves and EONIA Discounting Curves for September 20, 2017

This figure shows the result of a modern swap curve building process for the EONIA and EURIBOR curves.

months afterward. The method of construction presented in this chapter does not cover this case but the spirit remains the same.

The mathematics of swap curve construction is not difficult—indeed Equations 12.16 and 12.20 contain almost all of the required mathematics. Yet, curve construction is nuanced and must be conducted with extreme care. Just as in the government bond case, pricing the par swaps must be performed with all of the correct conventions in order to achieve an arbitrage-free curve.

As opposed to government bond market, all quoted rates are arbitrage-free. Therefore, curve construction proceeds by bootstrapping or global fit resulting in a market curve. The OIS curve is constructed first, because discounting all of the securities is needed when constructing the LIBOR projection curves.

The market instruments used in curve construction are heterogeneous, beginning with cash deposits for the very short end, followed by forward rate agreements and Eurodollar futures for the six to 18 month region, followed by swaps that typically are quoted from two to 50 years. Determining which swap quotes to use requires gathering liquidity data from swap data repositories and day-over-day stability tests because the illiquid quotes typically do not move coherently with the rest of the quotes.

Summary and Conclusions

The yield curve has evolved over the years from a collection of data points to a sophisticated tool that can be used to determine the price and risk characteristics of financial securities. Curves can be equilibrium or market, where the choice depends on the purpose, intent, and ultimate use of the curve. Although mathematically straight forward, curve construction techniques are nuanced and begin with robust pricing algorithms of the securities, as the market data quotes represent more than just a number, but a transactable security that can be purchased and can alter a portfolio's characteristics.

The important properties of a curve reflect a noteworthy financial aspect that the curve must exhibit. If the curve is not arbitrage-free, then it cannot be used to price any securities not used in curve construction. A nonlocal curve misrepresents the risk of the portfolio and an unstable curve produces unreasonable daily fluctuations in intermediate yield predictions.

The GFC fundamentally changed quantitative finance and led to the reexamination of swap curve building. The overnight index swap curve rose to prominence as the proxy for the risk-free rate, and therefore the discount curve used in swap pricing, ending the notion of a single swap curve to use for both discounting and projecting LIBOR rates. Swap curve construction now requires an entire family of curves to be built sequentially.

Discussion Questions

1. Explain the meaning of the term arbitrage-free yield curve.
2. Explain the difference between equilibrium and market curves.
3. Discuss why duration is an inappropriate measure of interest rate risk for interest rate swaps.

4. Give one reason countries are moving away from the LIBOR averaging process and opting for market traded rates similar to Australia and New Zealand.

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13

Models of the Yield Curve and Term Structure

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Introduction

The previous chapter provides an introduction of term structure of interest rates models to motivate the idea of an equilibrium curve. In general, academics and practitioners use these models for two purposes: (1) studying and forecasting dynamics of rates and security prices in absolute terms, and (2) pricing and hedging of derivative securities that can be done on a relative basis. When using the models to understand and predict rates and prices, the emphasis in the models' design is on accurately reproducing the observed statistical properties of the underlying rates that the models are trying to predict. But for relative value pricing and hedging, the focus shifts toward recovering accurately all prices and volatilities of a given set of vanilla instruments used in hedging of the complex derivative products. The difference in ultimate models' goals leads to the very important distinction in modeling approach. Although relative pricing models can work in a risk-neutral measure and are not influenced by the actual market price of risk, the forecasting models have to be able to reproduce statistical features of rates dynamics under a real-world probability measure.

The difference between these two approaches can be illustrated with two examples. Relative value traders use the models to build yield curves that have "correct" dependence of the individual yields or par rates on maturity, assuming that the failure of the model to reproduce exactly the market prices of given instruments could indicate a trading opportunity. Similarly, traders of plain vanilla options (i.e., instruments with optionality that are liquidly traded and have no special or unusual features) compare the volatility surface implied by a given model with the market quoted volatilities. In both cases, a model's inability to recover the market price of options or securities does not indicate a failure of the model, but rather a likely arbitrage opportunity. Thus, in both cases the only requirement to the model is the recovery of the market prices of several instruments at a given time, with the assumption that the model thus calibrated can indicate the "correct" prices of the other instruments from the same class such as bonds of different maturities and options to enter into a swap of a given length, known as *swaptions*, of different expiration.

Complex derivatives traders do not have readily available market prices for their traded instruments, and use the models to compute prices of exotic derivatives, given observable market data for simpler, vanilla instruments and options. Vanilla options are then used to hedge the volatility exposure of the complex derivatives, which increases the importance for the model to be able to reproduce exactly the market prices of all these hedging instruments. Although the approach is different from relative value trading and equilibrium curve construction, which leads to different approach to model building, the main goal remains the same—the recovery of a set of market prices at a given time with the assumption that the model will price other instruments correctly.

Analyzing and predicting rates dynamics requires a different approach. Instead of recovering a set of market prices at one time only, the model now is required to reproduce some time series properties, such as the historical trends and statistical measures, of the underlying prices. For example, the model that deals with the bond yields has to be able to reproduce several aspects of bond yields dynamics. Bonds of different maturities as well as different issue dates and coupons are traded together and are, therefore, interconnected. Bonds with long maturities carry more risk, and investors demand compensation for that risk. Thus, arbitrage opportunities exist unless long yields reflect risk-adjusted expectations of average future short yields and movements in yields of different maturities are highly correlated. The term structure model has to be able to reproduce the high correlation between different maturities when forecasting the time evolution of the cross-section of yields, and, at the same time, reflect the risk aversion of bond investors and recover the market price of risk.

The term structure modeling starts from the theory of the derivative pricing created by Black and Scholes (1973). However, complexities of the fixed income market and critical differences between dynamics of bond and stock prices quickly lead to a different approach. Unlike stocks, most of the fixed income securities mature at a given time in the future, and their prices experience the *pull to par effect* (i.e., their market prices converge to par value and their volatilities drop to zero as the bonds near maturity). Furthermore, assuming that the interest rate is constant while bond prices move randomly is impossible. Finally, most of the fixed income derivatives have an interest rate as the underlying, but the interest rate is not a tradable asset and thus cannot be used as such to construct a replicating portfolio.

To cope with these complexities, the term structure models deal directly with interest rate dynamics, instead of the bond price dynamics. The first models of Vasicek (1977) and Cox, Ingersoll, and Ross (CIR) (1985) were built on the general assumption that the dynamics of the whole yield curve (i.e., yields of all the bonds quoted on the market) is driven by the instantaneous short rate only. All subsequent models that were developed for the purpose of yield curve forecasting are based on the same short-rate approach. A deficiency of the first model was the description of the short rate as a single stochastic variable diffusion process. Inadequacy of a single source of uncertainty for the accurate description of the yield curve dynamics led to development of multifactor models, culminating in the class of affine term structure models that represent the instantaneous short rate as a linear combination of an unobserved multidimensional stochastic variable known as state vector (Dai and Singleton 2000; Piazzesi 2010).

The Vasicek (1977) and CIR (1985) models effectively prescribe the shape of the yield curve given a set of fixed model parameters. In other words, fitting the model parameters to a limited set of market variables results, in case of these models, in a continuous yield curve consistent with these market variables. This feature makes the models ideal for constructing the equilibrium yield curve that can be used for discovering tradable arbitrage opportunities. Conversely, this same feature makes recovering the market prices of all tradable instruments of a given asset class (such as all treasury bond prices or all par swap rates) impossible, which is necessary to build the market curve. Hull and White (1992, 1993) took the next step in the development of term structure models by extending the Vasicek (1977) and CIR (1985) models by adding a purely deterministic time-dependent component to the drift term of the short rate diffusion. This change immediately allowed producing the term structure model that is capable of recovering market bond prices of all tradable instruments of a given asset class.

Other models such as Ho and Lee (1986), Black, Derman, and Toy (BDT) (1990), and Black and Karasinski (1991) were created, which are also capable of reproducing an arbitrary exogenous set of bond prices. A common feature of all these models is that the description of the yield-curve dynamics is carried out only in the risk-neutral measure. Therefore, these models are not designed to address the issue of the real-world evolution of bond prices.

These new models could now reconstruct an arbitrary yield curve but could not recover the volatility surface. Their main feature was still a constant short-rate volatility, which meant that the models were characterized by a rigid shape of the volatility term structure, and could not price correctly an exogenous set of volatility sensitive interest rate securities. At best in models where the short rate was represented as a function of several random variables (i.e., models that had several constant volatilities as parameters), an exact fit to only a few caplets or swaptions could be carried out. For traders in complex derivative products that meant an inability to price correctly their main hedging instruments.

The Heath, Jarrow, and Morton (HJM) (1992) approach to term structure modeling resolves the issue of the inability to recover the volatility surface. Their approach used instantaneous forward rates as building blocks of the yield curve dynamics as opposed to instantaneous short rate. It actually uses endogenously specified instantaneous forward rate market curve as its starting point, ensuring that an arbitrary yield curve can always be fully recovered. At the same time, it allows for full specification of the volatilities and correlations of the forward rates and prescribes how to construct the drift of the forward rates process to make the resulting term structure arbitrage free.

However, the main feature of the approach—the ability to recover the full yield curve and the volatility term structure of the instantaneous forward rates simultaneously—makes it much more difficult to apply to term structure modeling than any short rate model. The main issue is that the instantaneous forward rate is not directly observable. Therefore, to construct the instantaneous forward rate yield curve that serves as a starting point for the HJM model, some other method of curve fitting is needed, and only after that the volatility term structure of the forward rates can be calibrated using a set of market quoted vanilla options volatilities. These difficulties are addressed in

LIBOR market model (LMM) (Brace, Gaterek, and Musiela 1997) that is designed to recover exactly both the market prices of all the traded vanilla options and the initial term structure of interest rates, while specifying an arbitrage-free dynamic for all the observable, simply compounded underlying forward rates.

This chapter attempts to present a concise overview of the modern state of the term structure modeling techniques just outlined. The first section presents an analytical framework applicable to all short rate models and considers them from the point of view of the classic approach of pricing by replication. It then explains the important notions of market price of risk and considers its relation to the drift of a short rate model. The chapter then examines the notable short rate models used in the industry for relative value pricing and follows to describe in brief the class of affine short rate models employed for forecasting the real-world dynamics of bond prices. It concludes with the description of the HJM derivative pricing framework and, specifically, with the analysis of the LIBOR market model. All the topics in this chapter have been covered extensively in literature in recent years (Rebonato 2002; Brigo and Mercurio 2006; Andersen and Piterbarg 2010).

Short Rate, Market Price of Risk, and Risk-Neutral Probability Measure

A logical starting point for creating a unified mathematical description of term structure is an assumption for a bond price process. Given that the most obvious requirement is that the bond prices should be strictly positive under any circumstances, modeling them as strictly positive stochastic processes is only natural. These processes can be decomposed into a sum of a stochastic component, representing random price movements due to arrival of new market information, and a "predictable" deterministic component. The simplest stochastic innovation process can be, in turn, modeled as a Brownian motion. In this context the real-world dynamics of the price process of a bond of maturity T, $P(t,T)$, can be written as shown in Equation 13.1:

$$\frac{dP(t,T)}{P(t,T)} = \mu(t,T)dt + \sigma(t,T)dW \qquad \textbf{(13.1)}$$

Here the simplest one-dimensional form of the process is used. A more generic assumption would be that the price process is driven by multiple random innovations, in which case the Wiener process dW will be replaced by a vector process, and its volatility will be similarly replaced by a vector $\sigma^T(t,T)$. The one-dimensional form is used here for simplicity; the logic and meaning of the results will not change in a multidimensional case.

Brownian motion by itself is a martingale and thus the price process with drift $\mu = 0$ will have zero expected return. (A *martingale* is a stochastic process for which, at a particular time in the realized sequence, the expectation of the next value in the sequence is equal to the present observed value). The drift $\mu(t,T)$ in the bond process (shown in Equation 13.1) can be interpreted as the expected rate of return of the bond and $\sigma(t,T)$ reflects the relative sensitivity of its rate of return to the exogenous random shocks that drive the market. In the real world, each asset has a different rate of return $\mu(t,T)$ depending on the amount of risk (volatility) associated with this asset. Hence, the larger is the risk, the larger would be the rate of return. This statement assumes that real-world investors are *risk averse* in that they are unwilling to take risk unless they are adequately compensated for it.

As Harrison and Pliska (1981) show, in an arbitrage-free market, a *risk-neutral* probability measure exists under which the price process normalized to, for example, a cash accumulation process, is a martingale. A cash accumulation process can be written in terms of the short rate process $r(t)$ as Equation 13.2:

$$\frac{dB(t)}{B(t)} = r(t)dt \tag{13.2}$$

Using both Equations 13.1 and 13.2, Equation 13.3 reflects the normalized price process $E(t,T) = P(t,T)B^{-1}(t)$ as:

$$dE(t,T) = -E(t,T)r(t)dt + E(t,T)[\mu^Q(t,T)dt + \sigma(t,T)dW^Q] \tag{13.3}$$

Note that, while Equation 13.1 was written in a real-world probability measure, Equation 13.3 uses the risk-neutral measure. Here μ^Q is the asset's rate of return (drift) and W^Q is a Brownian motion under the risk-neutral measure Q.

Equation 13.3 shows that the drift of the process $E(t,T)$ under risk-neutral measure can be written as $\mu^Q(t,T) - r(t)$. But the process $E(t,T)$ must be a martingale under this measure, and its drift must be equal zero. Therefore, under the risk-neutral measure the drift of the price process μ^Q of any bond is the same and is equal to the instantaneous short rate (risk-free rate), Equation 13.4 follows:

$$\mu^Q(t,T) = r(t) \quad \forall T \tag{13.4}$$

Thus, Equation 13.5 reflects the price process of a bond under the risk-neutral measure:

$$\frac{dP(t,T)}{P(t,T)} = r(t)dt + \sigma(t,T)dW^Q \tag{13.5}$$

Conversely, according to the Girsanov theorem, a change of measure for a Wiener process can be represented simply as adding a drift to the process reflected in Equation 13.6:

$$dW^Q = \lambda dt + dW^P \tag{13.6}$$

where dW^P is the process under the real-world or physical measure. Thus, it follows from Equation 13.1 that the price process for a bond under the risk-neutral measure can be also written as Equation 13.7:

$$\frac{dP(t,T)}{P(t,T)} = (\mu(t,T) + \sigma(t,T)\lambda)dt + \sigma(t,T)dW^Q \tag{13.7}$$

This, together with Equation 13.5 leads to the following conclusion: for any two bonds maturing at T_1 and T_2, Equation 13.8 must hold.

$$\frac{\mu(t,T_1) - r(t)}{\sigma(t,T_1)} = \frac{\mu(t,T_2) - r(t)}{\sigma(t,T_2)} = \lambda \tag{13.8}$$

In absence of arbitrage, the excess return over the riskless rate per unit volatility is independent of security. This statement expresses mathematically the risk aversion assumption—investors demand more excess return for higher amount of risk (i.e., return volatility). This normalized excess return over the short rate is called the *market price of risk.*

The market price of risk plays a very important role in term structure modeling and asset pricing in general. The price of any asset can be computed as an expectation under the risk-neutral measure, and the market price of risk represents the change of measure from real-world to risk-neutral. Thus, in principle, all that is required to price any asset is to know the market price of risk.

Assuming that a Brownian motion drives bond prices, a natural assumption is to let the same exogenous shocks drive the short rate process reflected in Equation 13.9:

$$dr(t) = \mu_r(r,t)dt + \sigma_r(r,t)dW^P \tag{13.9}$$

where μ_r and $\sigma(r,t)$ are real-world drift and volatility of the short rate diffusion. Under the risk-neutral measure, the process $r(t)$ will acquire an additional drift $-\lambda\sigma_r$ shown in Equation 13.10:

$$dr(t) = (\mu_r(r,t) - \lambda\sigma_r)dt + \sigma_r(r,t)dW^Q \tag{13.10}$$

From Harrison and Pliska (1981), it follows that the price of any claim X_T at time T as shown in Equation 13.11:

$$P(t,T) = E_Q\left[e^{-\int_t^T r(s)ds} X_T \right] \tag{13.11}$$

Thus, prices of all securities can be computed if the process $r(t)$ is known under the risk-neutral measure. The statistical properties of the short rate can be analyzed to determine μ_r and σ_r, and may be used to estimate a utility function for the bond investors in order to derive the market price of risk λ. This will produce the complete knowledge of the short rate process and allow pricing any security at any time point t. In practice, however, estimating the real-world drift of the short rate and the market price of risk is extremely difficult if not impossible (Dai and Singleton 2000; Jagannathan, Kaplin, and Sun 2000; Ahn, Dittmar, and Gallant 2002; Bansal and Zhou 2002; Duffee 2002).

In practice, the approach is usually reversed. One constructs the risk-neutral measure such that Equation 13.5 produces prices of a given set of bonds that are equal to their market quoted prices. In computational terms, this process requires calibrating the values (or functional forms) of short rate drift $\mu^{Q}(r,t)$ and $\sigma_r(r,t)$ to obtain a set of exogenously given prices. Given the invariance of the risk premium across securities, once the equation for short rate has been built, it can be used to value any derivative. In this case, the actual market price of risk is unknown since only the combination $\mu^{Q}(r,t)=\mu_r(r,t)-\lambda\sigma_r(r,t)$ is obtained. This situation is pure relative pricing when prices of derivative securities are obtained "relative" to the set of given calibration prices of a predefined set of vanilla securities at the time point for which the model was calibrated. The relative prices of the calibration securities lead to "hedging ratios," which represent the amount of that security needed to exactly hedge the risk of first-order movements in those securities. In other words, this exercise leads to the precise delta hedged portfolio for that derivative security. Using this approach, nothing can be determined about the real-world behavior of bond prices.

Vasicek and CIR Models

Historically, the first term structure models built on the principles described in the previous section were the Vasicek 1977 and CIR (1985) models. The Vasicek model takes the simplest form of the real-world short rate process described by the Equation 13.9 and makes several simplified assumptions:

The real-world drift is assumed to be constant of the form shown in Equation 13.12:

$$\mu=\kappa(\theta-r) \tag{13.12}$$

The volatility of the short σ_r rate is constant and the market price of risk λ is constant. These assumptions attempt to take into account real-world rate dynamics, especially the mean reversion of rates, but mainly are made to allow for simple analytical solution of the pricing Equation 13.5. Under these assumptions and assuming the model is correctly specified, one can use it to estimate the real-world quantities, such as short rate drift, volatility, and market price of risk, directly from observed bond prices.

Empirically, researchers never proved the model was correctly specified. They found that the estimates of the model parameters were not constant over time, but nonstationary and wildly fluctuating on a daily basis (Brown and Schaefer 1994). Also, the fact that the Vasicek (1977) model allows for negative short rates was always considered one of its largest difficulties. However, in light of the latest development in global markets, this feature of the model should probably be considered an advantage, rather than a deficiency.

To avoid negative short rates, the CIR (1985) model postulated the dependence of the short rate volatility and market price of risk on square root of the rate itself as shown in Equations 13.13 and 13.14, respectively:

$$\sigma = \sigma\sqrt{r} \tag{13.13}$$

$$\lambda = \lambda\sqrt{\mathrm{r}} \tag{13.14}$$

Apart from not allowing negative rates, these assumptions produce the model with characteristics very similar to Vasicek's model.

However, the apparent contradiction between these models assumptions—constant parameters and non-stationarity of their parameters fitted to actual market data—and finite probabilities of negative short rate are not the main problems of the models.

Because of their stationary nature, both models cannot reproduce an arbitrarily observed yield curve, which is both a strength and a limitation of the approach. The approach provides the prescriptive element and allows for equilibrium curve construction, thus making relative value trading applications possible. However, the inability to recover the prices of all the underlying instruments when pricing derivatives is clearly a problem.

Time-Inhomogeneous Models

Recovery of an arbitrary exogenous set of bond prices is achieved by using an approach first introduced by Hull and White (HW) (1993, 1994a, 1994b). The approach consists of a seemingly simple modification of the short rate equations that allows for fitting an arbitrary yield curve—the assumption that one of the model parameters in the real-world rates dynamic is time-dependent. This approach was easily extended to other time-inhomogeneous models.

The HW models postulates the time-dependence of the mean reversion parameter θ in Vasicek (1977) or CIR (1985) model as shown in Equation 13.15:

$$dr(t) = \kappa(\theta(t) - r)dt + \sigma_r dW \tag{13.15}$$

Ho and Lee model (1986) uses the basic short rate Equation 13.9 and assumes that the drift term is time-dependent as shown in Equation 13.16:

$$dr(t) = \mu_r(t)dt + \sigma_r dW \tag{13.16}$$

The Black, Derman, and Toy (1990) and Black and Karasinski (1991) models were developed initially as finite differences algorithms that allowed for computing arbitrary cash flow discount factors such that the discounted expectations of the zero coupon bonds would recover correctly their market prices. To achieve this, both approaches effectively carried out the description of interest rate dynamics directly in risk-neutral measure. Therefore, they cannot be used to describe real-world dynamics of the bond prices, as opposed to the Vasicek (1977) and CIR (1985) models that do allow for estimation of the market price of risk. The technical constraints implied by such an approach (i.e., the requirement that the computational tree should be recombining), led to some undesirable features of the models. For example, the continuous time formulation of the BDT model as shown in Equation 13.17.

$$\frac{dr(t)}{r(t)} = \left[\theta(t) - f'(t)(\psi(t) - \ln r(t))\right]dt + \sigma_r(t)dW \tag{13.17}$$

where

$$f'(t) = \frac{\partial \ln \sigma_r(t)}{\partial t}$$

shows that mean reversion of the rate is achieved only if the volatility of the short rate is decaying with time (i.e., its time derivative is negative). But the decaying volatility function would imply that the yield curve becomes less volatile with time, a fact that is not borne out in reality.

The Black and Karasinski (BK) (1991) model is free of the possibility of the yield curve becoming less volatile with time. It incorporated a deterministic function of time in the drift for the short rate, but retained a true mean-reverting behavior that does not depend on the time behavior of the short-rate volatility. It could be computationally modeled on a recombining trinomial tree. However, another severe limitation of this model is that the price of Eurodollar futures is infinite, thus ruling out the use of the model for any practical purpose.

The time-inhomogeneous models allow not only for reconstruction of an arbitrary yield curve, but also for recovery of the term structure of market volatilities. While keeping σ_r in the short rate equation constant results in a "prescribed" volatility term structure, using time-dependent σ_r allows for computation of correct prices of an arbitrary set of caplets. Thus, despite their deficiencies, the models show a very clear advantage: they allow for speedy and simple calibration to the arbitrary yield curve and to caplet prices. Interest-rate options can be priced with the confidence that the underlying bonds are priced correctly. Furthermore, the relatively simple form for the drift ensures that, conditional on a future realization of the short rate, the corresponding future bond prices can be obtained analytically.

The obvious shortcoming of this approach is that the rate's volatility is uniquely determined once the fit to the caplet prices or other suitable calibration instruments such as swaptions is produced. No degrees of freedom are left to reproduce the realistic correlation or decorrelation between forward rates. The correlation of forward rates is set by the model and cannot reflect the correlation structures as seen in the market.

Affine Term Structure Models

One possible way of creating a flexible correlation structure between forward rates is to look for models with more than one stochastic driver. An additional advantage of the approach is that time-homogeneous models driven by several stochastic factors are capable of reproducing a wider range of yield curve shapes than one-dimensional short rate models.

The intuition behind the multi-factor models is provided by principal component analysis of the dynamics of the yield curve. The analysis reveals that much of the variance in yield changes is explained by the first few principal components, and the driving factors of the models implied by calibration of the models to the market yield data typically behave like principal components. A general multi-factor model represents the short rate as a function of a multidimensional stochastic state variable X as shown in Equation 13.18:

$$r = R(X) \tag{13.18}$$

A nonlinear function can be used to insure, for example, nonnegative short rates, but in most models $R(\cdot)$ is a linear function. In particular, affine models are the models where both real-world and risk-neutral dynamics of the zero-coupon bond yields are described by affine functions of an underlying state vector that can be thought of as a multivariate latent or observable stochastic driver as illustrated in Equation 13.19:

$$r(t) = \delta_1 + \delta_2^T X(t) \tag{13.19}$$

where δ_1 is a real scalar, δ_2 is a real vector, and that X itself is an affine diffusion under Q as shown by Equation 13.20:

$$dX = \mu_x^Q(X,t)dt + \Sigma_x(X,t)dW^Q \tag{13.20}$$

In particular, both the drift $\mu_x^Q(X,t)$ and the covariance matrix $\Sigma_x(X,t)$ that replaces volatility σ_x in multi-factor models are affine under the risk-neutral measure Q, specifically as in Equation 13.21:

$$\mu_x^Q(X,t) = \kappa(\bar{X} - X) \tag{13.21}$$

The affine drift $\mu_x^Q(x,t)$ makes sure that the change dX is likely to pull the process $X(t)$ back to its mean $\bar{X}$. The strength of the pull is determined by κ. If $\kappa = 0$, the process is nonstationary. Shocks dW disturb $X(t)$ from moving back to its mean. The effect of these shocks on $X(t)$ is determined by the covariance matrix $\Sigma_x(X,t)$. With constant volatilities and correlations, the normally distributed shocks translate into a conditional normal distribution for changes of X. Gaussian processes and square-root processes are the best known examples of affine diffusions, and the most basic examples of those are the Vasicek (1977) and CIR (1985) models considered above.

Under specific regularity conditions (Piazzesi 2010), the price of a zero coupon bond under the affine model can be written as shown in Equation 13.22:

$$P(t,T) = e^{\left(a(T)+b(T)^{\mathrm{T}} X(t)\right)} \tag{13.22}$$

where $a(T)$ and $b(T)$ are solutions of some ordinary differential equations (ODE). The values of these functions can be computed in closed form only for a few cases, with typical examples being the Vasicek (1977) and CIR (1985) models. More generally, the system of ODEs that defined them can be solved numerically. The pricing Equation 13.22 implies that yields are given by Equation 13.23:

$$y(t,T) = -\frac{1}{T}\left(a(T)+b(T)^{T} X(t)\right) \tag{13.23}$$

and thus are themselves affine function of the state variable X.

The main advantage of affine models is tractability. Having tractable solutions for bond yields allows for relatively simple calibration of the model to the statistical properties of time series of yields. Since the models explicitly specify the dynamic of the state vector X under the risk-neutral measure, an assumption about the functional form of the market price of risk is required to use the models to analyze the statistical properties of the actual bond yields. Evidence suggests that the restrictive assumptions on the risk-neutral dynamics of the state vector (i.e., affine diffusion) may lead to counterfactual data-generating processes for yields for a number of different specifications of the market price of risk. The failure of these models is driven by one of their key features—the compensation that an investor expects to receive for taking risk (i.e., the excess return) is a fixed multiple of the variance of the rate. Because the variance is non-negative, this means that excess return cannot switch sign over time. On the other hand, Treasury yields vary widely over time around both sides of their (sample) means. Across the entire maturity spectrum, the unconditional mean excess return of bonds is small relative to the variation in conditional mean excess returns. Although the average return of Treasury bonds is not much greater than zero, the slope of the term structure predicts a relatively large amount of variation in excess returns of bonds. One implication of this second feature is that, as noted by Equation 13.12, the sign of predicted excess returns of Treasury bonds changes over time.

To overcome this contradiction, different specifications of affine models have been proposed that define the market price of risk itself as an affine function of the state variable. Although a detailed description of these models is beyond the scope of this chapter, reviews are available from Duffee (2002) and Cheridito, Filipović, and Kimmel (2007).

The HJM Framework

Although the initial motivation behind the multi-factor models was the need to account for forward rate decorrelation, Rebonato and Cooper (1996) show that low-factor models display intrinsic limitations in producing this decorrelation between contiguous forward rates. Besides, the multi-factor models did not address the main problem of all short rate models used for pricing complex derivative products—an implicit assumption that market completeness for a bond market can be extended to the market of complex volatility products.

The short rate models postulate that a single stochastic variable—the short rate—drives the dynamic of the yield curve. That assumption is based on the idea of replication. Even if a forward rate appears economically implausible, it is a "true" rate as long as it can be locked by trading two zero coupon bonds. Extending that idea to the complex derivative markets by requiring that the model reproduce the caplet volatility surface makes an implicit assumption that these markets are also complete in a sense that a combination of zero coupon bonds and caplets can replicate every rate derivative. A simple examination of the rate derivatives market shows that this assumption is not always valid. For example, one can consider the relation between swap options and caps, which are two types of plain vanilla options on forward rates.

A swap rate is a combination of forward rates. Thus, if volatilities and correlations of the forward rates are given, both caps and swaptions can be valued using the same set of forward rates. It follows that, if one were to determine the market-implied forward-rate volatilities estimated from swaption prices and those estimated from caplet prices, these volatilities must agree. Yet, as shown in Rebonato (2002), the instantaneous volatility computed from swaptions and caplets have a very similar qualitative shape irrespective of the instruments used for their estimation, but are systematically lower when estimated from swaption data. Also, the implied correlation required to price a set of co-terminal swaptions given the market prices of the caplets is much lower than what is historically observed. A Rebonato and Cooper (1996) show, achieving realistic correlations of forward rates with adjacent maturities is very difficult for a general class of two-factor interest rate models. The market prices of swaptions deviate systematically from prices based on two-factor models parametrized to fit the cap curve. The difference is caused by the fact that the model is forced to imply a too-high correlation between adjacent forward rates. In fact, a perfect fit to bond and caplet prices can be achieved in an essentially infinite number of ways, resulting in substantially different prices of complex derivatives that correspond to the same yield and volatility term structures. Only introduction of HJM type models, specifically the LIBOR market model, can resolve this conundrum.

The essential contribution of Heath, Jarrow, and Morton (1992) was to determine conditions under which an arbitrary interest rate model is guaranteed to be arbitrage-free. They did so by extending the ideas of Harrison and Pliska (1981) to the case where the price process is driven by an underlying stochastic process, thus translating the no-arbitrage condition on prices to the underlying interest rate model.

HJM began by looking at the entire instantaneous forward rate curve as the stochastic driver. In its most general form, such a model can be written as:

$$df(t,T) = \alpha(t,T)dt + \sigma(t,T)dW \tag{13.24}$$

This equation describes the evolution of the entire forward curve $f(t,T)$ for some time-dependent volatility $\sigma(t,T)$ and drift $\alpha(t,T)$, which are both deterministic functions of time and maturity.

To give a simple example of an HJM model, the volatility can be set to be constant and a one-dimensional stochastic driver can be considered.

$$df(t,T) = \alpha(t,T)dt + \sigma_0 dW \tag{13.25}$$

The meaning of the results is the same as in more complex multidimensional models with time-depending volatilities (for treatment of such models see (Baxter and Rennie 1996)).

Since the instantaneous forward rate $f(t,T)$ is the price for instantaneous borrowing at time T, the short rate is equal $r(t) = f(t,t)$. Thus, the same process can be followed with the short rate model and the discounted price process can be built with the cash accumulation process given by the equation for the short rate. But in this case the market price of risk λ turns out to be the function of both the drift and volatility as shown in Equation 13.26:

$$\lambda = -\frac{1}{2}\sigma_0(T-t) + \frac{1}{\sigma_0(T-t)}\int_t^T \alpha(t,u)du \tag{13.26}$$

Because the market price of risk must be independent of maturity T, the arbitrage-free assumption for this model is equivalent to the restriction on the drift $\alpha(t,T)$ of the forward rate process to ensure all bonds are driftless when normalized to the cash accumulation process as shown in Equation 13.27.

$$\alpha(t,T) = \sigma_0^{\,2}(T-t) + \sigma_0\lambda \tag{13.27}$$

The drift is uniquely defined by the volatility process. With full time varying volatility, the HJM condition for the drift of the instantaneous forward rate curve is Equation 13.28:

$$\alpha(t,T) = \sigma(t,T)\int_t^T \sigma(t,s)ds \tag{13.28}$$

Since the entire forward rate curve is modeled, the initial forward rate curve is left unspecified and can be set to exactly replicate the current term structure. This accomplishes two important things: (1) the current term structure can be endogenously supplied and the shape does not have to conform to the shape specified by the model, and (2) this information can be used to eliminate the market price of risk in the HJM framework, circumventing the need to determine these variables, which leads to inconsistent pricing models, as discussed earlier.

Given that all arbitrage-free models fall under the HJM framework, all short rate models previously discussed obey the drift condition. Different choices of the functional form of volatility lead to different short rate models. For instance, choosing $\sigma(t,T)=\sigma_0$ constant leads to the time-inhomogeneous Ho-Lee model in Equation 13.29:

$$r(t)=f(0,t)+\frac{\sigma^2}{2}t^2+\sigma_0 dW \tag{13.29}$$

and choosing the volatility to be an exponentially decaying constant $\sigma(t,T)=\sigma_0 e^{-a(T-t)}$ leads to the Hull-White (time-inhomogeneous Vasicek) model in Equation 13.30:

$$r(t)=f(0,t)+\frac{\sigma^2}{2a^2}(e^{-at}-1)^2+\sigma_0\int_0^t e^{-a(t-s)}dW_s. \tag{13.30}$$

Numeriares and Market Models

The models discussed in this chapter so far have as their underlying drivers instantaneous rates, be it the instantaneous short rate or the instantaneous forward rate. Although working with these variables is mathematically convenient, the variables are unobservable in the market, where only discrete forward rates are observable—the cost of borrowing between two fixed dates. Using instantaneous rates as the stochastic drivers produces two core issues that need to be addressed: (1) the empirically observed correlations between observable forward rates cannot be reproduced and (2) lognormal models of the instantaneous rates are ruled out as they result in infinite prices for Eurodollar futures as pointed out by Sandmann and Sondermann (1997).

This second restriction seemed to contradict the long-standing practice of valuing interest rate options with Black's 1976 model (Black 1976). Initially a commodity model, the Black's 1976 model was essentially a repurpose of the Black-Scholes model where the futures contract has no cost to enter, but is applicable to any security whose forward is a martingale. The model shown in Equation 13.31:

$$C(t)=N(t)\mathbb{E}_{\mathbb{N}}[\max(R-K,0)] \tag{13.31}$$

where $C(t)$ is the price of a call option on underlying R with strike K at time t, can be used to price both interest rate caps and swaptions for the correct interpretation of $N(t)$ and R.

The "numeraire" $N(t)$, analogous to the cash accumulation process described earlier in the chapter, is the security that is used as the normalization of the security price $C(t)$. The contribution of Harrison and Pliska (1981) was to show that if markets are complete, then regardless of which numeraire is used, an equivalent probability measure $\mathbb{N}$ exists such that the normalized security process is a martingale.

When $N(t)$ is a bond maturing coincident with the security payoff T then the measure is known as the T-forward measure. In this case, when R is interpreted as a lognormally distributed discrete forward rate, Equation 13.31 describes the value of an interest rate cap. If R is a lognormally distributed swap rate and $N(t)$ is an annuity whose span is the same as the swap rate, Equation 13.31 describes the value of an interest rate swaption.

Despite the market practice of using the assumption of lognormal rates to quote interest rate volatilities, lognormal instantaneous forward rate models produced infinite prices for Eurodollar futures. The resolution was pointed out in Equation 13.30 that the simply compounded discrete forward rate did not exhibit this behavior; the issue arose from infinitesimal compounding. Simultaneously, Brace, Gaterek, and Musiela (BGM) (1997) published a model that incorporated lognormality of a single forward rate, but also incorporated the correct treatment for all discrete forward LIBORs spanning the forward rate curve. The BGM model, also known as the LIBOR market model (LMM), specifies the collective lognormal dynamics of all observable discrete forward rates. The starting point is the choice of a T_i -forward measure in Equation 13.32, in which the discrete forward rate $L_i(t)$ that matures at the time T_i is a martingale, which is permissible because the payoff of a forward rate agreement is proportional to the discrete forward rate.

$$dL_i(t) = \sigma_i(t,T_i)L_i(t)dW_i. \tag{13.32}$$

The HJM drift conditions uniquely determine the drifts for the other forward rates and these drifts are proportional to the covariance between all of the forward rates as shown in Equation 13.33.

$$dL_j(t) = \begin{cases} -L_j(t)\sum_{k=1}^{i-1}\frac{\tau L_k(t)}{1+\tau L_k(t)}\sigma_j(t)\sigma_k(t)\rho_{jk}dt + \sigma_j(t)L_j(t)dW_i & j<i \\ L_j(t)\sigma_j(t)dW_i & j=i \\ L_j(t)\sum_{k=i+1}^{N}\frac{\tau L_k(t)}{1+\tau L_k(t)}\sigma_j(t)\sigma_k(t)\rho_{jk}dt + \sigma_j(t)L_j(t)dW_i & j>i \end{cases} \tag{13.33}$$

This model has enough degrees of freedom to model not only the volatilities of the individual forward rates but also the covariance between them, allowing for a much richer treatment of correlations. In fact, the number of degrees of freedom is usually too large for practical computation because a one-to-one correspondence exists between the number of stochastic drivers and the number of LIBOR rates. The latter can reach up to 360 for quarterly LIBOR simulated to 10 years.

Although the LMM is by far the most popular market interest rate model, other variants exist. An analogous model to LIBOR rates exists for swap rates, where the swap rates are the fundamental stochastic variables, and are jointly lognormally distributed. Although swap rates are related to LIBOR rates by a transformation, both cannot be lognormal simultaneously. In this model, individual LIBOR rates are given by a linear combination of swap rates, and variance of the LIBOR rates is governed by the correlation of the swap rates.

Summary and Conclusions

Models of the term structure of interest rates are used for two primary purposes: (1) modeling the statistical properties of rates and (2) providing the relative valuation of securities based on other traded securities in the market. This chapter deals primarily with the latter type of model. Early interest rate models focused on the stochastic evolution of the instantaneous short rate and sought to contain some salient characteristics of interest rates such as their mean-reverting nature and remaining explicitly positive. However, this feature is no longer seen today as a desirable property for interest rate models. These simple models were time homogeneous and primarily used as equilibrium models where the term structure itself was a model output, as opposed to a model input. Although not a limitation of the model per se, this feature did restrict the utility of the models. A far larger drawback of these initial interest rate models was their restrictive treatment of volatility, resulting in an inability to fit prices of interest rate option.

An important classification of early models came when Duffie and Kan (1996) introduce "affine yield" models, where the yield was an affine function of the underlying stochastic drivers. This class of model could be extended to an arbitrarily high dimension. However, even by adding more stochastic factors, the inability for the models to realistically match observed volatility persisted. That is, the covariance properties of these models were still too restrictive to properly account for decorrelations amongst adjacent forward rates.

The sound quantitative footing for interest rate modeling came when Heath et al. (1992) published the HJM condition under which any term structure model is arbitrage free. Starting with the entire instantaneous forward curve as the underlying stochastic driver with arbitrary volatility, they determined the condition on the drift, which depends only on the volatility, such that the model is guaranteed to be arbitrage-free. Another feature of the HJM framework was that it adds an extra degree of freedom in that it specifies the evolution of the forward rate curve, without endogenously specifying the initial forward rate curve. Therefore, HJM proved that any model that is arbitrage free could also take in any arbitrary initial term structure.

A necessary consequence of the HJM framework was that lognormal instantaneous forward rates and therefore short rate models were inadmissible because they produced infinite prices of liquidly traded Eurodollar futures. The culprit was the continuous compounding. Researchers quickly showed that simply compounded forward rates do not have this drawback. Brace et al. (1997) introduced a complete model of discrete forward rates that described the dynamics of all observable forward rates spanning the term structure. This model also had a very rich covariance structure that allowed for the simultaneous pricing of LIBOR-sensitive instruments and their options.

Discussion Questions

1. Discuss what the calibration of a short-term model involves.
2. Define the market price of risk.
3. Discuss the conditions under which an interest rate model is arbitrage-free.
4. Identify the available numeraires in the LIBOR market model.

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PART IV

BOND PRODUCTS

14

International Bonds

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Introduction

Sovereign debt is extremely important despite representing only a portion of the total international bond market. Tomz and Wright (2013) calculate that sovereign debt accounts for approximately 19 percent of total global assets in 2010. As of 2016, this equates to $60 trillion in sovereign debt compared with $70 trillion in global equity markets. The share of sovereign debt as a percentage of total global assets has grown steadily since marking a low of 11 percent in 1976 (Tomz and Wright). Moreover, sovereign bond markets have important connections with domestic bond markets. For emerging market economies, sovereign debt has a strong two-way interaction with the real economy and the debt offerings of corporations domiciled in the country. Sustained growth in the volume of sovereign bond issuance, and the importance of the sovereign bond market globally, motivates the in-depth review that follows.

The chapter is organized as follow. The chapter begins by providing a discussion of the factors affecting sovereign bond yields, market development, and market integration. Next, it reviews the possible benefits of diversification and then discusses sovereign default including the real economic impact of default and debt forgiveness. The chapter concludes with a discussion of sovereign credit ratings and the real impacts of the so-called sovereign ceiling.

Sovereign Markets

The first part of the chapter discusses factors that contribute to the cost of sovereign debt. Issues considered include macroeconomic risk factors related to the issuing nation as well as the global economy, domestic and international political risks, and cultural factors. Next, the level of market integration for sovereign debt is considered for developed, developing, and emerging market economies. In closing, the benefits of diversification provided by sovereign bond markets are briefly discussed.

Sovereign Bond Yields

Given the size of the sovereign debt market, analyzing factors that influence the cost of sovereign debt is important. For example, the cost of debt affects the choices that governments make concerning the issuance of new debt, possible default, and a host of other economic policy choices. Although the sovereign's credit rating is important, it is not the sole factor driving the cost of debt.

Ilmanen (1995) provides an early discussion of the factors that influence sovereign bond returns. Examining the bond returns of six developed countries, including the United States between January 1978 and June 1993, the author finds that global bond returns are driven primarily by the world's advanced economies. This finding suggests global sovereign bonds in developed countries respond strongly to global factors. Similarly, Driessen, Melenberg, and Nijman (2003) examine common risk factors in the United States, Japan, and Germany in an attempt to disentangle the risks affecting the terms of debt issuance in these countries. Applying principal component analysis (PCA), they find a factor model of five linear factors explains more than 96 percent of the total variation in bond returns. The first element is a global factor tied to the term structure of global interest rates. This factor alone explains more than 45 percent of all variation. The next two factors also relate to changes in the term structures of bonds, but also account for shifts of the term structure in the opposite direction at the country level. Collectively, the first three factors explain about 91 percent of the total variation in the sample. However, the authors report that only the first two factors explain returns, rather than the variation in yields alone. This finding suggests that within the soveriegn bond markets of developed nations global factors drive a substantial portion of returns. A common theme throughout the chapter is that bonds from advanced economies are integrated and respond more closely to global as opposed to domestic risk factors. However, whether this relation holds for developing or emerging market economies is unclear.

Macroeconomic fundamentals and conditions should play the most important role in determining the yield on bond spreads. Poghosyan (2014) uses a novel approach to disentangle long-run and short-run economic changes to the price of sovereign debt in advanced economies. His sample includes 22 countries between 1980 and 2010. He applies the debt/gross domestic product (GDP) ratio and a measure of potential growth as long-run measures and introduces variables such as short-term interest rates and inflation to proxy for short-run factors. A one-percentage-point increase in the debt/GDP ratio corresponds to a two basis point (bp) increase in yield. Conversely, the author finds that an increase in potential growth rates corresponds to a 45 bps increase in yield. In the short run, deviations from the long-run expected rate can occur. However, the study finds that nearly half of the difference from the long-run predicted rates reverts to the expected value within six months.

Hilscher and Nosbusch (2010) analyze the difference in rates among emerging markets. They consider the conditions and the perceived risk of sovereign debt in these markets alongside volatility in key macroeconomic variables and contend that a country with highly volatile economic fundamentals should be less creditworthy. Focusing on terms of trade which impact the nation's ability to generate dollar revenue from exports, Bulow and Rogoff (1989) note that trade volatility and yield spreads exhibit a positive correlation.

Many approaches are available to quantify the impact of different economic factors on bond prices. For example, credit default swaps (CDSs) can be used to estimate the risk of a sovereign bond and have a direct correlation with bond yields and spreads. Aizenman, Jinjarak, and Park (2016) study CDS spreads from several emerging markets between 2004 and 2012 searching for a link between macroeconomic conditions and reported CDS rates. They find that inflation, external debt, and commodity volatility correspond positively with CDS rates. Moreover, consistent with Hilscher and Nosbusch (2010), the authors also note a link with trade volatility and interest rates. They also find that the more open a nation's trade policy, the lower the CDS. The authors further report the time-varying nature between observed spreads and macroeconomic conditions highlighting that in the pre-crisis period, trade openness and state fragility (broadly political and economic risk) are the most important factors influencing CDS spreads. However, during and after the financial crisis of 2007–2008, perceptions of risk appear to change as a nation's inflation rate and debt-to-GDP increased substantially. Geographically, Asian countries display lower spreads, on average, than Latin American nations. This gap in CDS spreads widened during the financial crisis and did not revert during the post-crisis recovery period.

Gómez-Puig (2009) investigates factors influencing spreads in 15 European Union (EU) countries analyzing spread data spanning the first seven years after the creation of the Euro, 1999 and 2005. The author considers the impact of systematic global factors versus idiosyncratic ones (i.e., local factors) in explaining yield spreads. Results suggest that local factors, as opposed to global factors, best explain differences in yield spreads among European bonds. The author also notes that common global (systematic) factors affect bond prices, and these factors tend to mostly offset each other in Euro-based countries. As a result, the evidence shows that idiosyncratic factors related to liquidity and credit quality determine sovereign yields.

Georgoutsos and Migiakis (2013) also investigate drivers of European bond spreads by studying the effects of economic factors in the Eurozone versus domestic economic factors. The authors control for differences in fiscal variables, concluding that investor confidence and future real economic activity are highly correlated with observed bond spreads.

Bredin, Hyde, and Reilly (2010) consider economic impacts in a novel way. Focusing on surprise changes in interest rates, they investigate how monetary policy affects returns on international bonds issued by the U.S., U.K., and German governments. They report that U.S. monetary policy shocks have little impact on the yields of either U.K. or German bonds, but observe a significant correlation between U.S. yields and the yields in the United Kingdom and Germany. Shocks to monetary policy within the United Kingdom and Germany do not seem to spread outside of their respective borders, but the domestic market response to these shocks differs. When a surprise tightening in Germany occurs, German bonds yields rise while an unexpected tightening in the United Kingdom leads British yields to fall. The authors theorize the market has more faith in the German system to adequately fight inflation compared to the United Kingdom.

Beyond macro-economic considerations, other factors also influence bond rates. Eichler (2014) considers the impact of political institutions on the cost of sovereign bond spreads. He reports that wider yield spreads are associated with certain political traits and institutions. For example, the parliamentary system of government and low-quality enforcement of law or government regulation are associated with higher yield spreads. Legal institutions are important as strong governance, efficient legal systems, strict regulatory systems, increased civil rights, and larger swathes of the population engaged in the political process all correspond with lower interest rates. The author concludes that the ability of the government to engage in economic policies that can stimulate the economy, increase tax revenue, and reduce government spending signal a lower probability of default.

Heinemann, Osterloh, and Kalb (2014) explore additional cultural factors that may influence rates. They contend that the preference for tight fiscal policy by a government or a constituency could be a by-product of cultural preference. The authors observe that cultural preferences play a role in determining bond yields. They report that while measures designed to impose fiscal restraint are still positively related to lower bond yields, statistical and economic effects dissipate when considering the impact of culture and institutions.

Many researchers and practitioners believe that most of the forces influencing the cost of a nation's debt may have little to do with a particular country. For example, Longstaff, Pan, Pedersen, and Singleton (2011) investigate to what extent broad global macroeconomic risk is priced into sovereign CDS spreads. They contend that global factors are the most important contributors to a nation's credit risk, and thus to its bond price. Using principle component analysis (PCA) to investigate the common variation in CDS spread changes, the authors find that the first component accounts for nearly 65 percent of total variation within CDS spreads. This component has a high positive correlation with U.S. stock market characteristics: 74 percent with U.S. stock market returns and 61 percent with changes in the VIX index. Furthermore, among the mostly developed nations in their sample, global factors and investment flows dominate country-specific characteristics in determining bond prices.

Conversely, based on studies of dollar-denominated bonds issued by major Latin American economies, Thuraisamy, Gannon, and Batten (2008) report at least two country-specific macroeconomic factors that influence the credit spread: (1) the prevailing exchange rate between the Latin American country and the United States, and (2) the sovereign yield curve slope. Based on these findings, the results of Longstaff et al. (2011) could be reflective differences between developed and developing market economies.

Market Integration and Diversification

Market integration and market contagion are important to the discussion of international sovereign bonds. What follows is a brief discussion of the market integration literature focused on national development.

Christiansen (2014) uses data from 17 European bond markets between 1994 and 2012 to examine integration between country markets and their relation to the European Monetary Union (EMU) during crisis periods. The author considers EMU ascension and the impact of the financial crisis of 2007–2008 and the subsequent European debt crisis effect on the integration of the bond markets. Before the financial crisis, EMU countries display nearly full integration as the bonds of the different sovereign nations within the EMU acted essentially as perfect substitutes. During the crisis period, the market appears to fragment as the level of integration weakens. National economic and political situations dominate global considerations in national debt markets during the period. Christiansen also finds evidence that the degree of integration within the European countries in the sample depends on EMU standing, whether the country is part of the EMU, and the date the country officially joined the EMU.

Abad, Chuliá, and Gómez-Puig (2010) also consider bond market integration within Europe. They examine the influence of two types of systematic risk—global and "Eurozone"—upon sovereign bond returns for EU-15 countries. Their findings are consistent with Christiansen (2014), who notes EMU membership significantly affects market integration. Abad et al. find that for EMU nations with high bond market integration global factors are not as important to returns as are factors endogenous to the Eurozone. However, for non-EMU nations, global factors play a more significant role in determining bond returns.

Posedel Šimović, Tkalec, Vizek, and Lee (2016) extend Christiansen's study and consider the integration of Eastern European countries into the EU, including the Czech Republic, Hungary, Latvia, Poland, Romania, and the Ukraine from 2004 to 2013. They report that although these bond markets are still largely segmented, their level of integration is increasing. Not surprisingly, the authors report that the most significant factor in determining the level of market integration is the level of economic development within the country.

The topic of contagion has became popular after the difficulties of the GIIPS (Greece, Ireland, Italy, Portugal, and Spain), particularly Greece. Proving contagion empirically is challenging, and different empirical research approaches are available. Pragidis, Aielli, Chionis, and Schizas (2015) consider the possible contagion effects of the 10-year Greek bond within the Eurozone. This study responds to the work of Gómez-Puig and Sosvilla-Rivero (2014), who report contagion transmission from Greek bonds throughout the rest of the EMU. By applying a different methodological approach to the same data, Pragidis et al. present evidence suggesting the Greek bond market did not trigger contagion throughout other EMU markets.

Beirne and Fratzscher (2013) investigate the drivers of sovereign risk in 31 countries before and during the debt crisis of 2000–2011. They find that regional contagion does not play a major role in explaining the movement of bond yields. In contrast, their work shows that deterioration in economic fundamentals explains most of the movement in both yields spreads and CDS spreads. They present evidence that the decline in economic fundamentals exhibited small levels of contagion among economically linked nations. According to the authors, economic fundamentals such as public debt levels, fiscal deficits, GDP growth, and current account performance had little explanatory power in predicting sovereign yields before the crisis. However, after the onset of the crisis, observed prices more accurately reflect these fundamental economic factors. As a result, the study concludes that market models before the European bond crisis do not adequately incorporate market fundamentals.

Piljak (2013) considers the integration of 15 countries—14 emerging market economies along with the U.S. bond market, 2000 to 2011. The author reports that a proxy designed to capture global bond market uncertainty is an important factor in describing the co-movement of the 14 bond markets investigated. Piljak further finds that local economic factors including monetary policy and inflation play a more significant role in explaining the comovement of bond markets than global factors.

Related to market integration is the degree of market development. Early research by Eichengreen and Luengnaruemitchai (2004) examines 41 primarily Asian developed and developing countries between 1990 to 2001 to understand co-movements in bond prices. They find higher domestic bond market activity and participation correspond with market development, including size of the economy, trade openness, investment profile (i.e., the net benefits and costs of foreign direct investment into the country), and the openness of capital accounts all play a role in the level of domestic bond market maturity.

Smaoui, Grandes, and Akindele (2017) extend this research by considering the period between 1990 and 2013 and focusing on 22 emerging market economies. The authors find many of the factors that relate to sovereign interest rates are also important in jointly determining the development of domestic bond markets for emerging market economies. Besides the factors presented by Eichengreen and Luengnaruemitchai (2004), GDP per capita, bureaucratic quality, and depth and quality of the domestic banking system all have a positive impact on bond market development. Conversely, they report that interest rate volatility and fiscal balance negatively correlate with bond market development.

A high degree of integration within developed sovereign bond markets is a challenge to investors seeking diversification. To address diminishing diversification benefits provided by the bond markets of develped economies, investors turn to the diversification benefits provided by emerging market sovereign bonds. Although investing in emerging market debt denominated in the local currency exposes investors to exchange rate risk, diversification benefits may still exist. For instance, Burger and Warnock (2007) consider the amount of foreign investor participation in local currency issued bonds. Besides market integration, their work discusses how an economic crisis can be exacerbated when local currency bond markets are inefficient and lack foreign investor participation. They report that U.S. investors could benefit from investments in emerging market foreign currency denominated sovereign debt. However, many investors avoid these markets due to high volatility and negative skewness in returns. The authors conclude that emerging markets should work to reduce macroeconomic instability to attract investment to their debt markets.

Miyajima, Mohanty, and Chan (2015) also investigate the local currency debt market in emerging economies. They study 11 emerging market countries (2000–2013) and find that domestic factors within emerging market economies drive the returns of local currency denominated debt. Their evidence is consistent with Burger and Warnock (2013) and supports the view that diversification benefits exist for investors of bonds from developed economies.

Piljak and Swinkels (2017) consider the diversification benefits of U.S. dollar–denominated sovereign debt from emerging and frontier markets. Dollar-denominated emerging-market debt removes exchange rate risk, while still providing exposure to emerging debt markets. The authors consider correlations between 29 countries at the aggregate, regional, and country levels from 2001 to 2013. Their most important finding is that the correlation between these markets and U.S. Treasuries are time-varying but typically close to zero.

Sovereign Debt, Default, and Impact

The following section explores how sovereign debt contracts are designed in accordance with the doctrine of sovereign immunity. This section also considers the impact of sovereign default and debt relief to creditors and issuing nations. It concludes with a discussion of the market impact of credit ratings, the effects of rating downgrades, and the "sovereign ceiling."

Sovereign Default

Pursuing legal recourse against a sovereign nation to extract payment on its debt is difficult in part due to the *doctrine of sovereign immunity*, a legal construct outlining the way in which a lawsuit against an independent legal state will proceed. The doctrine outlines a policy that prohibits a private party from securing a sovereign's property without the state's consent. Given this situation, a logical question is why would any creditor agree to lend to a sovereign state? Although different viewpoints exist, common themes emerge.

The jurisdiction in which the debt is issued affects the ability of the private lender to enforce a debt contract and, by extension, borrower risk, as this determines the legal process in the event of default. Das, Papaioannou, and Trebesch (2012) provide further insight concerning emerging market debt and the laws governing debt contracts. They report about two-thirds of the bonds are bound by New York law, while the legal jurisdiction of London constitutes nearly a quarter of the total. These findings support the view that debt issuers strongly prefer the protections offered by the British Common Law origins (La Porta, Lopez-de-silanes, Shleifer, and Vishny 1997). Also, with respect to the general legal structure of debt, some clauses are becoming more popular for sovereign debt issues. Clauses include, but are not limited to, *pari passu* and collective action clauses. The *pari passu* clause obligates the sovereign to treat all creditors equally. According to Choi, Gulati, and Posner (2012), nearly 25 percent of all sovereign debt contracts contain this clause with almost 75 percent of all emerging market debt contracts featuring this requirement. A *collective action* clause reduces the threat of holdout creditors by allowing a super-majority to impose a settlement between the sovereign and all creditors. The requirement of unanimity has dropped precipitously since the Argentine default in 2001 (Richards and Gugiatti 2003; Choi et al. 2012).

For practical reasons, a standard definition of sovereign default must be established. A natural starting point is the definition used by most credit rating agencies (CRAs), which is a broader construct than the legal definition. CRAs identify a default when either the sovereign violates the terms within the contract (legal definition) or the sovereign makes a tender offer to its current creditors of a new debt issue containing less favorable terms. According to Tomz and Wright (2013), this definition was applied to Argentina and Greece in 2001 and 2012, respectively, despite neither country having missed any required payments.

How often do sovereigns default? Tomz and Wright (2013) analyze a sample covering nearly 200 years and report the unconditional probability of default is about 2 percent. Interestingly, when considering more recent history (1980–2012) and countries that have previously defaulted, the probability of a future default nearly doubles to 3.8 percent. As nation states can issue debt contracts in different currencies (domestic or foreign), Jeanneret and Souissi (2016) consider defaults by currency denomination. If a country has both foreign and domestic debt, it can choose to default on one or both issues. In this instance, Standard & Poor's assigns two separate credit ratings, one for each issue type, though the ratings for both are often the same. In such cases, the expectation is that the local currency issue tends to default less frequently because the government can meet the contract requirements by printing more money (i.e., issuing new debt).

Counterintuitively, Jeanneret and Souissi (2016) find that the probability of default is independent of the currency issue. Their evidence shows that economic conditions influence which bond the nation elects to default. When domestic firms have primary financing from local banks, and when inflation is already high, countries elect not to default on local currency debt. However, these factors do not affect the choice to default on the foreign-issued debt. Conversely, if a country has a substantial and increasing debt burden, decreasing domestic investment, and an increasing fraction of its debts maturing in the short-term, that country is more likely to elect to default on its foreign currency denominated issues.

The magnitude of the potential loss to creditors should a country default is an important consideration. Indeed, consensus suggests that losses incurred due to sovereign default amount to between 30 and 40 percent on average (Sturzenegger and Zettelmeyer 2008; Yue 2010; Cruces and Trebesch 2013). Although these losses are large, they are not necessarily catastrophic. The punitive cost to the sovereign is difficult to measure but provides answers as to why the haircut is relatively small. In finance, a *haircut* is the difference between the market value of an asset used as loan collateral and the amount of the loan. The amount of the haircut reflects the lender's perceived risk of loss from the asset falling in value or being sold in a fire sale. Empirical research shows that on average countries that default wait about seven years before they re-enter the capital markets. According to Cruces and Trebesch, the waiting period is longer if the haircut is in the extreme range of more than 50 percent. Countries in default also experience a reduction in foreign trade as well as embarrassment in other diplomatic spheres (Rose 2005; Borensztein and Panizza 2009). Lastly, default imparts a reduction in real economic output. Trebesch and Zabel (2017) consider the impact of default on real output by examining both hard defaults (i.e., violating credit contract) and soft defaults (i.e., renegotiating debt contract). The authors conclude that although defaults decrease GDP output, the severity of the decline depends on the type of default as well as the size of the haircut associated with the default.

Debt Relief

The occurrence of defaults is concentrated in developing countries and popular support for sovereign debt relief existed in the 1990s and early 2000s. The so-called Brady Plan began in the early 1990s and started a wave of debt restructuring that spanned the next 15 years. Along with the Brady Plan, the World Bank, International Monetary Fund (IMF), and other multilateral, bilateral, and commercial creditors began the heavily indebted poor country (HIPC) initiative in 1996 (HIPC I) and in 1999 (HIPC II). These programs resulted in debt forgiveness of more than $60 billion. However, whether the nations that received debt relief continued on a path toward high indebtedness again or if the relief allowed these governments to effect positive change to their economies remains unanswered.

Arslanalp and Henry (2005) examine the stock market to understand the impact of debt relief. They report that when an emerging economy announces a debt relief agreement under the Brady Plan, the stock market in the affected country appreciates by an average of 60 percent. The authors suggest the increase in value is due to three fundamental economic drivers: (1) net real resources transfer (NRT), (2) investment, and (3) growth. They note that during a debt crisis, NRT is negative, indicating resources are flowing out of the country. Following the announcement of a debt restructuring, an inflow of funds commenced. They also observe that the abnormal change in GDP matches movements in the country's stock market. Finally, the country at the focus of the debt restructuring is likely to experience an investment boom.

Arslanalp and Henry (2005) also consider the impact of debt restructuring on U.S. commercial banks. They find the restructured banks experience an increase in their total market capitalization by about $13 billion, which supports the position that debt relief for emerging economies benefits both debtors and creditors.

Freytag and Pehnelt (2009) consider the impact of governance quality in countries that restructured their debt during the Brady Plan era, as well as between 1990 through 2004, which includes the period of the Argentine default. The authors study the characteristics of sovereigns receiving debt restructuring that met the HIPC criterion relative to HIPC nations that did not meet their obligations. Moreover, Freytag and Pehnelt examine how the governance quality of the countries affected their ability to receive debt relief. Results show that a country has a higher probability of classification as an HIPC if it exhibits a high fiscal deficit, poor governance, and lower monetization of country's economy (Addison and Rahman 2004). The authors find that governance did not influence a country's ability to receive debt relief during the 1990s. They also report the actual level of indebtedness did not play a large role in determining if the sovereign received debt restructuring. Freytag and Pehnelt note that if a country received some debt relief in the first half of the 1990s, a higher probability exists that it also received debt relief in the subsequent five-year period. However, following the HIPC II initiative, governance appears to positively affect subsequent debt relief.

In a related study, Reinhart and Trebesch (2016) consider similar questions over two periods: 1920 to 1939 and 1978 to 2010. The earlier period is interesting as restructuring mechanisms at the time involved countries working directly with other countries. According to the authors, debt relief across the two time periods is surprisingly similar, 21 percent of GDP during 1920 to 1939 period for advanced economies and 16 percent GDP for high- and middle-income emerging market countries from 1978 to 2010. They further document significant economic improvement in the countries studied, but only when debt relief involved an actual write-off of the debt burden. Other types of relief, including the extension of the debt maturity or a reduction in the rate of bond interest, do not appear to improve subsequent economic activity. After a write-off, per capita GDP grew by more than 10 percent in the five years after the event. Moreover, the authors note that total debt/GDP declines from 55 to 33 percent over the same five year period. In summary, the research suggests that reducing a sovereign's debt burden is beneficial for the nation overall.

Table 14.1 summarizes the distribution of sovereign credit ratings issued by Standard & Poor's as of November 30, 2017. Although the number of countries given an

Table 14.1 **Sovereign Credit Ratings**

Credit Rating	*Number of Sovereign Nations*
AAA	11
AA+	4
AA	7
AA–	6
A+	8
A	2
A–	7
BBB+	9
BBB	6
BBB–	8
BB+	5
BB	7
BB–	10
B+	11
B	13
B–	11
CCC+	4
TOTAL	**129**
Investment-Grade (IG)	**68**
Non-Investment-Grade (non-IG)	**61**

This table displays the distribution of sovereign credit ratings from Standard & Poor's.

Source: Standard & Poor's (2017).

investment grade rating (68) is nearly equal to that of countries that are non-investment-grade (61), the amount of investment grade debt is considerably larger.

Credit Rating Agencies

A country's credit rating should reflect the perceived underlying risks of its national debt. However, this measure may not adequately quantify the risk of a country's debt. Many market participants rely upon the credit ratings provided by the three primary CRAs. If the models of the agencies comprehensively reflect a nation's actual credit risk, this approach should not cause issues (Williams, Alsakka and Gwilym 2013). However, these ratings could be subjectively biased and may not accurately reflect the underlying risk of sovereign debt (Öztürk 2014).

CRAs consider many factors when determining the risk of debt repayment including the rate of inflation, per capita income, GDP growth rate, the ratio of debt/GDP, debt/exports, and budget surplus/deficit. Although models used by the CRAs incorporate all these factors, the model still involves inherent subjectivity that can allow for both home bias and familiarity bias to filter into the sovereign rating.

Vernazza and Nielsen (2015) analyze 18 years of credit rating data to estimate the central nonsubjective portion of a nation's credit rating. They then use the residual from this model to estimate the subjective portion of the credit rating. Using the objective and subjective components of a credit rating, they predict defaults over both the short and long run. The authors find that the objective element is a strong predictor of default over short time periods of less than a year, as well as up to three years in advance. Interestingly, they also find the subjective component does not explain default in the short or long run. Furthermore, Vernazza and Nielsen note that the relation between default and the subjective element is negative, increasing the probability of default. The following section considers how this subjective component affects not only the cost of sovereign debt but also the costs of capital throughout a country's economy.

The Sovereign Ceiling

The importance of the sovereign bond markets extends beyond sovereign issues alone. Evidence suggests that the quality, depth, and credit rating of a nation restricts bond issuance and real activities of firms operating within the country. Informally, this situation is called the *sovereign ceiling*. Aside from the sovereign ceiling, the sovereign credit market has a meaningful impact on the corporate bond market, and efficiency in a nation's debt markets provides an important outlet to prevent domestic economic crisis.

Arteta and Hale (2008) consider how sovereign debt risk transfers to the private sector. They provide evidence that private sourcing of capital through international bond markets is substantial, accounting for more than 30 percent of total net capital inflows to emerging markets. The authors observe that countries in default concurrently experience a decline in access to international credit markets for domestic private firms. They find that this restriction on access to debt continues for at least two years after the restructuring of the sovereign debt.

Chen, Chen, Chang, and Yang (2013) explore how change in a sovereign's credit rating affects private investment. Based on a sample of 178 rating changes between 1983 and 2009 across 48 countries, they find that when a country experiences a positive rating change, investment within that country increases. A downgrade conversely elicits a decline in investment. In both instances, the impact on investment is temporary.

Bedendo and Colla (2015) investigate sovereign credit risk transmission to the credit risk of non-financial firms in the Eurozone by examining soveriegn and corporate CDS instruments. They observe that an increase in the spread of the sovereign corresponds with an increase in corporate credit spreads. The increase in firm's credit spread also increases the cost of borrowing and could impair a firm's ability to invest. The authors also isolate the characteristics associated with firms that experience increases in debt cost. These characteristics include firms that are more likely to receive government aid, those with primarily domestic revenue sources, and firms that are mainly financed by domestic banks. Bedendo and Colla find an increase of 10 percent in sovereign yield spreads corresponds with between 0.5 to 1 percent increase in corporate spreads. These European firms are sufficiently large to have liquid CDSs. As a result, they are large multinational enterprises and therefore less dependant upon domestic bank financing. The composition of the sample suggests that the economic impact to average domestic firms is greater than that experienced by large multinationals.

Lee, Naranjo, and Sirmans (2016) investigate how corporations can reduce their exposure to sovereign credit risk. Given the findings of Bedendo and Colla (2015), a reasonable assumption is that large corporations can separate their creditworthiness from the credit risk of their sovereign domicile and in turn reduce their borrowing costs. The authors constructed a large sample of CDS spreads covering 2,364 companies in 54 different nations between 2004 and 2011. They investigate two different ways in which firms can reduce both exposure to sovereign credit risk and borrowing costs: (1) the institutional channel and (2) the informational channel. The institutional channel focuses on increased property rights exposure through hard assets owned in foreign countries. Meanwhile, the informational channel relates to cross-listing on international exchanges with stronger and more transparent disclosure and reporting standards. As Lee et al. note, when firms increase their exposure to both channels they can reduce the spreads on their debt thereby reducing their cost of capital. The authors observe the effects of both channels are approximately equal; an increase of one standard deviation change corresponds to a decrease of about 40 basis points in the CDS for the firm. These findings support the results of Klapper and Love (2004) who observe that firms with strong corporate governance are more likely to list outside of countries perceived to have poor governance mechanisms.

Almeida, Cunha, Ferreira, and Restrepo (2017) investigate the real economic impact of sovereign rating changes on national economies, extending the work of Lee et al. (2016). This study provides evidence that sovereign debt rating downgrades correspond with slowdowns in domestic investment. Downgrades also correspond with increases in the cost of capital that can undermine strategic investment and growth. This result is a consequence of a "hard application" of the sovereign ceiling situation whereby a firm is capped so as not to carry a rating greater than its home nation. Besides reducing investment, bound firms (i.e., firms with a debt rating equal to that of the sovereign) tend to reduce debt issuance and increase equity issuance. The impact to high quality firms is most severe as non-bound firms of lower quality are less affected by the host nation's credit rating. Moreover, the rating downgrade may also trigger clauses within a firm's debt covenants, further impeding strategic growth and expansion.

Hill, Bissoondoyal-Bheenick and Faff (2018) show that the impact of sovereign credit rating spillover to corporate bonds is worse in emerging economies. They find evidence that the transmission effect is more severe when a country is in a crisis state. Furthermore, the authors observe that positive ratings changes for sovereigns are slow to transmit to corporate debt markets and this is likely to prolong the recovery within the affected nation.

Summary and Conclusions

The sovereign debt market is relatively understudied despite its global size and importance. Sovereign debt markets correspond with macroeconomic conditions present in the broader economy of the issuing nation. Sovereign debt also provides potential diversification benefits for fixed income investors.

The extant research shows that dollar-denominated debt of large economies tends to respond to global macroeconomic conditions more so than specific macroeconomic shocks within the nation. As such, dollar-denominated debt or currency-hedged debt provides little additional diversification benefit to U.S. investors. Moreover, research suggests that the debt markets of developed economies display a high degree of integration while emerging economies display less market integration with respect to sovereign debt. Thus, sovereign debt from less developed countries, even when issued in U.S. dollars, provides potential diversification benefits to U.S. fixed income investors. Meanwhile, investing in local currency-denominated debt offers additional diversification benefits while also exposing investors to increased risk.

Sovereign nations have defaulted on their debt issues. Given the difficulty private entities have in litigating a sovereign nation, these bonds appear to have greater risk when compared to other similar securities. However, covenants found in sovereign bond issues are slowly changing to ameliorate some concerns in the market. Although the unconditional risk of default historically is about 2 percent, the default rate increases to nearly 4 percent if the sovereign has previously defaulted. However, evidence suggests that debt relief is broadly beneficial for both the nation and the investor in the long run. Finally, a nation's sovereign market can have a direct effect on the private market through the "sovereign ceiling." This informal practice of capping corporate debt ratings by tying them to the debt rating of the sovereign can have real costs and by extension valuation effects on the firms within the economy.

Discussion Questions

1. Discuss the impact of trade volatility on fixed income in an open economy.
2. Discuss the level of integration between sovereign debt markets and comment on the differences between developed and emerging economies.
3. Explain how governance quality affects debt relief.
4. Explain the impact of sovereign risk on the private sector.

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15

Floating Rate Notes

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Introduction

In the late 1970s and early 1980s, the interest-rate environment was in constant flux as policymakers and market participants adapted to the dynamic conditions of the market (Jordahl 2012). To ensure that savings institutions would not compete for depositors' money, U.S. lawmakers created regulations and limitations on the rate of interest that could be earned on savings balances (Brealey, Myers, Allen, and Mohanty 2012). However, in response to the creation of an interest-rate ceiling, private financial institutions began to investigate alternative methods and possible loopholes for providing higher rates of interest, thereby securing new forms of deposits. The creation of floating rate notes (FRNs), originally issued in 1974 by Citicorp, was one such solution. By offering a periodically changing coupon rate, which adjusted based on a bond index or foreign exchange rate, Citicorp provided a lucrative option to investors. With FRNs, buyers could hedge from the instability of the market without adversely affecting their initial investment. Although fixed rate debt instruments offer a higher initial yield, rising interest rates adversely affect bond prices and purchasing power. FRNs protect investors from fluctuating market conditions by periodically adjusting to changes in the market. Providing a floor rate protects investors from extreme drops in interest rates. In short, Citicorp's novel response to the changing market was revolutionary and allowed the company to issue $650 million during its initial launch. The next decade witnessed the issuance of $43 billion of floating-rate security debt, leading to a new financing source in the market and the ubiquity of FRNs (Brealey et al. 2012).

This chapter provides a comprehensive look at FRNs by exploring their market structure, types, potential risks, and valuation methodology. The chapter ends with a summary and justifies FRNs in investment portfolios.

Floating Rate Note Structure

Although FRNs can have maturities of up to 30 years, most predetermined benchmarks adjust periodically on a daily, weekly, or monthly basis. The most common external benchmarks used to determine the floating-rate are based on government bond indices or foreign exchange rates. Additionally, owners of FRNs have the opportunity to return the securities by giving notice before each adjustment date. As such, discussing the characteristics of FRNs is important to be able to determine the potential risks that may be present for both issuers and investors.

Factors associated with FRN performance include the reference rate or external benchmark, frequency of rate adjustments, and minimum and maximum interest rates the borrower is willing to pay. Issuers initially choose to create the floating rate by comparing it to those of U.S. Treasury bills (T-bills), London Interbank Offered Rate (LIBOR), prime rate, or other short-term interest rates. From one of these external references, the issuer determines the amount of points or excess premium that contributes a surplus to the referred rate. This spread is then added to the external reference to determine the overall coupon. For example, an issuer may agree to pay an excess of 30 basis points (bps) above the three-month LIBOR rate. If the LIBOR rate is 320 bps on the FRN issuance day, the initial coupon would be 350 bps (320 bps + 30 bps = 350 bps). The issuer's credit quality and the time until maturity also help to determine the coupon rate. As short-term rates are usually lower than longer-term rates, the initial rates of FRNs are typically lower than those of a longer-term fixed-rate note.

FRNs can also vary considerably regarding the frequency at which the rate is adjusted. Generally, the coupon note is reset each time the issuer makes an interest payment and remains constant until the next payment date. However, the frequency of resetting the floating-rate can affect the amount that the borrower receives. For example, if a floating-rate resets monthly but the issuer pays the interest quarterly, then the payment will be an average of the three reset rates during that quarter. The issuer may also decide to add a call option, giving the issuer the right to buy back the notes before maturity. Another safeguard to protect the issuer is setting a maximum interest rate (i.e., ceiling) that the issuer will pay regardless of the referenced rate at the time of readjustment. This feature protects the issuer from escalating interest costs. However, minimum interest rates, also known as *floors*, cause issuers to pay out a guaranteed interest amount even if the referenced interest rate has fallen below this barrier. This feature partially protects the investor from declining income in periods of instability and benefits investors.

Risk

Although FRNs offer various benefits to both investors and issuers, they can also involve substantial risks: interest rate risk, credit risk, call/reinvestment risk, inconsistent income stream, spread influence risk, liquidity risk, fluctuation of market prices, and statement pricing. The following subsections discuss each risk factor in more detail.

Interest Rate Risk

During periods of rising interest rates, FRNs benefit investors by periodically adjusting upward. Although market fluctuations may not dramatically affect the market value of FRNs, the payout to investors increases. During periods of falling interest rates, the returns on FRNs decline. In these cases, the return on investment may be substantially lower than what would have been achieved through a fixed-rate note because such notes tend to increase in value when rates fall. To mitigate the effects of interest rate uncertainty, investors should buy and hold FRNs until reaching maturity (Piper Jaffray & Co. 2005).

Credit Risk

FRNs reflect interest rate volatility based on an external benchmark. To compensate for credit risk, the issuer adds additional basis points to the interest rate. These basis points are an agreed-upon amount in excess of the external benchmark. As a result, the coupon note depends highly on the issuer's credit quality and ability to meet its payment obligations. Issuers with stronger financial histories can generally meet payment obligations to investors. By contrast, issuers with weaker credit quality may struggle to meet financial obligations and generally offer higher coupon rates to compensate investors for increased credit risk. Additionally, independent rating agencies may downgrade the issuer's credit rating if they fear that credit quality has weakened. The security's price is also likely to fall if an issue is downgraded. Yet, in many cases, the price is changed in advance of the downgrade or when the issuer is placed on a "credit watch." Considering an issuer's financial health before buying FRNs should help to ensure that the issuer meets expected payment obligations and the investor receives the best rate.

Call and Reinvestment Risk

FRNs are likely to experience the best performance when purchased and held until maturity. However, when FRNs have a call option, the issuer can buy back the FRN before maturity. Issuers typically exercise call options on FRNs when rates are rising that negatively affect the issuer. This strategy generally protects the issuer from further risk. Exercising an FRN's call option may adversely affect investors who often have difficulty finding another FRN with similar or better rates to reinvest. Typically, investors should try to purchase non-callable FRNs.

Inconsistent Income Stream

FRNs adjust to fluctuations in the market rate. Investors often opt for such notes because they can possibly provide more income than traditional fixed-rate notes. Nonetheless, during times when interest rates fall, investors may struggle with the lack of income or the variability in income. Generally, investors prefer fixed-rate notes during such times because of their stability. As a result, those who require a steady stream of income should rely on a fixed-rate note for income generation rather than an FRN.

Spread Influence Risk

A common belief is that FRNs always trade in line with current market interest rates. However, changes in credit spreads relative to the benchmarked rate could affect prices. For example, a sudden widening of credit spreads in 2008 led to the decrease of various financial assets. Thus, many financial institutions lacked capital and relied on public bailouts to sustain them. This situation adversely affected investors in those banks who then lost money in their investments.

Over time, spreads can widen or narrow. When spreads widen, the value of any outstanding FRN is likely to fall below the par value. Therefore, investors who opt to sell FRNs before maturity could lose the value of their principal. Yet, they would benefit from holding FRNs until maturity to try to mitigate the effects of a fluctuating market.

Liquidity Risk

Holding FRNs until maturity reduces the impact of multiple risks associated with these securities. For example, they could face less fluctuation in the value of the note and cash flow concerns. This situation arises because risk decreases as an FRN matures and converges to par value over time. As a result, an investor's financial standing may be affected because generally only the issuer can call the FRN. Although investors may opt to sell an FRN in the secondary market, a chance exists that the prevailing market price may be less than the original amount invested. Because FRNs cannot always guarantee a stable income stream, those with liquidity concerns may consider fixed-rate notes, which generate a steady rate of interest payments regardless of changing interest rates.

Fluctuation of Market Prices

The market's dynamic and unpredictable nature can cause instability for FRN investors. Multiple factors often overlap and lead to this instability such as the value of the external referenced benchmark, volatility of the reference benchmark, interest and dividend rates, issuer's credit quality, maturation timeline, and political or geographic conditions. Additionally, making predictions based on these factors is difficult because past performance is not necessarily indicative of future results. Despite the ever-changing nature of market prices, investors may also benefit from fluctuation of market prices in situations where FRNs can be readjusted for rising rates.

Statement Pricing

Investors often lack the information needed to assist them in pricing FRNs causing them to make sub-optimal investment decisions. Although institutions may seek to obtain more information for their clients, ultimately an informed consumer with knowledge of how floating rates are calculated is likely to have better results as a decision maker.

Types of Floating Rate Notes

An FRN's coupon rate can have multiple reset dates such as semiannually, quarterly, monthly, or weekly. The term *adjustable rate* or *variable rate* typically refers to securities with coupon rates reset not more than annually or based on a longer-term interest rate (Fabozzi and Mann 2005) while floating rates adjust more frequently.

Many variations on FRNs are available in the market. These differences exist not only to provide financial institutions and investors with options that offer the largest financial payouts but also to protect the interests of both parties. The next section describes the following types of FRNs: plain, capped, floored, collared, super floating rate note, deleveraged, inverse or reverse, perpetual floating rate notes, and flip-flop rate notes.

Plain Floating Rate Notes

With a plain FRN, the interest rate changes proportionally to its reference rate. The rate resets periodically and the reference rates can be based on LIBOR, T-bill rate, prime rate, or domestic CD rate with a spread (Fabozzi and Mann 2000). For example, a rate can be set at LIBOR + 30 bps. Figure 15.1 shows how coupon rates follow the reference rate with a + 30 bps spread. At the third month, LIBOR is 75 bps and the coupon rate is 105 bps.

Capped Floating Rate Notes

A capped FRN is similar to a plain vanilla FRN but with a maximum interest rate cap. This feature protects the issuer from an extreme rise in market interest rates. The issuer can limit risk by putting a cap on the amount of interest to be paid regardless of the reference rate. When the reference rate goes above the cap, the investor only receives the cap rate coupon payment. Figure 15.2 shows a cap of 200 bps. Thus, at month 18 when the three-month LIBOR goes to 175 bps and the coupon (LIBOR + 30 bps) is above the cap, the investor receives the lower capped rate of 200 bps.

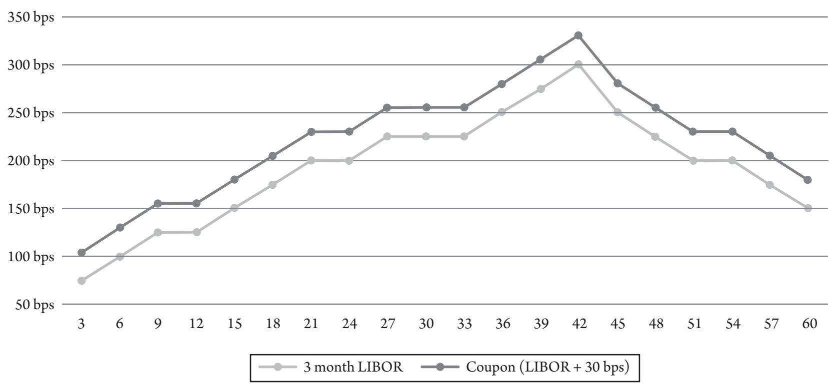

Figure 15.1 Plain Floating Rate Note

Figure 15.1 shows a 3-month LIBOR and a coupon that equals LIBOR plus a spread of 30 bps. No limits exist on how high or low the coupon paid can be in this type of FRN.

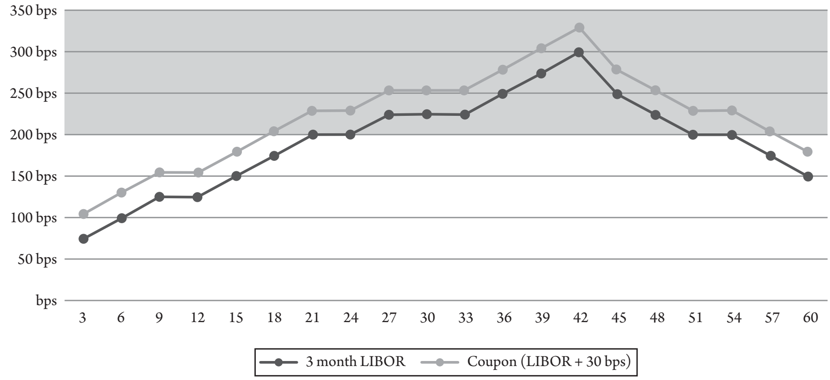

Figure 15.2 Capped Floating Rate Note

Figure 15.2 is an example of a capped FRN. This FRN is capped at a 200 bps coupon. At month 18, the reference rate plus the spread rise above the 200 bps cap. The investor receives a maximum 200 bps coupon regardless of how high beyond the cap the reference rate rises. At month 60, the rate falls below the cap, and the investor receives a 180 bps coupon.

Floored Floating Rate Notes

Unlike a capped note, a floored FRN benefits the investor because it guarantees a minimum rate regardless of the market's reference rate. That is, the note has a minimum coupon rate even if the reference rate falls below the set floor. When the reference rate falls below the floor, the investor receives the floor rate coupon payment. Figure 15.3 shows that at months 15 through 24, the coupon rate is below the set floor of 150 bps. In this case, the investor receives a coupon of 150 bps even though the reference rate plus spread is lower.

Collared Floating Rate Notes

A collared floater is often called a *mini-max floater* because it provides both an upper and lower limit on the coupon to be paid to investors. Thus, a collared FRN is a combination of the previous two notes offering a minimum (floor) and maximum (cap) coupon. If the reference rate goes above the cap, the investor receives the cap rate coupon payment. If the reference rate goes below the floor, the investor receives the floor rate coupon payment. Figure 15.4 shows the acceptable band of coupon rates. If rates go above or below the band, the issuer pays the respective cap or floor.

Super Floating Rate Notes

Super FRNs are best suited for trading environments in which the interest rates are increasing. Super floaters adjust the coupon rate according to the external benchmark, but unlike traditional FRNs, the coupon rates are leveraged against the benchmark in ratios greater than one. This feature allows investors to maximize their potential gains. For example, a super floater coupon may be determined by the following formula: 3 × (one-year US$ LIBOR)—600 bps. So, if the one-year LIBOR is 300 bps, the coupon

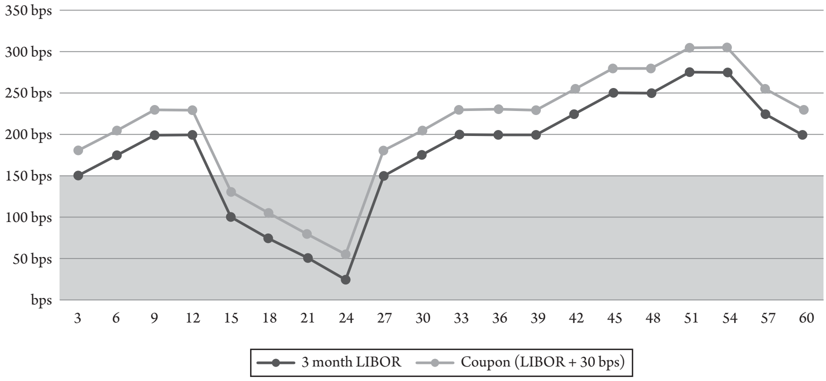

Figure 15.3 Floored Floating Rate Note
Figure 15.3 is an example of a floored FRN. The figure shows a coupon floor of 150 bps. If interest rates drop below the coupon floor, the investor coupon would be 150 bps regardless of how low rates decline.

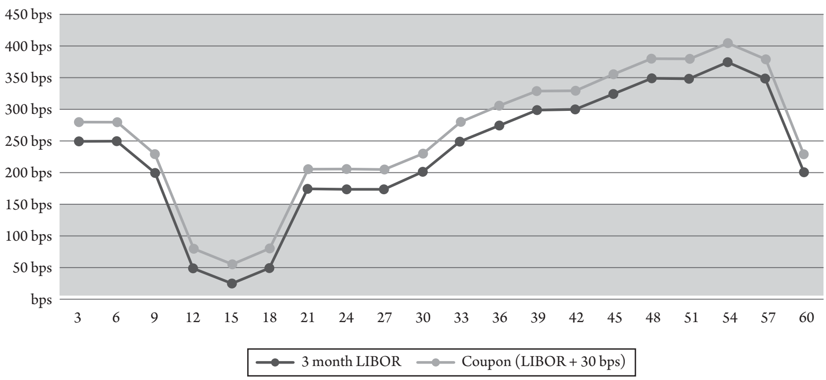

Figure 15.4 Collared Floating Rate Note
Figure 15.4 is an example of a collared FRN, which has both a coupon floor and a coupon cap. If interest rates drop below the coupon floor, the investor receives the coupon floor rate of 150 bps. If the rates rise above the coupon cap, the investor receives the coupon cap rate of 300 bps.

rate would be 3 × 3 percent – 6 percent = 3 percent. To avoid potential drops in the market, super floaters often have a floor built into the product, thus protecting investors from adverse market fluctuations and negative coupons.

Deleveraged Floating Rate Notes

As super floaters leverage the market and offer rates greater than one, deleveraged floaters adjust the market rate by leverage factors less than one. For example, consider a deleveraged floater with quarterly coupon payments based on the LIBOR and a leverage factor of 0.8, with a margin of 1 percent. At the time of the first coupon payment, if the LIBOR rate is 3 percent, the coupon rate on this deleveraged floater would be 3.4 percent, 1 percent + 0.8 × 3 percent. In essence, the coupon note would be calculated as a fraction of the referenced rate plus the fixed margin as determined by the issuer. This feature is a preferable option for issuers in either highly unstable markets or markets where a decline in market rates is likely to occur.

Inverse or Reverse Floating Rate Notes

An inverse or reverse FRN is desirable in situations where the externally referenced benchmark is high at the point of purchase and is expected to drop in the future. As with other floaters, the inverse floater adjusts the coupon rate depending on current market conditions. However, it differs because as the interest rate rises, the coupon rate drops and vice versa. For example, a common inverse floater may be expected to mature in three years, with interest payments occurring quarterly. It would include a floating coupon rate of 400 bps minus two times the three-month LIBOR. In this case, as the LIBOR rate increases, the payments of the bond decrease. To avoid the coupon rate falling below zero, a floor is placed on the coupons after adjustment. Typically, the floor is established at zero. Alternatively, an inverse or reverse floater may be bought when the external benchmark is low at the time of purchase and the investor expects it to remain low. If the investor is correct and the rates remain low, an inverse floater will outperform the FRN.

Perpetual Floating Rate Notes

A perpetual FRN extends the idea of holding FRNs until maturity by removing the maturity date and allowing investors to invest in an FRN that consistently and continually pays interest forever. Market participants often consider perpetual FRN's as capital investments due to the extensive period for which interest may be collected.

Flip-Flop Rate Notes

Flip-flop rate notes provide investors with the financial benefits of an FRN with the predictability of a fixed-rate note. In a flip-flop rate note, if the interest rate drops below the fixed coupon rate, investors can elect to receive the payment according to the specified fixed rate at that time. Conversely, if the interest rate increases relative to the fixed coupon rate, investors can opt to receive an even higher payment. In this way, they can select the return option that provides the higher yield for the desired time period. In many ways, the flip-flop rate note is similar to the generic FRN with a built-in limit or floor.

Reference Rates

FRNs can use a benchmark or index to set their rates. Some of the FRN rates are derived from LIBOR, T-bill rate, or prime rate.

London Interbank Offered Rate

The *London Interbank Offered Rate* (LIBOR) is the average interest rate that banks charge for short-term loans to other banks. LIBOR has seven maturity rates for five currencies. The maturity periods are overnight, one week, two months, three months, six months, and 12 months. The currencies are based on the United States dollar, British pound sterling, Swiss franc, Japanese yen, and European euro (Global-Rates.com 2009). LIBOR is often used as the reference for FRNs in addition to many other financial products. An FRN's spread interest rate changes based on a certain maturity and currency selected.

LIBOR is scheduled to be replaced by 2021 due to a 2005 fixing scandal in which traders from Barclays made numerous requests to fix LIBOR rates. At the beginning of the financial crisis in 2007–2008, Barclays misreported its LIBOR, resulting in a fine in 2012 by the U.K. Financial Services Authority (FSA) for £59.5 million and about £290 million by the Commodity Futures Trading Commission (CFTC) (BBC 2013). Further investigations led to additional bank fines. Deutsche Bank received a fine of $2.5 billion, Societe Generale €446 million, Royal Bank of Scotland €3,921 million, JP Morgan €79.9 million, and Citigroup €70 million (Thompson 2013; Ridley and Freifeld 2015).

The United States will transition from the U.S. dollar LIBOR to the Broad Treasury Financing Rate (BTFR). The Federal Reserve is expected to begin publishing rates in 2018 (Tortoise Investments 2017).

Treasury Bill Rate

A *Treasury bill* (T-bill) is a short-term U.S. government security with maturities issued for one month, 13 weeks, 26 weeks, and 52 weeks. T-bills are sold at a discount and do not pay a coupon. The T-bill rate is the interest earned between the purchase price and the face value at maturity. T-bills are sold by auction weekly, except for the 52-week T-bill, which is auctioned every four weeks (Investopedia 2017). Many market participants consider T-bills as a proxy for a risk-free rate given their backing by the U.S. government.

Prime Rate

The *prime rate* is the best available interest rate to borrow money. It is derived from the Federal funds rate, which is the overnight rate banks use to lend each other from reserves (Investopedia 2016). Unlike LIBOR and the T-bill rate, individual banks set prime rates. The prime rate is a benchmark at which the bank would lend money to their lowest risk customers.

Investing in Floating Rate Notes

Several ways are available for institutional and individual investors to gain exposure to FRNs. Investors can choose to invest in FRNs in the traditional way through corporate bonds and U.S. Treasuries. Besides purchasing bonds, a more contemporary vehicle by which investors can gain exposure to FRNs is through indirect purchases via an exchange-traded fund (ETF) or a mutual fund.

Corporate Bonds

Although floating rate securities have variable interest rates that usually reset in six-month intervals, they can have various reset periods. Market participants often use FRNs when they expect short-term interest rates to increase. One way to invest directly in FRNs is through corporate bonds. Investors can buy corporate floaters through bond dealers or traditional brokerages.

Treasuries

Another way to invest in floaters is through treasuries. The U.S. Treasury recently indicated that it plans to increase issuance of floating rate securities due to increased investor demand and new governmental funding needs. Investors can also invest in international government-issued floaters, but the market is limited relative to international corporate floaters. Individual and institutional investors can buy floating-rate treasuries directly from both the U.S. Treasury Department during auctions and traditional brokers (Shriber 2017). Investing in U.S. government–issued FRNs is a good option for those who want exposure and prefer to limit credit risk but still profit from increasing interest rates.

Exchange-Traded Funds and Mutual Funds

Another way to invest in floating rate instruments is through mutual funds and ETFs. ETFs have increased in popularity because their expense ratios are typically lower than their mutual fund counterparts. Mutual funds often require a minimum deposit for the initial purchase (Benge 2011). Investing in mutual funds and ETFs is useful in achieving broad exposure thereby reducing certain risks inherent in a single issuer or security. An advantage of investing in ETFs instead of mutual funds is that ETFs trade throughout the day, which enhances their liquidity. By contrast, investors buy and sell mutual funds directly from the mutual fund company at the fund's net asset value (NAV) at the end of the day. The NAV is calculated as the value of all the fund's underlying holdings at their closing prices less its liabilities. Because they trade throughout the day, market prices can sometimes differ from their NAVs, but usually the differences tend to be small (Zucchi 2014). Some examples of popular floating rate bond ETFs include iShares Floating Rate Bond ETF (ticker FLOT), SPDR Barclays Capital Investment Grade Floating Rate ETF (ticker FLRN), and VanEck Vectors Investment Grade Floating Rate ETF (ticker FLTR) (ETFdb).

Measures of Relative Value

Valuing fixed-rate securities differs substantially from valuing floating-rate securities. Valuation methods differ because of the many non-constant coupons of floaters, which make calculating a yield to maturity (YTM) difficult. Different evaluation techniques are required to value floaters because the conventional methods of valuation for fixed-rate securities do not apply. Some examples of valuation techniques that are discussed in this chapter are spread for life, effective margin, total adjusted margin, and discount margin (Fabozzi 1986).

Spread for Life

Spread for life (SFL), also known as *simple margin* or *positive margin*, originated in the Eurofloater market as a means of calculating the relative value of a floater in comparison to the syndicated loan market. The valuation technique is considered "simple" because it is a basic measure of potential return that accounts for the accretion (amortization) of the discount (premium) combined with the constant fixing spread over the floater's life. The SFL method is extremely useful for investors who want to match their assets with their liabilities. An example of the SFL method is when an institution such as a commercial bank accepts deposits for money market accounts while paying a variable interest rate based on T-bills or a money market index. The institution then can reinvest the deposits in an FRN with a wider spread over a similar security. If the floater is trading at a discount to par, the positive margin will be greater. This method essentially measures the amortization of the discount or the premium. If held to maturity, this margin is assured over the base rate regardless of interest rate movement (Fabozzi 1986). The formula for the SFL is shown in Equations 15.1a and 15.1b:

$$SFL = \left(\frac{\frac{(100 - P)}{BY} + \frac{F}{100}}{\frac{P}{100}} \right) 100 \tag{15.1a}$$

or

$$SFL = \left[\frac{100(100 - P)}{BY} + F \right] \frac{100}{P} \tag{15.1b}$$

where BY = bond years; F = fixing spread in basis points; and P = market price (per \$100 of par value) (Fabozzi 1986; Fabozzi and Mann 2000).

For example, consider an FRN on January 1, 2018, that is due on April 1, 2018, and currently priced at 99.80. The coupon rate is adjusted weekly at 50 basis points above three-month LIBOR. The spread for life is calculated as follows:

$$SFL = \left(\frac{\frac{(100 - 99.8)}{0.25} + \frac{50}{100}}{\frac{99.8}{100}} \right) 100$$

$$SFL = 130.26$$

The SFL method only considers the accretion/amortization of the discount/premium over the security's remaining life and does not consider the time value of money or the coupon level. This method is accurate only if the floater's present coupon and base rates are approximately the same.

Effective Margin

The *effective margin* (EM), or the *adjusted simple margin*, is an adjustment to the SFL. The SFL method does not take the level of interest rates into consideration. This adjustment accounts for the one-time cost of carry effect when a floater is purchased with borrowed funds (Fabozzi and Mann 2000). The EM method factors in the effect of the current coupon and the interest rate for a more accurate evaluation of the floater. This method is a more effective way to value a floater when the coupon and base rates differ substantially. Besides considering the value of the discount or premium, this approach also accounts for the spread between the coupon and base rate over the next coupon reset date. The EM approach improves upon the SFL approach in that it takes into account the positive or negative spread between coupon and base rates and weights it according to the number of days until the next reset date, which is called *positive* or *negative carry*. If the coupon is greater than the base rate, this situation is considered a positive carry. The positive or negative spread is an adjustment of the floater's purchase price. If the carry is positive, the purchase price is adjusted downward and vice versa. Before calculating the EM, the adjusted price (AP) must be computed. Based on Fabozzi (1986), the formula for AP is shown in Equation 15.2:

$$AP = P - \left[\frac{\left[\left(\frac{C-B}{100} \right) (P + AI) \left(\frac{D}{360} \right) \right]}{1 + \left(\frac{B}{100} \times \frac{D}{360} \right)} \right] 0.01 \tag{15.2}$$

where C = current coupon rate of the floater (in percent); B = base rate; P = market price (per \$100 of par value); AI = accrued interest; and D = number of days to refixing (i.e., the coupon reset date). Equations 15.3a and 15.3b show the calculation for EM:

$$EM = \left[\frac{\frac{(100 - AP)}{BY} + \frac{F}{100}}{\frac{AP}{100}} \right] 100 \tag{15.3a}$$

or

$$EM = \left[\frac{100(100 - AP)}{BY} + F \right] \frac{100}{AP} \tag{15.3b}$$

where BY = bond years; and F = fixing spread in basis points (Fabozzi and Mann 2000).

To demonstrate an EM calculation, suppose that on September 15, 2018, a floater due on May 28, 2030, is selling for 99.4 and has a coupon rate of 12 percent. The fixing spread is 12.5 basis points above three-month LIBOR. The base rate, three-month LIBOR, is 11.8125 percent. The coupon adjusts quarterly on November 3, 2018 (49 days). Using Equations 15.2 and 15.3a, the adjusted price will be:

C = 12.00 percent; B = 11.8125 percent; P = 99.4; AI = 0.144; and D = 49 days.

$$AP = 99.4 - \left(\frac{\left[\left(\frac{12 - 11.8125}{100} \right) (99.4 + 0.144) \left(\frac{49}{360} \right) \right]}{1 + \left(\frac{11.8125}{100} \times \frac{49}{360} \right)} \right) 0.01$$

$$AP = 99.3997$$

BY = 11.6 and F = 12.5:

$$EM = \left(\frac{\frac{(100 - 99.3997)}{11.6} + \frac{12.5}{100}}{\frac{99.3997}{100}} \right) 100$$

$$EM = 17.79 \text{ percent}$$

When valuing floaters, investors should note that when the spread between the present coupon and the base rate is small, the SFL method is sufficient to use. When the spread between the present coupon and base rate becomes large, the EM method is more accurate because it considers the effect of the current yield over a shorter period of time where it measures the relative value until the next coupon reset date. The EM method differs from the SFL method in that the SFL method measures the value over the floater's life (Fabozzi 1986).

Total Adjusted Margin

Total adjusted margin (TAM) or *adjusted total margin* is a valuation method that changes the EM approach from a shorter-term relative valuation method to a longer-term value metric. The EM method calculates the spread between the base rate and the present coupon until the next coupon adjustment date while the TAM method produces an association of this spread over the security's life. However, the major drawback to the TAM method involves the assumptions needed to apply this method. Because predicting future interest rates is extremely challenging, analysts often use historical averages of both the reference rate and the quoted margin. To arrive at educated estimated averages to use in the TAM approach requires using historical data and current economic trends coupled with an expert's forecasts. An inherent problem with this approach is that past performance is not necessarily an accurate predictor of future performance. Nonetheless, investors still commonly use this approach due to the lack of alternative methods of valuation over long time periods. Calculating the TAM requires first computing the adjusted price (AP) as defined earlier. Using the variables defined previously, Fabozzi (1986) provides the following formula for the TAM in Equation 15.4:

$$TAM = \left(\frac{\frac{100 - AP}{BY} + F + \frac{(B)\times(100 - AP)}{100}}{\frac{AP}{100}} \right) 100 \qquad (15.4)$$

To illustrate a calculation of the TAM method, assume a floater on November 15, 2018 due on February 15, 2030 that is selling for 99.4 and has a coupon rate of 9.5625 percent. The coupon has a quarterly readjustment at the three-month LIBOR rate in which the next readjustment is February 15, 2019 (90 days). The assumed three-month LIBOR base rate is 9.5 percent. Using equations 15.2 and 15.4 and assuming C = 9.5625 percent, B = 9.5 percent, P = 99.4, AI = 0, and D = 49 days.

$$AP = 99.4 - \left(\frac{\left[\left(\frac{9.5625 - 9.5}{100} \right) (99.4 + 0) \left(\frac{90}{360} \right) \right]}{1 + \left(\frac{9.5}{100} \times \frac{90}{360} \right)} \right) 0.01$$

$$AP = 99.3866$$

BY = 11.21 and F = 0:

$$TAM = \left(\frac{\frac{100 - 99.3866}{11.21} + 0 + \frac{(9.5)\times(100 - 99.3866)}{100}}{\frac{99.3866}{100}} \right) 100$$

$$TAM = 11.37 \text{ percent}$$

Discount Margin

The discount margin (DM) uses discounted cash flows to determine potential returns. Given an assumed path that the reference rate takes to maturity, this method indicates the average spread or margin above the reference rate the investor can expect. Assuming not change in the reference rate over the floater's life, the DM method is as follows:

1. Determine the cash flows.
2. Select a spread above the reference rate.
3. Discount the cash flows found in (1) by the current value of the reference rate plus the margin selected in (2).
4. Compare the present value of the cash flows as calculated in (3) with the price. If the present value is equal to the security's price, the discount margin is the margin assumed in (2). If the present value is not equal to the security's price, go back to (2) and select a different margin.

Option-Adjusted Spread

One important drawback of using the SFL, EM, TAM, and DM methods is that they fail to consider embedded options such as callable/puttable floaters and floaters with caps and floors. Incorporating embedded options is critical to accurately pricing floating rate securities. A preferred method of valuing floaters is to use arbitrage-free binomial interest rate trees and Monte Carlo simulations because these methods are designed to price securities having interest rate–dependent cash flows (Fabozzi and Mann 2005).

The previous spread measures do not consider floaters with embedded options, so an option-adjusted spread (OAS) measure needs to be addressed. In a binomial tree, the cash flows at each node are discounted at the appropriate rate where the valuation yields a theoretical value of the floater. The option-adjusted spread is used to compare the bonds theoretical value with its market price. The theoretical value is usually higher than its market price because of the differences in perceived risk (e.g., liquidity and default). In other words, the discounting rates are too low. Floaters are less liquid than on-the-run, most recently issued, benchmark securities and the discount rates used in binomial tree valuation to determine theoretical value of floaters are too low. The *OAS* is the spread that is added to each node to make the theoretical value equal to the market price of the security. The interpretation of the OAS depends on the benchmark used but often practitioners use the Treasury on-the-run yield curve for binomial trees (Fabozzi and Mann 2000).

Measures of Price Sensitivity

The measure of the price sensitivity of a security to changes in interest rates is known as the *duration* of a security, which is the approximate percentage change in price for 100 bps change in rates. The standard definition also assumes a one-time, parallel shift in the yield curve. However, for a floating rate security, the price changes due to several factors including changes in the reference rate and/or changes in the required margin.

Spread Duration

The measure of responsiveness of a floating rate security's price to a change in the required spread or required margin is known as *spread duration*. For example, a common spread measure is the OAS. Rates are shifted upward and downward in small increments of basis points in order to calculate a security's duration based on the resulting prices. Equation 15.5 shows the formula for spread duration:

$$\text{Spread duration} = \frac{\text{Price at lower OAS} - \text{Price at higher OAS}}{2(\text{Initial price})(\text{Change in OAS used to compute prices})} \quad (15.5)$$

For the purposes of calculating a floater's spread duration, the OAS is shifted upward or downward in increments to measure sensitivity. The OAS that has been incrementally decreased is used to calculate the rates for the nodes of the binomial tree. Given the new rates at each node, the price is computed for the floater at the lower OAS. Similarly, the same procedure for the price at the higher OAS is used in the spread duration formula simply by increasing the OAS by the same basis points higher to produce the new discounting rates for the binomial tree (Fabozzi and Mann 2000).

Summary and Conclusions

This chapter reviewed the characteristics and valuation of FRNs. The multiple types of FRNs enable investors with different risk preferences to choose a type that matches their desired risk level. When compared to traditional bonds, FRNs provide a higher yield if the reference rates are expected to rise. Aside from inverse/reverse floaters, FRNs provide the investor with a positive return above the reference rate. Portfolio managers can use FRNs to hedge their portfolios to reduce risk. In times when interest rates are expected to fall, portfolio managers can benefit from inverse/reverse floaters because of the increase in coupon payments for declining rates. Besides understanding the structure of various FRNs, investors should make informed decisions before investing in FRNs because of the fluctuating coupon payments. Calculating a bond's YTM with variable coupon payments can be difficult, but this chapter briefly discusses several valuation methods for FRNs that allow investors to gain insights on how to derive relative value in the bond market. Also, this chapter also discussed duration or a bond's price sensitivity for an incremental rate change that provides investors more tools to gauge risk.

Discussion Questions

1. Explain the difference between a capped and a floored FRN.
2. Identify the main components that affect an FRN's performance.
3. Identify when the spread for life and effective margin methods are appropriate.
4. Identify the most accurate method of determining an FRN's relative value and explain why.
5. Identify a main drawback of using relative valuation methods for FRNs.

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16

Bonds with Embedded Options

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Introduction

The debt capital markets are deep and diverse, filled with myriad products and innovations that in some form adhere to the basic characteristics of fixed income. Investors (lenders) in debt securities hold a financial claim against the issuer (the borrower), which commits the issuer to returning the principal borrowed along with pre-specified interest payments over a stated period (Martellini, Priaulet, and Priaulet 2003). Because issuers promise a rate of return irrespective of whether interest is actually paid in cash or simply accrued (as in the case of zero-coupon bonds), the value of debt securities is susceptible to changes in interest rates. Generally, an inverse relation exists between changes in interest rates and changes in the fair value of debt securities: if interest rates rise, debt security prices decline and vice-versa. This relation is true for *straight* debt securities, which do not have any embedded options. The existence of an embedded option and, moreover, the rights granted to the option holder potentially alter the expected return and cash flows of the security and therefore the security's theoretical value.

Embedded options represent contracts inseparable from the security that provide the right, but not the obligation, to buy or sell some underlying asset at a predetermined price within a prescribed window of time. The option holder can be either the investor or the bond issuer or both. Many examples of existing bond offerings are available in which both the investor and the issuer hold certain options concurrently, for example, a callable convertible bond. In a callable convertible bond, the investor holds a conversion option to exchange the bond into shares of the issuer, and the issuer holds a call option to retire the bond ahead of maturity. Because embedded options can alter cash flows of the security, often traditional fixed income analysis is unable to deal with the challenges posed by the options. Metrics, such as yield-to-maturity (YTM) and modified duration, cannot be relied upon because the option could alter a security's tenor or life.

This chapter considers the case of bonds with embedded options, which share some similarity to other fixed income securities without embedded options. The three types of bonds with embedded options found most frequently in capital markets are callable, puttable, and convertible bonds, each of which is discussed in more detail in successive sections. Other classes of embedded options are also available, such as extendable bonds and bonds with knock-in and knock-out features. However, these types of offerings represent the minority of bonds with embedded options.

Bonds with embedded options are the result of innovation, providing issuers and/or investors with certain rights that were impossible to obtain through straight or plain vanilla bonds. Although inseparable from one another, the value of bonds with embedded options is the sum of the value of its individual parts. Put another way, the theoretical fair value of a bond with an embedded option is the value of the bond adjusted for the value of the option. Although embedded options may protect against certain risks influencing straight bonds, they invariably introduce additional uncertainty into the model.

The remainder of this chapter is organized as follows. To supplement the understanding of embedded options, the next section provides an overview of option mechanics and terminology. The following section discusses both callable and puttable bonds, and how embedded options affect traditional analysis and bond valuation compared to bonds without call and put rights. Next, the chapter provides a detailed account of convertible bonds and other convertible securities that share common characteristics. The penultimate section provides a brief overview of the less common and more complicated exotic embedded options. Finally, the chapter offers a summary and conclusions.

Brief Overview of Options

Because bonds with embedded options rely on analyzing the embedded option together with the bond itself, a brief overview of different types of option rights and styles is necessary. This section provides a brief introduction to options, including common terminology, types of contracts, and exercise styles.

Types of Options

Options are financial contracts between a seller (writer) and a buyer (holder), conferring upon the buyer the right but not the obligation to buy or sell an underlying asset at a pre-specified price on or before a specified date in exchange for a premium paid to the seller. A *call* option affords the holder the right to buy the underlying asset, and a *put* option allows the holder to sell the underlying asset. If the call (put) buyer exercises the option, then the option's writer is legally obligated to sell to (buy from) the buyer the underlying asset.

Call and put options can be further categorized based on the *style of the option contract*, which explains the exercise rights granted by it. The two most popular styles are

European and *American. European options* can be exercised only at maturity, whereas *American options* can be exercised at any time before and including maturity. Option styles are simply nomenclature and relate to the exercisability rights or payoff of the option, irrespective of the domicile of the underlying asset, or where the option was written. American and European style contracts are commonly called *plain vanilla* option styles. Option styles that are neither European nor American are called *exotic* including Bermudan, Asian, barrier, and binary options.

Option Features and Value

Although this section is not an exhaustive discussion of options terminology, it provides the necessary information to understand option mechanics, profit and loss, and valuation. The *strike price*, or *exercise price*, is the price at which the underlying asset can be bought (call) or sold (put). Options have a finite life, and therefore at maturity, the option expires and ceases to have value.

An option's value (premium) consists of two parts: an intrinsic value and a time value. The *intrinsic value* of an option is the larger of the option cash flow if exercised immediately and zero. Because an option represents a right, but not an obligation, a rational investor would not exercise the option unless its intrinsic value exceeds zero. The *time value* represents the value based on the remaining period until maturity. Although a rational holder might not exercise the option today, the right to possibly exercise the option in the future, when prices may have changed, is still valuable. Therefore, such options where the intrinsic value is zero still have positive time value. Excluding marketplace frictions, the payoff to a long call is the opposite of a short call because option cash flows must be a zero sum. The same holds for long puts and short puts. To *go long* an option is to buy the option; to *go short* an option is to sell (write) an option. For instance, going long an American call option gives the buyer the right to purchase the underlying security at the option's exercise price during the life of the option. Figure 16.1 presents illustrative payoff diagrams for the long and short positions of both calls and puts, net of premiums.

Moneyness

Moneyness is a term used to describe the intrinsic value of an option. *Out-of-the-money* (OTM) *options* have intrinsic value of zero today, but *in-the-money* (ITM) *options* have positive intrinsic value. *At-the-money* (ATM) *options* describe a relation when the market price of the underlying equals the exercise price. Due to market frictions such as the bid-ask spread, market convention is to widen this area to include a range of slightly OTM to slightly ITM values.

Stoll (1969) illustrates put-call parity when he examines the connection of the two types of options. Under the assumptions of no arbitrage, frictionless markets, and the ability to borrow and lend at a risk-free interest rate, a call (put) option's cash flow can be replicated with a portfolio of long and short positions in a put (call) option, a bond, and the underlying asset. In other words, synthetic (economically equivalent) portfolios can recreate option contracts. For example, an investor can create a synthetic long call

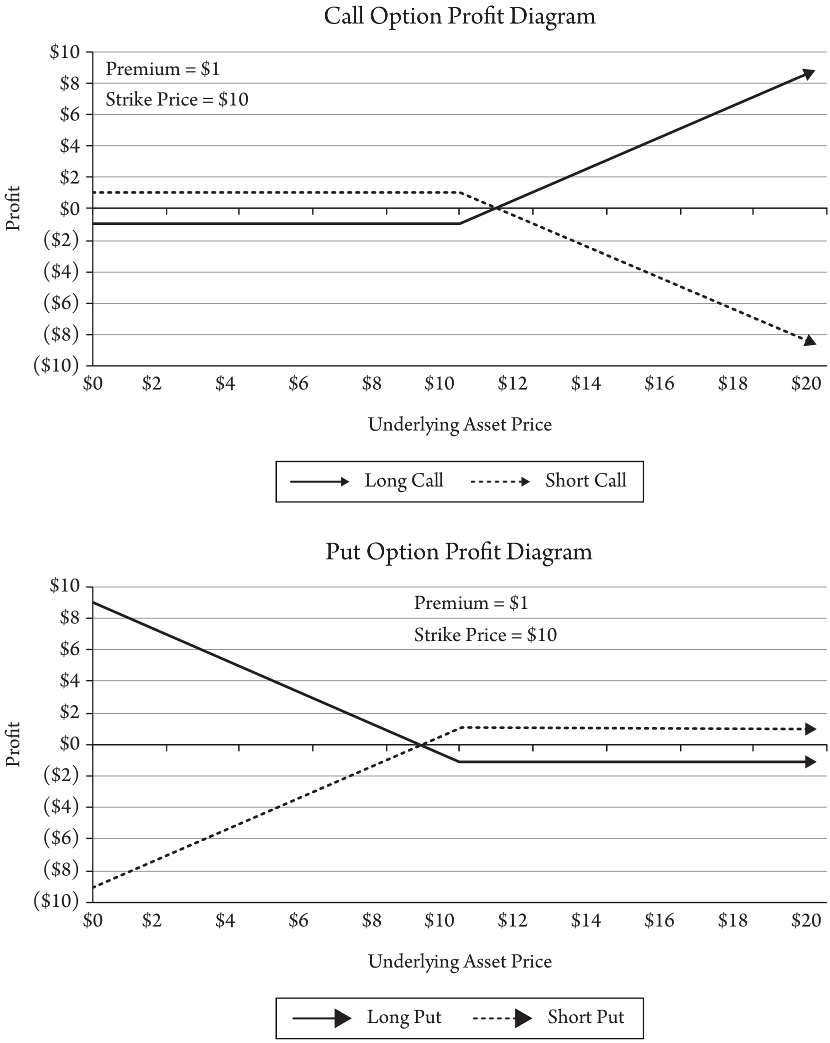


Figure 16.1 Profit Diagrams of Long/Short Call/Put Options
This figure depicts the zero-sum nature of options, portraying the profit diagrams of long and short call and put options.

position by buying the underlying security, buying a put option on the same underlying security, and borrowing at a risk-free rate with maturity equal to the option's expiration. The put-call parity relation enabled Black and Scholes (1973) to develop a model to value put and call options as a function of the underlying asset's spot price, volatility of returns, time to maturity, exercise price of the option, and the risk-free rate of return. Merton (1973) extends Black and Scholes's pivotal option pricing equation by introducing the effect when the underlying stock pays continuous dividends. Together, these form the Black, Scholes, and Merton (BSM) model for equilibrium options pricing. The BSM model for European options for dividend paying stocks follows in Equations 16.1 through 16.4.

$$Price\ of\ Call = S_t e^{(r-q)(T-t)} N(d_1) - Ke^{-r(T-t)} N(d_2) \tag{16.1}$$

$$Price\ of\ Put = Ke^{-r(T-t)} N(-d_2) - S_t e^{(r-q)(T-t)} N(-d_1) \tag{16.2}$$

$$d_1 = \frac{ln\left(\frac{S_t}{K}\right) + \left(r - q + \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}} \tag{16.3}$$

$$d_2 = \frac{ln\left(\frac{S_t}{K}\right) + \left(r - q - \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}} = d_1 - \sigma\sqrt{T-t} \tag{16.4}$$

These equations together represent the classic Black-Scholes-Merton model for pricing European call and put options (Merton 1973), where S_t is the current spot price, K is the strike price, r is the continuously compounded risk-free rate, T is the expiration date, q is the continuous dividend yield, and σ is the volatility of the underlying asset, commonly measured by the standard deviation of the underlying asset's returns. $N(\cdot)$ is the cumulative distribution function of the standard normal distribution, e is the base of the natural logarithm, and $ln(\cdot)$ is the natural logarithm function.

The BSM model for fair value call and put option prices provides the foundation for option "Greeks." The Greeks are partial derivatives of the BSM model, and they are traditionally delineated with characters from the Greek alphabet. The first-order Greeks include *delta, theta, rho*, and *vega*. Each Greek represents a sensitivity of the option price to a change in the corresponding input of the BSM equation. *Delta* is the sensitivity to changes in the underlying share price; *theta* is the sensitivity to changes in the time to maturity; *rho* is the sensitivity to changes in the risk-free rate of return; and *vega* is the sensitivity to changes in volatility. Although many other higher order (e.g., second derivative) Greeks exist, such as gamma, a comprehensive review of these higher order Greeks is beyond the scope of this chapter.

Callable and Puttable Bonds

Callable and puttable bonds are two common types of option-embedded bonds. These bonds provide the issuer or the investor with specific rights regarding the redemption of the underlying bond. Issuers can redeem callable bonds ahead of maturity to take advantage potentially lower interest rates. Investors can redeem puttable bonds before maturity if interest rates increase.

Callable Bonds

Callable bonds give the issuer the right to repurchase the debt ahead of its maturity at pre-specified dates. As a result, investors could be compelled to relinquish their bonds if the issuer exercises its call option. Typically, these issues include a *call protection* period, which prevents the issuer from calling the bond for some predetermined length of time. To entice an investor to accept the additional risk of early retirement, the issuer must pay a higher interest rate relative to a similar option-free bond. Put another way, because the call option benefits the issuer, the investor in a callable bond essentially writes a call option, thereby reducing the investment by the proceeds of the call option.

Duration and convexity are two measures that describe sensitivity of bond prices to changes in interest rates. *Duration* measures the sensitivity of the bond price to small, parallel changes in interest rates, and *convexity* measures the sensitivity of the bond price to changes in duration. Convexity is useful because it adjusts for the nonlinear relation assumed by the duration calculation based on current interest rates, maturity, and bond prices. Duration and convexity for bonds are analogous to the Greeks, delta and gamma, for options. Plain vanilla bonds (straight bonds) exhibit positive convexity, which means for a similar magnitude parallel change in yields, a bond's price increases more with falling yields than it decreases for rising yields. Whereas straight bonds always exhibit positive convexity, the introduction of the short call option for an investor of a callable bond leads to a phenomenon known as negative convexity. *Negative convexity* occurs when bond prices increase at a decreasing rate. Since the probability of being called increases as rates decline, the added call risk reduces the upside potential of callable bonds.

Negative convexity is also exhibited by a *mortgage-backed security* (MBS), which is a type of asset-backed security in which multiple mortgage loans are pooled together into a portfolio, and subsequently split into multiple *tranches*, or slices. Because mortgages allow, but do not require, borrowers to repay the loans early, the borrower holds a call option on the loan. Like call risk in callable bonds, investors in MBSs face prepayment risk, in which the underlying security is redeemed ahead of the expected maturity. When the prevailing interest rates fall, mortgagors are more likely to repay or refinance the mortgages to take advantage of the now lowered rates.

The call provision affects the potential term of the bond. Although investors generally have some period of call protection, which shelters them from call risk during some prearranged deferment period, the bond's issuer may decide to redeem the debt after the call protection expires depending on the movement of interest rates. For example, if an issuer offers callable bonds with a 10 percent coupon rate in year one with three years of call protection, but the prevailing rates fall to 7 percent in the fourth year, the issuer could retire the outstanding bonds and would like to reissue the debt at the now lower prevailing rate. All else equal, an issuer would have no incentive to call its debt when rates have risen. Therefore, the upside an investor experiences when rates decline could be limited.

Moreover, the potential for a truncated investment horizon means that traditional metrics for bonds such as YTM, duration, and convexity may be inappropriate in analyzing bonds with embedded options. Instead, bond holders presumably must focus on other metrics such as yield-to-call (YTC), yield-to-worst (YTW), effective duration, and effective convexity. YTM must be replaced with a YTW, defined as the lowest yield based on each possible call date (each YTC). Puttable bonds have corresponding yield-to-put (YTP) and YTW measurements as well. Essentially, adjustments to these traditional metrics must account for the embedded options to be dependable.

Although all callable bonds have the possibility of being redeemed ahead of their maturity, not all call features are the equivalent. A *sinking fund provision* and an *extraordinary (special) redemption provision* are two other types of call provisions in addition to the traditional optional call provision that exist in the market (Securities and Exchange Commission 2017).

Sinking Fund Provision

A *sinking fund provision* is a special version of a callable bond that retires a predetermined portion of the bond issuance according to the redemption schedule. The bond issuer sets aside cash in a sinking fund account, specifically for redemption of the bonds, and the issuer can repurchase the bonds in the open market at the lesser of a pre-specified price, usually par, or the market price (Mitchell 1991). Although an investor in a sinking fund bond bears early redemption risk by the issuer, the investor also benefits from the reduction in the issuer's default risk because redemption of the debt is spread out over multiple periods rather than entirely at maturity as for a bullet redemption. Furthermore, the increased liquidity of the bonds, stemming from scheduled issuer repurchases, serves to reduce the required return demanded by investors (Wu 1993).

Extraordinary (Special) Redemption Provision

An *extraordinary redemption provision* is another style of callable bond that is prevalent in the municipal bond market. This provision either permits or requires the issuer to redeem the outstanding bonds ahead of maturity should some extraordinary or one-time event occur. Some examples of extraordinary circumstance are a catastrophe or a calamity such as destruction or damage to the revenue generating facility, eminent domain acquisitions, change in use, and change in the preferred tax treatment of bond interest (Municipal Securities Rulemaking Board 2016).

Puttable Bonds

Whereas a callable bond embeds the call option with the issuer, a puttable bond provides the bondholder with a put option on the bond. Unlike a callable bond that features a lock-out period in which the issuer cannot call the bond, puttable bonds typically have no such provision because the bondholder owns the option. Puttable bonds are also called *retractable bonds*.

Compared with a similar option-free bond, as yields rise, a puttable bond always has less convexity, indicating the price flattens out more quickly, when interest rates increase. The reduced convexity stems from the increased value of the put option from rising yields. All else equal, bond prices fall when yields rise. The put option permits the bondholder to sell the bond at the redemption price (typically par), thus limiting the downside to the redemption price. As yields rise, the embedded put option's value increases, more than offsetting the underlying bond's value. Conversely, as yields fall, the diminished value of the put option leads to a convergence between value of the puttable bond and the option-free bond. To recap, Figure 16.2 offers an illustration of the theoretical price-yield relation between a callable, puttable, and option-free bond.

Puttable bonds expose investors to some unique risks. Although investors may demand redemption of their bonds from the issuer, a run on the issuer can result in the issuer defaulting if it cannot meet all its obligations. If access to capital is tight, the issuer may be unable to raise additional funds to redeem the bonds. Unlike callable bonds, the market for puttable bonds is much more thinly traded because of the relatively scant number of issues, generating liquidity risk for holders.

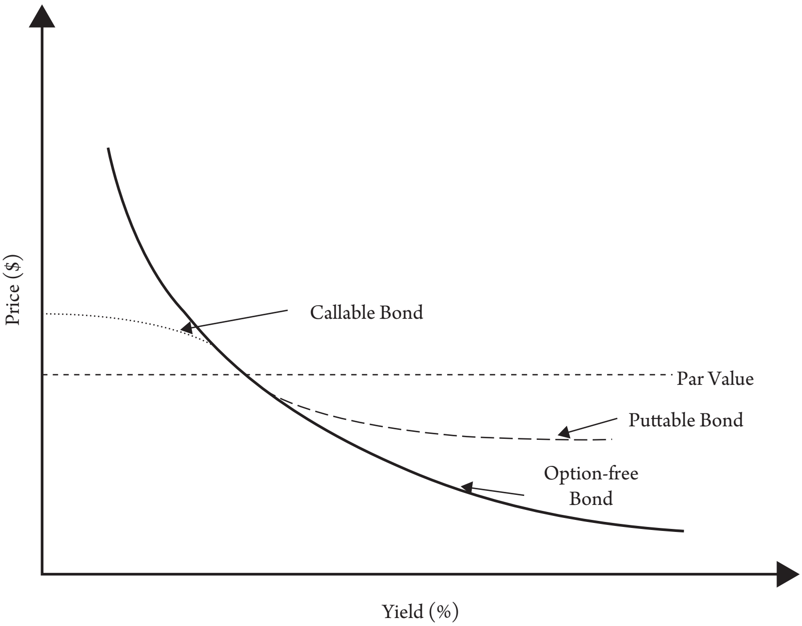


Figure 16.2 Price-Yield Relation for Callable, Puttable, and Option-Free Bonds
This figure provides a graphical representation of the price-yield relation for callable, puttable, and option-free bonds. When interest rates rise, the puttable bond displays higher positive convexity because the put option creates a price floor for the bond. When interest rates fall, the put option value is negligible, and the puttable bond acts like the option-free bond. The callable bond exhibits negative convexity as rates fall because of the inverse relation between the call probability and change in interest rates. When interest rates rise, all else equal, the issuer has no incentive to call the bond, thereby nullifying the call risk and enabling the callable bond to trade like the option-free bond. Although the put price acts as a price floor for puttable bonds, the call price acts as a price ceiling for callable bonds. The call and put prices of these bonds can equal any value, including par.

Convertible Bonds

Convertible bonds and convertible preferred shares are a hybrid between debt and equity products, which offer investors downside protection in the form of a fixed income instrument with upside potential from equity participation. Like a straight bond, convertibles pay coupons and have a stated maturity at which point the principal is returned assuming no conversion has taken place. In the event of relative share price underperformance (e.g., the underlying share price is below conversion price as maturity nears), the investor still receives the benefits of the bond itself. Although convertibles are typically lower in seniority to straight bonds issued by the company, they have higher priority than equity investors in the event of bankruptcy. Conversely, when the share price rises substantially above the conversion price, investors can convert the bond into the underlying shares, therefore participating directly in the equity of the company.

Certain circumstances occur where issuers prefer to issue convertible debt relative to straight debt. For many convertible issuers, access to traditional credit markets may be nonexistent or be prohibitively expensive. Often younger firms that are initially focused on revenue growth more than cash flows may issue convertible debt to meet their financing needs. All else equal, convertible debt is likely to require a lower cost of capital compared to a straight debt offering, as investors pay a premium for the implicit call option on the stock. To minimize the dilution to existing shareholders, most issuers offer convertibles with conversion prices greatly exceeding the current share price. Typical premia on convertible bonds range from 25 to 45 percent (Dinsmore, O'Keeffe, and Dinsmore 2016). Because convertible bonds are usually priced at a premium to the current share price, issuers may choose to sell the convertible if they perceive their share price is undervalued.

For example, assume a company issues a convertible bond with a 25 percent premium when its share price is $100 (the conversion price is $125). Today, investors can convert their bonds into 8 shares ($1,000 of par value divided by the conversion price of $125). However, this conversion would be unprofitable for the investor because the shares are only worth $100 today. Until the share price exceeds the conversion price, the conversion option is OTM, and an investor would choose not to exercise the conversion option all else equal. Table 16.1 explains the optimal decision investors in convertible bonds should make under multiple share price scenarios immediately before maturity.

Although the convertible bond gives exposure to the underlying equity, convertible bond holders are not entitled to receive any dividends paid to equity holders unless conversion has occurred. However, convertible bonds pay coupons, and the coupon rate on convertibles is generally higher than the expected forward dividend yield on the issuer's equity. The extra yield from the coupon above the expected forward dividend yield is called the convertible's *yield advantage*, excluding reinvestment risk posed by the difference in frequency of dividend and coupon payments.

Upon exercising the conversion option, the investor surrenders the rights to the bond's future cash flows and principal and receives the underlying shares. Investors should nonetheless note the terms listed in the bond's prospectus, as certain convertibles have been issued granting the issuer the option to redeem the convertible in shares or cash. Although cash or shares would be granted in equivalent amounts, depending on

Table 16.1 **Convertible Option Exercise Decisions**

	Conversion Price			$125.00
	Receivable Shares upon Conversion			8
	Annual Coupon Rate			5.0%
Share Price	***Premium (Discount)****	***Value of Converted Shares***	***Par Value***	***Decision*****
$93.75	(25.0%)	$750	$1,000	Redeem for cash
$125.00	0.0%	$1,000	$1,000	Redeem for cash
$131.25	5.0%	$1,050	$1,000	Indifferent between cash and shares
$156.25	25.0%	$1,250	$1,000	Convert into shares

This table illustrates the optimal redemption decision for a convertible bond at maturity, based on a cross section of share prices. The bond is assumed to pay an annual coupon rate of 5 percent.

*Premium (discount) to conversion price at maturity

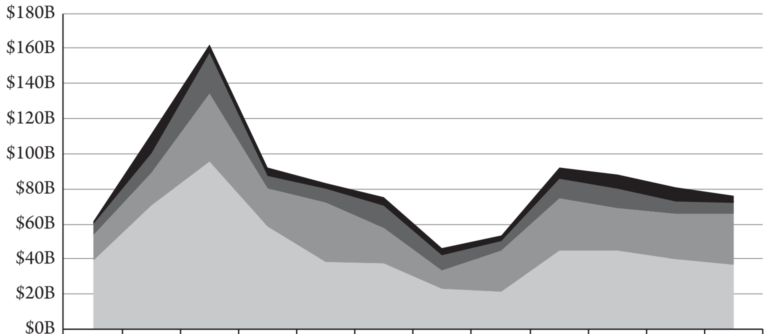
**If the share price equals the conversion price at maturity, investors should redeem the bond for cash in order to receive the final coupon payment, which is received at maturity.

jurisdiction, the transaction could expose the investor to additional tax liabilities. From an issuer's perspective, redeeming the convertible in cash would mitigate the dilution potential for the issuer.

Normally, the conversion option is not exercisable until the shares have appreciated and have remained above some predefined threshold. The requirement that the underlying shares trade above the predefined threshold is actually an example of an exotic embedded option called a barrier, which will be discussed later. After the shares have appreciated beyond the predetermined threshold, the barrier option knocks in the conversion option, which then becomes exercisable. The conversion option is generally of American style, meaning holders can exercise the option at their discretion.

Market for Convertibles

Convertible issuance is predominantly skewed to the United States. Moreover, analyzing the historical issuance and redemption patterns of the convertible market between 2005 and 2016 indicates a roughly stable dispersion globally. Over this period, the United States accounted for about 52 percent of global issuance on average, the Europe, Middle East, and Africa (EMEA) region for about 29 percent, and the remainder of issues was from Asia-Pacific (Calamos 2016). Through 2016, global issuance of convertible bonds has not returned to the high levels experienced leading up to the financial crisis of 2007–2008. Figure 16.3 provides historical context for the global issuance of convertible bonds between 2005 and 2016.



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
■ Japan	$2	$11	$4	$5	$4	$5	$4	$3	$6	$8	$8	$5
■ Asia Ex-Japan	$7	$12	$25	$8	$9	$13	$9	$7	$12	$12	$9	$7
■ Europe	$14	$18	$39	$22	$34	$21	$11	$24	$30	$24	$26	$29
■ US	$39	$71	$95	$59	$38	$37	$23	$21	$44	$44	$40	$36

Figure 16.3 Convertible Issuance by Region between 2005 and 2016
This figure provides a time series of gross global issuance of convertible debt, segmented by the domicile of the issuer. These data show that convertible offerings peaked in 2007. Moreover, throughout the profiled time, the United States remained the largest region by par value of convertible debt issued, accounting for around 52 percent on average between 2005 and 2016.
Source: Bloomberg (2018).

Dividing the issuers by sectors highlights some key takeaways. Most issuers tend to be information technology, healthcare, and financial firms, which seemingly prefer the lower cost of capital relative to potential future dilution. Based on data from 2016, the implied market capitalization of the outstanding convertible issues totaled $207 billion (Dinsmore et al. 2016). Based on Figure 16.4, the implied $207 billion market capitalization of outstanding convertible bond issues as of December 2016 displays the outsized portion of issues from these three sectors.

Between 1999 and 2017, convertible bonds and convertible arbitrage funds have generally outperformed the S&P 500 on a relative basis. However, the S&P price performance does not include reinvested dividends. Between 2008 and 2017, the convertible arbitrage fund index underperformed both the convertible bond index and the S&P 500. Figure 16.5 displays the relative price performance among convertible bonds, convertible arbitrage fund managers, and the S&P 500 index.

Convertible arbitrage funds overall appeared to underperform the market between 1999 and 2017, coincident with a diminished supply of convertibles in the market relative to the end of 1999. At a high level, convertible arbitrageurs attempt to exploit mispricing in the market for convertibles by buying an issuer's convertible securities and simultaneously shorting shares of the same issuer. According to fund flow data from BarclayHedge (2018) through December 2017, investors have been diverting money from convertible arbitrage funds since 1999. Figure 16.6 presents the assets under management (AUM) at convertible arbitrage funds at year-end between 1999 and 2017.

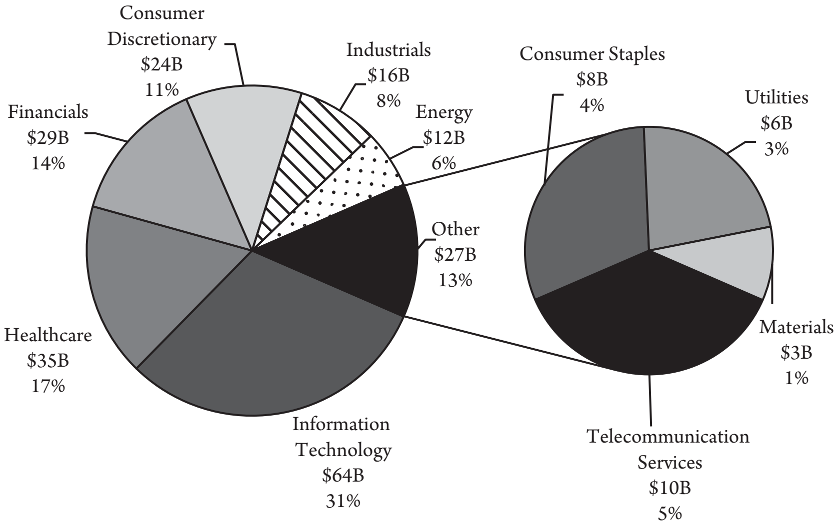


Figure 16.4 Implied Market Capitalization of Outstanding Convertible Bonds by Sector
This figure displays the implied equity market capitalization of outstanding convertible issues, which totals $207 billion, organized according to the sector of the issuer as of December 2016. The sector mix delineates the tendency of financial services, healthcare, and technology companies to offer convertible bonds.
Source: Bloomberg (2018).

Trading Patterns of Convertibles

Depending on the price of the underlying shares, a convertible bond trades like other assets such as a distressed bond, straight bond, combination of bonds, and equity, straight equity, and discounted equity. Figure 16.7 provides a graphical representation of these trading patterns.

Starting on the left, OTM convertibles are divided into two subsegments: distressed and debt-like. If the issuer's financial solvency is questioned or if the underlying share price approaches zero, convertibles trade like distressed bonds. As a result, investor focus shifts substantially toward the creditworthiness of the issuer. Investors in these so-called "junk" or "busted" convertibles face certain risks not prominent in financially solvent bond issues. Howard and O'Connor (2001) discuss these risks including the seniority of the convertible offering in the issuer's capital structure, bankruptcy laws of the country in which the issuer is incorporated, and general accounting and transparency risk if the issuer has hidden claims on its assets by other parties. They contend that even if a formal bankruptcy were to occur, the convertible bond would still have value greater than zero because the market would assign a value to the conversion option, regardless of the degree the option is OTM.

When financial solvency is no longer an imminent risk, but the stock price is considerably below the conversion price, the convertible trades more like a straight bond. Although the conversion option is OTM, the convertible still has value in the form of a straight bond. If exercising the conversion option is unprofitable, the convertible still

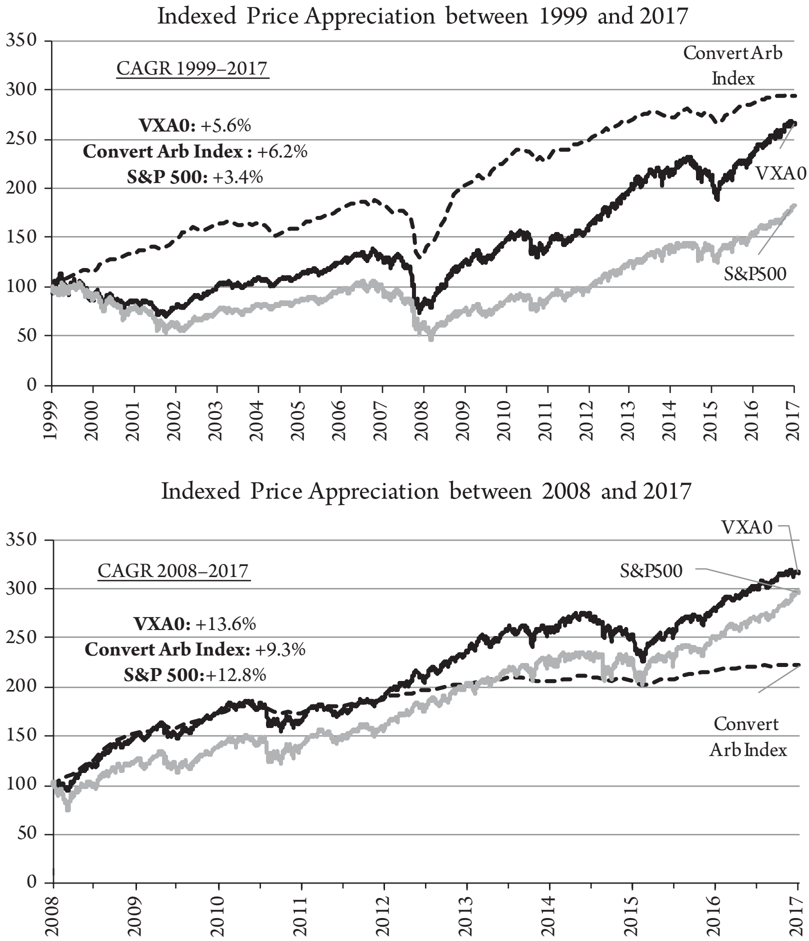


Figure 16.5 Convertible Bond Price Performance versus S&P 500 Index
This figure portrays the indexed price performance of convertible bonds, measured by the BAML All Convertibles Index (VXA0), convertible arbitrage funds, measured by BarclayHedge's Convertible Arbitrage Fund Index, and the S&P 500. Between December 1999 and December 2017, convertible bonds have enjoyed generally higher price appreciation than the S&P 500. Convertible Arbitrage fund managers, measured by BarclayHedge's Convertible Arbitrage Index, have also generally beaten the S&P 500 in price appreciation over the same period. Between December 2008 and December 2017, convertible arbitrage fund managers have lagged the S&P 500 in terms of price appreciation.
Notes: CAGR stands for compound annual growth rate. Because these figures explicitly show price appreciation, the S&P 500 returns exclude the effect of reinvested dividends.
Source: Bloomberg (2018), FactSet (2018), and BarclayHedge (2018).

pays coupons throughout the bond's life and the principal at maturity, regardless of the underlying share price movements.

Convertibles in the ATM region tend to trade with characteristics of both debt and equity. As the share price approaches and initially exceeds the conversion price,

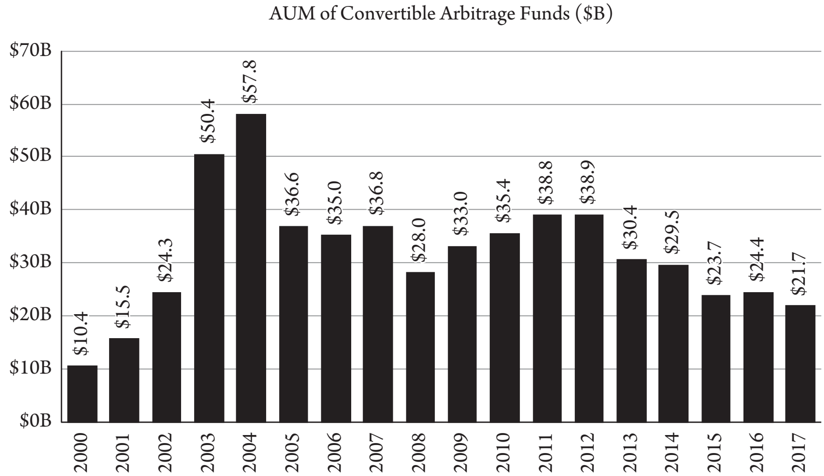


Figure 16.6 Convertible Arbitrage Fund Assets under Management between 2000 and 2017

This figure portrays a time series of convertible arbitrage fund AUM between 2000 and 2017, revealing that investors have generally moved funds away from convertible arbitrage funds since the financial crisis of 2007–2008. This trend of investors exiting convertible arbitrage funds can likely be attributed to fewer convertible bonds outstanding in the market today, coupled with relatively worse returns compared to the S&P 500.
Source: BarclayHedge (2018).

the price of the convertible begins to exceed its bond floor as the conversion option becomes more valuable via its equity participation rights. As the share price appreciates well beyond its conversion price, the convertible bond behaves substantially more like the underlying equity. The likelihood that the holder will exercise the conversion option increases as the underlying share price appreciates. Howard and O'Connor (2001) find that the delta on ATM convertibles is asymmetrically skewed to the upside, meaning the absolute magnitude of change in delta is greater when the share price rises. This asymmetry provides bond holders with enhanced equity participation as the share prices rises, while also offering protection when the share price falls.

Lastly, some deep ITM convertible bonds have displayed a peculiar trading pattern—they sometimes trade at a discount (Howard and O'Connor 2001). Although an arbitrage opportunity may seem to exist, market frictions and regulatory restrictions may cause the discount to parity relative to the value calculated by a pricing model. Regulations and statutes governing convertible securities can vary widely between jurisdictions, and certain market restrictions or convolutions regarding conversion could explain the peculiarity of deep ITM convertibles trading at a discount to fair value. For example, these restrictions could include limits or controls on foreign ownership, or even lack of clear, unencumbered conversion processes. For a while, certain Asian markets required convertible bonds to be converted into entitlement certificates, not the underlying shares themselves. These entitlement certificates could have their own respective restrictions, permitting

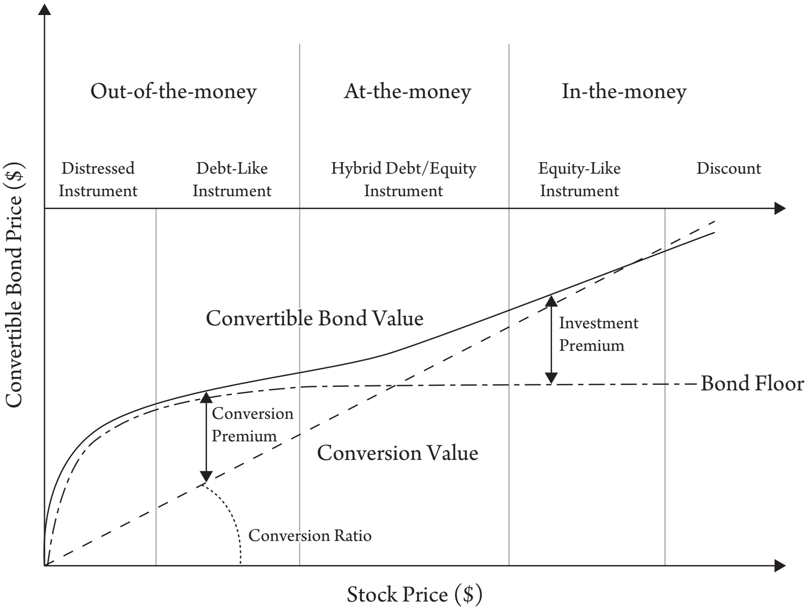


Figure 16.7 Relation Between Convertible Bond and Underlying Equity
This figure depicts a comprehensive view of the nonlinear relation between a convertible bond's theoretical price and the underlying equity's share price. The chart illustrates the flexibility of convertible securities to behave and trade like multiple distinct assets. At a high level, the moneyness of the conversion option segments the chart into three regions: out-of-the-money, at-the-money, and in-the-money. Although the discount region may indicate an arbitrage opportunity exists, often regulatory restrictions or market frictions in the conversion process prevent its exploitation. The bond floor represents the value of the straight bond (i.e., without any options). The conversion value depicts parity—the value of the convertible bond if converted into the underlying equity at an array of prices. The difference between the convertible bond's theoretical value and its conversion value is the conversion premium. The difference between the convertible bond's theoretical value and its bond floor is the investment premium.

conversion into shares only on specific dates. Similarly, in less developed convertible markets, a lag may exist between the time an investor submits the bond for conversion and when he ultimately receives the shares. Investors are exposed to adverse market conditions during this latency period, if insufficient stock lending and borrowing exist.

Exchangeable Bonds

Exchangeable bonds are essentially a subset of convertible bonds, with one key distinction: instead of converting into shares of the underlying issuer, exchangeable bonds are exchanged into shares of a third party. Barber (1993) explores the motivations of firms that issue exchangeable debt, concluding that exchangeable debt provides issuers with an effective strategy to divest equity holdings in another company, while also dispelling the notion that tax implications are a persuasive factor in exchangeable debt offerings.

When an issuer holds a substantial equity position in another company, exchangeable bond offerings provide the issuer with a means to divest the stake efficiently without directly selling the shares in the open market.

Convertible and exchangeable bonds potentially expose investors to multiple currencies if the bond pays interest in one currency while the underlying shares are priced and traded in another currency. Investors should be aware that volatility in foreign exchange rates creates additional risks.

Contingent Convertibles

Contingent convertibles (CoCos) are another type of convertible bond that triggers the conversion option if some predetermined event occurs. Originally, CoCo bonds emerged from changes in accounting rules in the United States (Olsen, Decker, Rustau, and Ho 2002), which allowed companies to report non-diluted earnings. Nevertheless, the contingency clause has become more common in convertible prospectuses as a means for companies to prevent holders from converting immediately. Typically, these clauses require the underlying shares to trade above some limit price for a certain time period before the conversion option becomes effective.

Automatic CoCo bonds share many characteristics with standard convertibles, but the conversion is not the investor's choice. Instead, it automatically occurs if the pre-specified circumstances take place. Unlike standard convertibles, CoCo bonds are only converted into equity when the issuer's financial profile degrades beyond some level. Therefore, if an automatic CoCo is triggered and converted because of financial duress, the share price is unlikely to have outperformed, thus leaving investors with underperforming shares (Albul, Jaffee, and Tchistyi 2015). Unlike a standard convertible, these CoCo bonds potentially expose the bondholder to additional downside risk by replacing the fixed income component entirely with straight equity (Wilkens and Bethke 2014). Automatic CoCo bonds should not be confused with mandatory convertibles. The subtle difference between automatic CoCo bonds and mandatory convertibles is that the automatic CoCo does not convert into the underlying equity unless the pre-specified event occurs. Mandatory convertibles always convert into equity on some pre-determined date (Chemmanur, Nandy, and Yan 2004).

Convertible Arbitrage

Convertible arbitrage is an investment strategy that exploits pricing inefficiencies between convertible bonds and the underlying equity of the issuer. The three main convertible arbitrage strategies include cash and carry, gamma trading (also called volatility trading), and credit trading (also called distressed convertible trading). Each of these strategies involves buying a convertible bond and simultaneously short selling the underlying stock. *Cash and carry* arbitrageurs can use leverage to enhance returns, but leverage is not necessary to perform the strategy. Cash and carry profits from the convertible bond's yield advantage, and in cases when short-term interest rates rise, the investor can obtain incremental interest income from the capital earned from shorting the stock (Long 2012). *Gamma trading* involves selling (buying) more shares when the stock rises (falls) to maintain a dynamic delta hedge, and this strategy profits when the underlying share price is volatile (Dinsmore et al. 2016). A *credit trading strategy* is very similar to cash and carry, except it focuses on distressed securities. When expectations for an issuer's default are high, the seniority of convertible bonds is valuable and could be mispriced due to the market wariness of default. Investors in distressed convertibles essentially receive free or substantially undervalued conversion options (a result of the option being deep OTM), which would appreciate should the issuer recover from financial duress (Howard and O'Connor 2001).

Like other relative value strategies, the term arbitrage is a misnomer because these strategies, while market-neutral, are not riskless. Convertible arbitrage is not truly riskless, as imperfect capital markets expose investors to risk even in circumstances when the investor is entirely hedged. For instance, following Lehman Brothers' bankruptcy and the financial crisis of 2007–2008, credit spreads remained wide, reducing convertible arbitrageurs' ability to close positions, and prohibitions on short sales in select markets and industries precluded the strategy altogether (Dinsmore et al. 2016).

Other Embedded Options

Although callable, puttable, and convertible bonds each introduce complexity into a straight bond's model, they are relatively simple compared to other structures that have evolved in the marketplace. Of course, the mere combination of one or more of these options into a single bond substantially increases the valuation complexity. Furthermore, bond issuers often offer debt securities with multiple clauses and embedded options, which investors must carefully analyze before making investment decisions. The sea of financial innovation in this area is too vast to discuss in this chapter. Additionally, the number of different exotic options available is considerably greater than the number of plain vanilla options, notwithstanding bespoke options created between counterparties. As such, this chapter only focuses on a few option-embedded bonds. Accordingly, this section describes extendable bonds, bonds with a combination of two or more options, and bonds with knock-in and knock-out structures.

Combinations of Embedded Options

Although put and call options are related, they are not mutually exclusive, and each option grants the holder different mutually exclusive rights. For example, a callable convertible bond can either be called by the issuer or converted by the investor but not both. Each of the previously discussed embedded options modifies the bond's payoff, and no reason exists that a bond cannot have multiple embedded options within it. In fact, numerous bond issues in the market today contain combinations of the aforementioned embedded options (e.g., put rights, call rights, conversion rights, extension rights, sinking fund clauses, and knock in/out clauses).

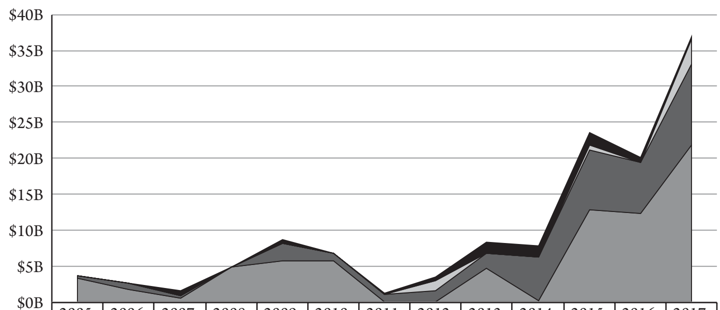
Extendable Bonds

An extendable bond contains an embedded option that lengthens the time to maturity of the bond either at the discretion of the bondholder or the bond issuer. For instance, a 10-year bond with a three-year extension option for the investor enables the bondholder effectively to convert the 10-year bond into a 13-year bond, if exercised. An extendable bond can be viewed as a portfolio of a short-term bond with a long call option on a longer-termed bond (Ananthanarayanan and Schwartz 1980). The structure of extendable bonds compares to a puttable bond that enables the option holder to demand early repayment of the bond's principal. Figure 16.8 shows extendable bonds issued by sector between 2005 and 2017, demonstrating the relative penchant financial firms have for extendable bond issues.

Knock-In and Knock-Out Structures

The imagination of financial engineers seems unbounded, and out of this imagination comes innovation in financial products offered in the market. Often, in combination with other embedded options, issuers include clauses in the bond prospectus that can affect the bond's characteristics. Knock-in and knock-out clauses that directly affect the coupons will be briefly discussed here.

An option's knock-in or knock-out feature refers to the triggering or extinguishing, respectively, of some characteristic or the entire option itself. These options are called *barrier options*, and they have been implicit in some of other embedded options examined in this chapter. For example, recall the contingent convertible, which was triggered, or knocked in, after some event occurred. Consider a bond with a combination of embedded callable, puttable, and conversion options. If the issuer wants to remove



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
All Other	$0.0	$0.0	$0.6	$0.0	$0.5	$0.0	$0.2	$0.6	$1.4	$1.5	$1.8	$0.7	$0.4
Tech, Media, Telecom	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$1.4	$0.0	$0.0	$0.7	$0.0	$3.5
Consumer & Industrials	$0.4	$0.9	$0.3	$0.0	$2.4	$1.2	$1.1	$1.6	$2.1	$6.1	$8.4	$7.1	$11.3
Financials	$3.3	$1.8	$0.6	$4.9	$5.8	$5.7	$0.0	$0.0	$4.8	$0.2	$12.8	$12.3	$21.8

Figure 16.8 Extendible Bond Issuance by Sector, between 2005 and 2017

This figure provides a time series of issuance of extendible bonds, grouped by the sector of the issuer. These data show that offerings of extendibles peaked in 2015. Moreover, throughout the profiled time, issuers in the financial sector accounted for 82 percent of all issuance in 2017.

Source: Bloomberg (2018).

the investor's put option if the underlying shares trade above some threshold, it could employ a knock-out put. Knock-in options can be further subdivided into up-and-in and down-and-in options, and analogously knock-out options can be classified as up-and-out and down-and-out options. At any period within the option's life, up-and-in (down-and-in) options become exercisable after the underlying trades above (below) some pre-defined threshold for the first time. If the underlying never reaches the barrier, these options are never knocked-in, which means they cannot be exercised. Up-and-out (down-and-out) options become exercisable at any period once the underlying trades above (below) the pre-specified barrier. These knock-out options expire worthless if the barrier is breached, regardless of how the underlying trades afterward. For instance, an investor who owns and up-and-in call option with a barrier of $20 may exercise the option if the underlying trades above $20 at some point during the option's life. The barrier should not be confused with the strike price. The barrier is simply a price level that permits (for knock-in options) or precludes (for knock-out options) exercisability once the underlying trades above or below the boundary. The strike price, as mentioned previously, is the price at which the underlying can be bought or sold.

Summary and Conclusions

Bonds with embedded options provide issuers and investors alike with a host of benefits and potential drawbacks. Although the existence of options complicates analysis, it does not preclude analysis. Although the embedded option cannot be stripped from and traded separately from its bond, the value of the financial instrument is the sum of the value of the bond and all embedded options. Hence, bonds with embedded options alter the risk-return profile relative to straight bonds.

This chapter examines both the theoretical and practical issues that arise in the markets for bonds with embedded options. Callable, puttable, and convertible bonds are the most common traditional forms of bonds with embedded options. A callable bond allows an issuer to retire the bond before maturity, while a puttable bond gives that right to the investor. Convertible bonds involve exchanging the bond for shares of the issuer, acting as a hybrid of debt and equity securities before conversion. In 2016, the global market for convertible bonds included $77 billion in par value and an implied equity market capitalization of $207 billion, under the assumption that the bonds are converted into equity.

Issuers choose to raise capital with embedded options for numerous reasons. A company may issue a callable bond to maintain flexibility of debt capital in the event interest rates decline. Issuers could offer puttable bonds to entice investors to lend their capital. Firms may issue convertibles for different reasons. Frequently, smaller issuers cannot access the traditional capital markets on favorable terms. Other issuers may believe their shares are undervalued, and convertibles enable them to raise equity capital at a premium to the current trading price (which implies that often convertible bonds are undervalued to their true theoretical value).

Because call and put options are not mutually exclusive, some issues even contain multiple options. Of course, even callable, puttable, and convertible bonds are not homogenous within each category. Just as several types of callable bonds exist, such as a sinking fund call or an extraordinary redemption call, several types of puttable and convertible bonds are also available.

Overall, investors must be aware of what the prospectus terms indicate, as embedded options are frequently inserted in corporate bond offerings. Even the insertion of one embedded option can markedly alter the security's risk-reward profile relative to a straight bond.

Discussion Questions

1. Compare and contrast callable and puttable bonds.
2. Discuss the advantages and disadvantages of convertible bonds to investors.
3. Describe negative convexity and its impact on callable bonds.
4. Discuss why convertible bonds are considered hybrids of debt and equity.
5. Discuss two examples of more complex embedded options than traditional callable, puttable, and convertible bonds.

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17

Bond Mutual Funds, Closed-End Bond Funds, and Exchange-Traded Funds

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Introduction

The Securities and Exchange Commission (SEC) regulates four types of U.S. registered investment companies: open-end investment companies (mutual funds), closed-end investment companies (CEFs), exchange-traded funds (ETFs), and unit investment trusts (UITs). According to Investment Company Institute (2017), these companies managed almost $20 trillion at the end of 2016, a sharp increase from $7 trillion in 2001. Mutual funds constitute about 85 percent of this amount, but a notable decline from 96 percent in 2001, followed by ETFs with 13 percent which represents a dramatic increase from just 1 percent in 2001. Most U.S. mutual fund and ETF assets are in long-term funds, with equity funds constituting 56 percent of this amount. Bond funds hold 22 percent of U.S. mutual fund and ETF assets while money market funds, hybrid funds, and other funds hold 22 percent. The number of funds also increased for mutual funds, CEFs, and ETFs and declined sharply for UITs during the same period. A notable increase observed in ETFs from 29 in 1998 to 1,716 in 2016 while UITs declined from 10,966 to 5,103 during the same period.

Fixed-income investments can help investors to reach their goals through receiving dependable income, preserving principal, and minimizing taxes. Other benefits include the ability to smooth out the volatility of equity prices as stock and bond prices are not perfectly correlated, to preserve capital as principal, which is usually returned at a predetermined maturity date, and to enjoy preferential tax treatments when coupon payments are exempt from taxes. The demand for fixed-income products increases as the U.S. population ages. Investors can gain exposure to fixed-income in many ways besides creating a bond portfolio including open-end bond mutual funds, closed-end bond mutual funds, and ETFs. Table 17.1 reports the net total assets under management (AUM) by each investment company type between 1998 and 2016.

Table 17.1 **Investment Company Types**

Panel A. Net assets

	Mutual Funds (Billions of $)	*Closed-end Funds (Billions of $)*	*ETFs (Billions of $)*	*UITs (Billions of $)*	*Total (Billions of $)*
1998	5,525	156	16	94	5,790
2000	6,965	143	66	74	7,247
2002	6,383	159	102	36	6,680
2004	8,096	253	228	37	8,614
2006	10,398	297	423	50	11,168
2008	9,621	184	531	29	10,365
2009	11,113	223	777	38	12,151
2010	11,834	238	992	51	13,114
2011	11,633	242	1,048	60	12,983
2012	13,054	264	1,337	72	14,727
2013	15,049	279	1,675	87	17,090
2014	15,873	289	1,975	101	18,238
2015	15,650	261	2,101	94	18,106
2016	16,344	262	2,524	85	19,215
CAGR	5.9%	2.8%	30.5%	–0.5%	6.5%

Panel B. Proportion of net assets by each type

	Mutual Funds (%)	*Closed-end Funds (%)*	*ETFs (%)*	*UITs (%)*	*Total (%)*
1998	95.4	2.7	0.3	1.6	100.0
2000	96.1	2.0	0.9	1.0	100.0
2002	95.6	2.4	1.5	0.5	100.0
2004	94.0	2.9	2.6	0.4	100.0
2006	93.1	2.7	3.8	0.4	100.0
2008	92.8	1.8	5.1	0.3	100.0
2009	91.5	1.8	6.4	0.3	100.0
2010	90.2	1.8	7.6	0.4	100.0
2011	89.6	1.9	8.1	0.5	100.0
2012	88.6	1.8	9.1	0.5	100.0
2013	88.1	1.6	9.8	0.5	100.0
2014	87.0	1.6	10.8	0.6	100.0
2015	86.4	1.4	11.6	0.5	100.0
2016	85.1	1.4	13.1	0.4	100.0

This table reports the net total assets under management (in billions of dollars) and the proportion of net assets by each investment company type.

Source: Authors' calculations using data from Investment Company Institute (2017). CAGR is the compounded annual growth rate.

Most funds are open-end funds. With an open-end structure, the fund stands ready to sell new shares to buyers and redeem shares from sellers. When an investor buys open-end fund shares, the fund issues them and then invests the money received. When someone sells open-end fund shares, the fund sells some of its assets and uses the cash to redeem the shares. As a result, the number shares outstanding changes over time. Conversely, with a CEF, the number of shares is fixed. CEFs have an initial public offering of shares and rarely offer new shares. Investors wanting to buy shares must buy them from other investors. Likewise, investors wanting to sell shares must sell them to other investors. Shares of CEFs are traded on the open market at prices that may differ from their net asset values (NAVs). An *ETF* is a pooled investment vehicle with shares that investors can buy and sell intraday on a stock exchange at a market-determined price. Investors can trade ETF shares through a broker or in a brokerage account. Table 17.2 reports the number of funds in each investment company type.

The purpose of this chapter is to examine bond mutual funds, closed-end bond funds, and ETFs. Each section provides an overview of the unique characteristics of various segments of the bond mutual funds, bond CEFs, and ETFs, respectively. Each segment also discusses the market performance evaluation of each group of funds along with the empirical findings. The final section offers some concluding remarks.

Table 17.2 **Number of Investment Companies by Type**

	Mutual Funds	*Closed-end Funds*	*ETFs*	*UITs*	*Total*
1998	7,489	491	29	10,966	18,975
2000	8,370	481	80	10,072	19,003
2002	8,511	543	113	8,303	17,470
2004	8,417	618	152	6,499	15,686
2006	8,721	645	359	5,907	15,632
2008	8,879	642	728	5,984	16,233
2009	8,611	627	797	6,049	16,084
2010	8,535	624	923	5,971	16,053
2011	8,673	632	1,135	6,043	16,483
2012	8,744	602	1,195	5,787	16,328
2013	8,972	599	1,295	5,552	16,418
2014	9,258	568	1,412	5,381	16,619
2015	9,517	558	1,595	5,188	16,858
2016	9,511	530	1,716	5,103	16,860

This table reports the number of funds in each investment company type.

Source: Investment Company Institute (2017).

Bond Mutual Funds

This section provides background information about bond mutual funds that experienced consistent growth between 1998 and 2016. The empirical studies measuring the performance of mutual funds are diverse and include some early U.S. studies (Blake, Elton, and Gruber 1993; Moneta 2015), high yield studies (Blume, Keim, and Patel 1991; Cornell and Green, 1991; Philpot 2000), timing ability studies (Chen, Ferson, and Peters 2010; Cici and Gibson 2012) and international studies (Gallo, Lockwood, and Swanson 1997; Polwitoon and Tawatnuntachai 2006, 2008) among others.

Background

According to Investment Company Institute (2017), the U.S. mutual fund industry remained the largest in the world at year-end 2016 with $16.3 trillion in assets. Investor demand for mutual funds, however, continued to decline with net redemptions of $229 billion in 2016, primarily driven by the shift to index-based products. Panel A of Table 17.1 reports that the net assets of mutual funds have continuously increased between 2011 and 2016 In contrast, the proportion of mutual funds based on total net assets has declined steadily, from 96.1 percent in 2000 to 85.1 percent in 2016 (Table 17.1 Panel B). Overall, although the mutual fund segment experienced a compounded annual growth of 5.9 percent between 1998 and 2016, it is currently a smaller part of an increasing market. Although the broad increases in U.S. and international stock markets contributed to the increase in net assets of mutual funds, the composition of funds has changed because of changes in the fund flows to these asset types. Demand for bond mutual funds continues to increase in part because of the aging of the U.S. population. Bond funds constitute 22 percent of U.S. mutual funds. For example, Figure 17.1 shows

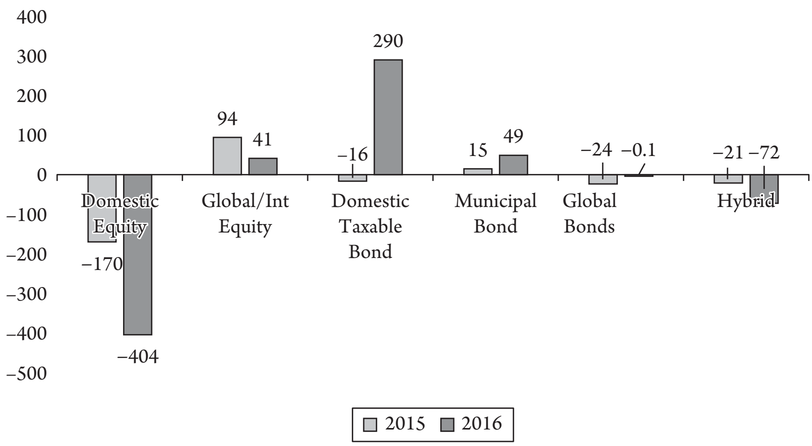

Figure 17.1 Net Issuance of Mutual Fund Shares by Investment Classification
This figure reports the net issuance of bond mutual fund shares (in billions of dollars) in each investment classification between 2015 and 2016.
Source: Author calculations using data from Investment Company Institute (2017).

an outflow of $575 billion from domestic equity funds and inflow of $340 billion to domestic bond funds during 2015 and 2016.

Bond Mutual Funds Performance

Various studies investigate the performance of bond mutual funds in domestic and global settings. The general conclusion is that bond funds do not outperform passive benchmarks.

U.S. Studies

Among earlier studies, Blake et al. (1993) represent the first major analysis of bond mutual funds. The study finds that bond mutual funds, including all subcategories, underperform relative to their indexes. The magnitude of underperformance is approximately equal to the average management fees, indicating pre-expense performance of these funds is comparable with their indexes. In a more recent study, Moneta (2015) finds that active bond fund managers exhibit outperformance before costs and fees generating about 1 percent gross returns per year relative to the benchmark portfolios, exceeding their fees and costs.

Pricing and performance of low-grade bond funds received early attention from researchers. Cornell and Green (1991) investigate the performance of low-grade bond funds between 1960 and 1989. Their findings show that over the long run, low-grade bond fund returns are comparable to the returns provided by an index of high-grade bonds. As a result, the authors maintain that the relative risks of high and low-grade bonds are more difficult to assess. Because of their shorter durations, low-grade bonds are less sensitive to movements in interest rates than high-grade bonds. Using data between 1977 and 1989, Blume et al. (1991) find that low-grade bonds have higher returns than higher-grade bonds but lower returns than common stocks. Furthermore, they document that low-grade bonds exhibit less volatility than higher-grade bonds due to their embedded call features and high coupons. Finally, the authors find no evidence of systematic under- or over-pricing in the low-grade bond market.

In a similar vein of study, Philpot (2000) examines a sample of 73 nonconventional funds, including high-yield bonds, global issue, and convertible bonds between 1988 and 1997. The author finds that short-term performance persistence is present but limited to the high-yield bond subsample. Philpot also finds that management change has no impact on performance persistence and risk-adjusted performance is inversely related to portfolio turnover among high-yield bond funds.

Lipton and Kish (2010) compare high-yield bond mutual funds with non-high-yield bond mutual funds between January 1999 and December 2008. Using a sample of 82 high-yield bond funds, the authors find that high-yield bonds exhibit lower mean returns and increased volatility when compared with other bond segments.

The relation between fund performance and fund attributes (Philpot, Hearth, Rimbey, and Schulman 1988; Peterson, Pietranico, Riepe, and Vroom 2000; Redman and Gullett 2007) as well as persistence and predictability (Droms and Walker 2006; Huij and Derwal 2008) have been at the center of research for bond funds. Among earlier studies, Philpot et al. show that past performance of fund returns fails to predict future fund performance and bond managers underperform fund benchmarks. Peterson et al. evaluate the effectiveness of various bond attributes to explain subsequent returns on domestic bond mutual funds using data between 1992 and 1999. Their findings show that standard deviation, average maturity, credit quality, past performance, and expense ratios explain most of the variation in subsequent returns. They further find that estimated premiums associated with past performance and expenses are more stable and, hence, may be used to improve the performances of their bond portfolios by investing in funds with good past performance and low expense ratios.

Droms and Walker (2006) analyze bond mutual fund performance persistence for government and corporate bond funds. Using a sample of 797 corporate and government fixed-income funds between 1990 and 1999, the authors report that these funds exhibit remarkable performance persistence. Persistence occurs when winner (loser) funds remain winner (loser) funds. The findings further show that intermediate-term (long-term) bond returns are higher than long-term (intermediate-term) bond returns for successive years. By contrast, if higher returns on intermediate (long) bonds are followed by a year of higher returns on long (intermediate) bonds, then persistence is negative.

Similarly, Redman and Gullett (2007) examine the factors that influence risk-adjusted returns for bond mutual funds using both taxable bond funds and municipal bond funds over two periods in the United States. The first period sample includes 332 taxable bond funds and 231 municipal funds between 1997 and 2000. For the second period between 2001 and 2003, the sample consists of 1,755 taxable funds and 1,100 municipal funds. Findings show that taxes, fund age, and operating expenses are important factors influencing the risk-adjusted returns for taxable bond funds. Portfolio concentration, fund expenses, and the average duration of the bonds in the portfolio, conversely, are important factors influencing municipal bond funds.

Huij and Derwall (2008) study whether active bond fund performance in the past persists in the future. Using a sample of 3,549 bond mutual funds between 1990 and 2003, the study finds strong evidence of performance persistence in bond funds. Specifically, the authors show that bond funds displaying strong (weak) performance over a past period continue their performance in the subsequent period with the difference in risk-adjusted return between the top and bottom decile of funds ranked on past alpha exceed 3.5 percentage points per year. Overall, the study reports that a strategy based on past fund returns earns an economically and statistically significant abnormal return, suggesting that bond fund investors, especially institutional investors, can exploit the observed persistence.

Trainor (2010) analyzes the risk-adjusted performance of 54 high-yield bond mutual funds between 1998 and 2007. The author also measures performance persistence over time and uses size, asset growth, asset duration, expense ratio, turnover, and manager tenure to explain the differences across funds. The findings show that high-yield bond funds significantly underperform the benchmark index by 1.6 percentage points on an annualized basis, which is 0.5 percent more than the average expense ratio. Furthermore, the author reports evidence of performance persistence as top-ranked funds in one period outperform bottom-ranked funds over the proceeding period.

Various studies also investigate the timing ability of fund managers and provide mixed evidence. For example, Chen, Ferson, and Peters (2010) contend that bond funds are more concave than their benchmarks. Hence, their different nonlinearities would appear as poor timing ability in naive models. Using 1,400 bond funds between 1962 and 2007, the authors show that after controlling for nonlinearity, timing ability becomes neutral to weakly positive. Overall, after controlling for nonlinearity, bond funds show significantly negative performance on an after-cost basis but significantly positive performance on a pre-cost basis. Similarly, Cici and Gibson (2012) examine how detailed security-level holdings are related to bond fund performance. Using a sample of 746 bond funds, the authors do not find consistent evidence of outperformance of bond funds. Instead, they find neutral to weakly positive evidence of the ability to time corporate bond characteristics. Overall, the results indicate that the costs of active management, on average, are higher than the benefits.

Conversely, Boney, Comer, and Kelly (2009) provide evidence of poor timing skills for managers of high-quality bond funds between 1994 and 2003. Specifically, they investigate the ability of bond fund managers to shift assets between bonds and cash and across bonds of different maturities to capture the changes in their relative returns. The authors find that the fund sample underperforms the benchmark index by 1.32 percentage points and only part of this amount of underperformance is attributed to expenses. Contrary to their expectations, they further find that funds demonstrate timing ability between cash and bonds and across bonds of various maturities.

Huang and Wang (2014) examine the market timing ability of government bond fund managers using their monthly or quarterly holdings of Treasury securities between 1997 and 2006. Overall, the findings show that government bond fund managers possess significant positive timing ability at the one-month horizon under an unconditional holdings-based timing measure. The authors also present evidence that government bond fund managers react to macroeconomic variables including both information exacted from bond yields and macroeconomic news announcements.

International Bond Mutual Fund Studies

A rich literature also provides evidence on the performance of international bond funds. Investing in bond mutual funds is a growing international phenomenon. Various studies investigate the performance of bond mutual funds of other countries. The findings do not provide consistent evidence on the performance of international bond funds. Among earlier studies, Gallo et al. (1997) analyze the monthly returns of 22 U.S.-based international bond mutual funds between 1988 and 1994. They report these funds perform better than the Salomon Brothers Non-U.S. Dollar World Government Bond Index. The authors find that portfolios consisting of all funds outperform the multi-index benchmark while five of the funds outperform the benchmark individually.

On the contrary, Detzler (1999) reports poor performance for global bond funds. After examining the risk and return characteristics of global bond mutual funds between 1988 and 1995, the author finds that these funds do not have superior performance, net of expenses, against a wide range of benchmarks and shows a negative relation between performance and fund expenses. Furthermore, Detzler reports that returns on global bond funds are sensitive to exchange rate movements, even after controlling for local currency returns on country bond indices. These results demonstrate the importance of exchange rate movements in a global portfolio, especially for non-U.S. bonds.

Some studies focus on certain regions or countries. Most of these studies report underperformance of bond funds relative to their benchmark. For example, Maag and Zimmerman (2000) examine German bond mutual fund performance. Using 40 bond funds between 1988 and 1996, the authors find that these funds significantly underperform relative to their benchmarks and display a negative correlation with the degree of active management. The expense ratio is also negatively related to the individual fund performance.

Silva, Cortez, and Armada (2003) use a sample of 638 bond funds from France (266), Germany (90), Italy (58), Portugal (22), Spain (157), and the United Kingdom (45) to evaluate the performance of European bond funds. The findings show that bond funds in France, Italy, Portugal, Spain, and the United Kingdom (gilt funds) exhibit negative performance but bond funds in Germany and the United Kingdom (corporate bond funds) show neutral performance. The authors observe slightly better performance when using the predetermined information variables, including term spread and real bond yield.

Ortiz, Sarto, and Vicente (2012) expand the current research on window dressing practice on strategic allocations by using a sample of 865 Spanish bond funds between June 1999 and December 2006. *Window dressing* involves replacing loser and riskier securities briefly with winner securities before reporting portfolio holdings. The findings show that bond managers hold less in public debt assets at disclosure dates. The authors also note that the decreasing trend experienced in public debt allocations during the entire sample period might influence this result.

Dritsakis, Grose, and Kalyvas (2006) investigate the performance characteristics of 27 Greek bond funds between 1997 and 2003. They further estimate the impact of fund flows on the performance of these funds. The authors report that these bonds, net of fees, do not offer risk-adjusted returns above the returns of the benchmark index. They further report that fund flows negatively affect market timing. This finding is consistent with Edelen (1999) who reports a negative relation between fund flows and performance because fund managers become engaged in liquidity-motivated trading in periods of increased inflows and thus ignore the market timing element.

Polwitoon and Tawatnuntachai (2006, 2008) provide evidence of outperformance by global bond funds relative to domestic bond funds. In their 2006 study, they investigate diversification benefits and performance persistence of 188 U.S.-based global bond funds between 1993 and 2004. Their findings show that global funds underperform broad-based benchmark indexes but outperform comparable risk-adjusted returns to domestic bond funds. For U.S. investors specializing in domestic bond funds, global funds can enhance return by 0.5 to 1 percentage point per year without increasing risk. Global funds also provide incremental diversification benefits to equity fund investors. The funds exhibit short-run performance persistence, which is difficult for investors to exploit especially in the long run. For example, the one-year ranking criteria can be used to predict subsequent year's winners and losers. Global funds show no return seasonality during the sample period. The authors suggest that investors should select larger funds with a long maturity and avoid older funds with a high-expense ratio.

Polwitoon and Tawatnuntachai (2008) analyze 50 emerging market bond funds between 1996 and 2005 and report that these funds outperform both domestic and global bonds funds. The authors contend that these bonds further provide international diversification benefits to both U.S. and international bond and equity portfolios. The findings further show that exchange rate risk does not explain the differences in portfolio performance. Both country-specific and liquidity risk explain a large portion of the variation in performances of these funds.

Finally, various bond fund studies involve convertible bond funds, money flows to bond funds, and the use of derivatives in bond funds. Domian and Reichenstein (2009) examine returns-based style analysis for a convertible bond index and 16 convertible bond funds between 1998 and 2007. The study results explicitly separate the index and bond funds into underlying exposures to high-grade bonds, stocks, and sometimes cash. Separating each fund's stock exposure into four asset classes—domestic small-cap value, small-cap growth, large-cap value, and large-cap growth—reveals that the convertible bond funds have strong tilts toward small-cap growth stocks.

Comer and Rodriguez (2013) analyze the investment style, performance, and cash flows of investment grade corporate and government bond funds between 1994 and 2009. The findings show that corporate funds have more exposure to cash and high-yield securities but government funds hold securities with much shorter average maturities. Using linear index models, the authors show significant differences in performance. The risk-adjusted performance of government bond funds is lower than that of corporate bond funds by an average of 31 to 74 basis points annually. Overall, the study concludes that distinct performance differences exist across classifications of bond funds.

Similarly, Chen and Qin (2017) examine money flows in corporate bond funds using a sample of 1,446 U.S. corporate bond funds between 1991 and 2014. The evidence shows that flows are sensitive to both fund performance, chasing recent fund performance, and macroeconomic conditions. Furthermore, the authors report that investor flows can predict fund performance and performance persistence explains the predictability. Funds experiencing net inflows subsequently outperform those with net outflows.

Adam and Guettler (2015) study the use of credit default swaps (CDSs) by the largest 100 U.S. corporate bond funds between 2004 and 2010. The results show that using CDSs increased from about 20 percent of funds in 2004 to more than 60 percent of funds in 2008 and stabilized at about 50 percent after the financial crisis of 2007–2008. The study observes a high turnover of CDS positions, suggesting that many fund managers use CDSs for market timing rather than for hedging strategies. The findings also show that when a fund uses complex trading strategies involving CDSs, team-managed funds outperform solo-managed funds during normal market conditions. According to the authors, this finding may result from the greater diversity of expertise, experience, and skill of teams relative to a single manager. Furthermore, team-based managed funds perform poorly during the financial crisis, possibly resulting from a less efficient decision-making process.

In a similar study, Natter, Rohleder, Schulte, and Wilkens (2017) analyze how investing in complex instruments such as derivatives, restricted securities, and securities lending influences bond fund performance. Their evidence shows that most complex investments do not affect fund performance or risk levels. However, using interest rate futures hurts the performance of bond funds. For example, bond funds engaging in interest rate futures significantly underperform nonusers.

Overall, the majority of bond fund studies provide evidence of underperformance of funds relative to benchmark index in domestic studies. By contrast, global bond funds studies provide mixed evidence of relative performance.

Closed-End Bond Funds

Although the number of CEFs has been relatively stable, the proportion of CEFs in terms of the total net AUM declined from 2.7 percent in 1998 to 1.4 percent in 2016. This section starts with background information about CEFs followed with the empirical studies on their performance. The literature mainly investigates the questions of why CEFs sell at premiums or discounts relative to their NAV. The proposed explanations include the expense ratio, tax treatments, volume patterns, and leverage, among others.

Background

Gabelli (2002) provides a history of the CEF industry. The first CEFs were British investment trusts formed in the 1860s to provide capital for the construction of U.S. railroads. Their primary investment objective was income rather than capital gains and these CEFs were usually leveraged with bank loans or bond issuances. During the stock market boom in the 1920s, CEFs became a widely popular investment vehicle for small investors reaching about 700 CEFs with assets totaling $4.5 billion by 1929. The stock market crash of 1929 wiped out many highly leveraged CEFs.

Closed-end bond funds are an important investment vehicle. According to Investment Company Institute (2017), CEFs had $262 billion net AUM, representing an increase from $156 billion in 1998. The proportion of CEFs in terms of total net assets in the industry, conversely, has been declining steadily, from a high of 2.9 percent in 2004 to 1.4 percent in 2016. As Table 17.2 reports, the number of funds has also declined from the high of 645 in 2006 to 530 in 2016. Overall, CEFs experienced a moderate compounded growth rate of 2.8 percent annually between 1998 and 2016.

An analysis of the net issuance of CEFs in Figure 17.2 between 2014 and 2016 shows a shift in the composition of investments. For example, the domestic equity component experiences a sharp decline in fund flows while domestic bond funds and municipal bond funds exhibit noticeable increases in fund flows. This finding may result from an increase in demand for bond mutual funds as the U.S. population ages.

Closed-End Bond Funds Performance

Despite the efforts of many studies, the valuation of closed-end investment companies remains an attractive research area. Most of this literature focuses on why shares of CEFs trade at prices that are at premiums or discounts relative to their NAV. Studies cite multiple factors as reasons for market prices varying from NAV including fund performance and expenses, leverage, tax liabilities embedded in NAVs, and investor sentiment. Among

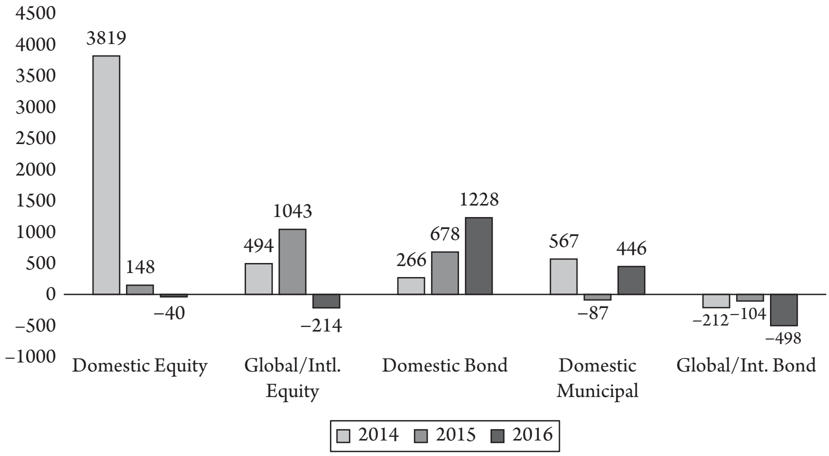

Figure 17.2 Net Issuance of CEF Shares by Investment Classification
This figure reports the net issuance of CEF shares (in millions of dollars) in each investment classification between 2014 and 2016.
Source: Authors' calculations using data from Investment Company Institute (2017).

the early studies, Abraham and Elan (1993) examine the investor sentiment hypothesis using the comparative performance of bond and stock CEFs. The findings indicate that discounts and premiums on closed-end bond funds exhibit the same sensitivity to broad market returns as stock fund discounts, contradicting the view that systematic risk from noise traders drives discounts. The authors further contend that investor sentiments cannot fully explain the CEF discounts. A similar analysis by Noronha and Rubin (1995) shows that investor sentiment, fund performance, agency issues, and the benefits of professional management are important in explaining the price deviation.

Malhotra, Martin, and McLeod (2003) investigate the expense ratios of closed-end bond funds and bond mutual funds. The analysis shows that open-end funds (mutual funds) have significantly lower expense ratios relative to CEFs. For example, in funds with less than $300 million of assets, both the average expense ratio and an average asset-weighted expense ratio of open-end funds are significantly lower than those of CEFs. The difference disappears for larger funds.

Some studies relate the marginal tax rates to fund performance. Among them, Blazenko, Poitras, and Chung (2004) study U.S. based closed-end bond funds to test the impact of marginal tax rates of long-term investors and dividend recapture activities of securities dealers and other short-term traders on ex-dividend date abnormal returns. The sample includes 307 funds between January 1988 and December 2000. The results show that both the tax clientele and short-term trading hypotheses play a part in explaining ex-date pricing behavior for the full sample of closed-end bond funds.

Starks, Yong, and Zheng (2006) examine turn-of-the-year return and volume patterns for 168 closed-end municipal bond funds to document the January effect for these funds. The authors pose that this effect can be largely explained by tax-loss selling activities at the previous year-end because dividends on municipal bond CEFs are tax-exempt, but price changes are not so that drive changes alone should drive tax-loss selling behavior. They further report that funds associated with brokerage firms display more tax-loss selling behavior, suggesting that tax counseling plays a role.

Leverage and liquidity explanations have attracted the attention of researchers to explain CEFs bond fund performance. Martin and Malhotra (2009) investigate the impact of leverage on the performance of CEFs by using the Sharpe, Treynor, and Jensen measures of portfolio performance. The authors note that closed-end bond and equity funds often leverage their assets by borrowing during low-interest rate environments and reinvesting in securities that pay higher rates, thereby enhancing returns. Using the Morningstar database, the findings show that closed-end bond funds usually do not benefit from leverage. Boyle and Szaura (2015) examine the role of leverage in closed-end bond funds and find that the debt involves little credit risk.

Elton, Gruber, Blake, and Shachar (2013) investigate why closed-end bond funds exist alongside open-end funds. Using a matched sample of closed- and open-end funds in which policy, manager, and fund family are held constant, the authors find no evidence of risk or liquidity differences in the assets held or the return earned on the assets. However, they show that almost all closed-end bond funds borrow, while open-end funds do not. The authors further show that borrowing using preferred stock is tax advantaged and leads to advantageous borrowing rates for all CEFs and leverage increases NAV returns and returns to stockholders, but it also increases the variability of return.

Anderson, Beard, Kim, and Stern (2016) analyze the short-run relation between CEF prices and their NAVs. The authors note systematic differences between the short-run pricing behaviors for stock and bonds funds. For equity funds, returns processes for both prices and asset values have characteristics of a random walk, while bond funds returns are more predictable. They also note the existence of stronger news and volatility spillover effects between the fund price and the NAV for bond funds than for stock funds. Finally, the authors find significantly weaker dynamic conditional correlations between the fund price and its fundamental value for bond funds after the Lehman Brothers failure but they find no such evidence for stock funds.

Exchange-Traded Funds

ETFs have experienced the largest growth both in terms of the number of funds and the share of the net assets between 1998 and 2016. The empirical studies measuring the performance of ETFs are relatively recent and the factors influencing the fund performance include the impact of tax and operational efficiency of funds, liquidity, cash flows, among others.

Background

The ETF market has experienced tremendous growth since 2006. An ETF is a pooled investment vehicle with shares that investors can buy and sell throughout the day on a stock exchange at a market-determined price. Investors may buy or sell ETF shares through a broker or in a brokerage account just as they would the shares of any publicly traded company. In 1993, the first ETF approved by SEC was the spider (SPDR), which stands for Standard & Poor's Depository Receipts. This ETF is a broad-based domestic equity fund tracking the S&P 500 index. In fact, the SEC only approved ETFs that tracked specified indexes until 2008. These ETFs referred to as index-based ETFs, are designed to track the performance of their designated indexes or, in some cases, a multiple (or a multiple of an inverse) of their indexes.

The first bond ETFs emerged in 2002. Panels A and B of Table 17.1 illustrate the tremendous growth of ETFs. The NAV under management increased from $16 billion in 1998 to more than $2.5 trillion in 2016. This increase represents a compounded annual growth of 30.5 percent during this period. The share of ETFs relative to the total net assets in the industry increased from 0.3 percent in 1998 to 13.1 percent in 2016. Table 17.2 reports the number of ETFs that increased from 29 in 1998 to 1,716 in 2016. The net issuance of ETF shares shown in Figure 17.3 demonstrates that bond ETFs have experienced continued net inflows between 2014 and 2016 totaling $194 billion unlike the other investment sub-classifications during the same period. The rapid growth in the bond ETF market can be attributed to the lack of transparency and liquidity in the over-the-counter (OTC) bond market. Unlike stock ETFs, where the underlying assets trade regularly throughout the day, the underlying bonds associated with many bond ETFs trade infrequently; in some cases, days (or weeks) can elapse between trades. This situation makes trading bond ETFs particularly attractive as they provide liquidity to an asset that, for many types of bonds, can be quite illiquid.

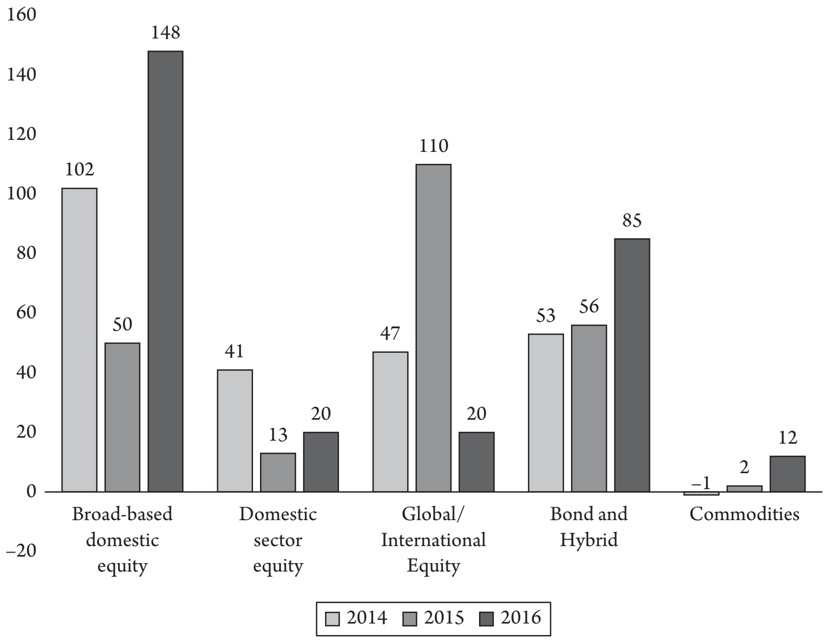

Figure 17.3 Net Issuance of ETF Shares by Investment Classification
This figure reports the net issuance of ETF shares (in billions of dollars) in each investment classification between 2014 and 2016.
Source: Authors' calculations using data from Investment Company Institute (2017).

A sponsor typically creates an ETF to track the performance of a specific index. For example, State Street Global Advisor created the first ETF (SPDR S&P 500 ETF) to track the performance of the S&P 500 index. In the process of ETF creation and redemption, the authorized participant (AP) plays the intermediation role between the ETF sponsor and the stock exchange. An AP is typically a large financial institution that enters into a legal contract with an ETF distributor to create and redeem shares of the fund. During the ETF creation, the AP assembles the basket of securities tracking an index for the sponsor for a specified number of ETF shares. The AP can then sell all or part of the ETF shares to investors on the stock exchange. The ETF redemption follows the reverse process. The AP purchases the ETF shares from the sellers on the stock exchange, returns the ETF shares to the sponsor for the underlying securities, and then puts the securities back into the secondary market. The creation and redemption process ensure that the price of ETF shares on the secondary market tracks closely to the NAV of the underlying securities. Otherwise, the AP can arbitrage away the mispricing by effectively changing the supply of ETF shares on the secondary market.

Exchange-Traded Funds Performance

Although ETFs are relatively new innovative products, most of the literature focuses on the performance of ETFs relative to the underlying index. Tax and operational efficiency of funds, bid-ask spread, same family funds, liquidity, cash flows, and seasonality in ETFs are also investigated. Among the first group of ETF research, Elton, Gruber, Comer, and Li (2002) examine the performance of an ETF relative to the underlying index. They study the characteristics and performance of the SPDR and find that its market price is kept close to its NAV by its ability to create and delete shares via in-kind transactions, which include exchanging ETF shares for a basket of securities, rather than cash. The authors find that the SPDR underperforms the S&P 500 index and low-cost index funds primarily due to the lost income caused by holding dividends received on the underlying shares in cash.

Aber, Dan, and Luc (2009) study the price volatility and tracking ability of four iShares ETFs from their inceptions to December 2006. The authors use the premium and discount position, daily return, and tracking error, compared with conventional index mutual funds tracking the same index. Their findings show that that the ETFs are more likely to trade at a premium than at a discount with persistence overvaluation, with comparatively large daily price fluctuations. Both fund types have about the same degree of co-movement with their benchmarks but differ slightly in their tracking ability.

Svetina (2010) analyzes 584 ETFs from their inception to year-end 2007. The findings show that almost 83 percent of all ETFs track indices that have no corresponding index funds, expanding the passive investment opportunity set for investors. On average, ETFs underperform their benchmark indices and are not immune to tracking error. ETFs that compete directly with index funds deliver slightly better performance when compared to retail index funds. The creation of new competing ETFs reduces both the flows for incumbent index funds and the market share of incumbent ETFs in the same investment style.

Agapova (2011) investigates whether conventional index mutual funds and ETFs are substitutes using the aggregate cash flows to both groups of funds. The author reports that conventional funds and ETFs are close but not perfect substitutes. Evidence suggests that the coexistence of both instruments can be explained by a clientele effect that segregates the two vehicles into different market niches.

Sharifzadeh and Hojat (2012) use a sample of 230 paired matches of ETFs and passive index mutual funds for various styles with inception dates before 2002 to compare their performances. The authors conduct the test both within each style and for all the styles combined. Of the 12 styles included in the sample, the authors conclude that ETFs outperformed index funds for five styles; for three of the styles (U.S. Broad market, U.S. large-cap growth, and U.S. REITs index funds) outperformed ETFs; and for four styles, no statistically significant difference exists between ETFs and index fund performances. The authors report no significant difference between ETFs and passive index mutual fund performances at the fund level and that investors' choice between the two is related to product characteristics and tax advantages.

Another related topic is the impact of tax and operational efficiencies on the performance of ETFs. For example, Poterba and Shoven (2002) examine the perception of ETFs as tax-efficient alternatives by comparing the pre- and post-tax returns of the largest ETF—the SPDR—with the returns of the largest equity index fund—the Vanguard Index 500 Fund. The results suggest a high level of similarity between the pre- and post-tax returns of the two funds between 1994 and 2000. These findings also suggest that ETFs offer taxable investors a method of holding broad baskets of stocks that deliver returns comparable to those of low-cost index funds.

Guedj and Huang (2009) developed an equilibrium model to investigate whether an ETF is a more efficient indexing vehicle than a mutual fund by examining liquidity differences between ETFs and conventional index funds. The authors show that conventional funds are beneficial to risk-averse investors due to the partial insurance against future liquidity shocks embedded in the conventional index fund structure. They also find that the overall transaction costs to all investors are the same in conventional funds and ETFs, but the allocation of the costs differs, concluding that investors with similar liquidity needs should be indifferent between the two fund types.

Gastineau (2004) investigates the performance of index ETFs relative to their respective benchmarks and conventional index funds by analyzing the operating efficiency of the funds. The author reports that conventional index funds outperform their benchmarks and similar index ETFs by eschewing the exact replication strategy. Gastineau further notes that a structural weakness in ETFs (non-reinvestment of dividends) partially explains their underperformance.

Researchers also investigate the performances of same-family ETFs and index funds. For example, Rompotis (2009) studied whether ETFs and index funds managed by the same investing family are treated in the same manner by using data from Vanguard ETFs and index funds. The results indicate that both ETFs and index funds deliver returns and risks, which approximate the returns and risks of the benchmarks. The author also provides evidence on the slight underperformance of ETFs and index funds relative to their benchmarks. Furthermore, the average return and risk of ETFs are essentially equal to the relevant return and risk of index funds, indicating that Vanguard manages these alternative investing products in the same manner.

Similarly, Romero-Pérez and Rodriguez (2012) examine the substitutability or complementariness of index ETFs and index mutual funds that track the same index and are offered by the same fund family that the authors call side-by-side funds. Using a sample that includes 34 pairs of ETFs and mutual funds created by the same fund family and that track the same index between 2000 and 2008, they find that conventional index funds and index ETFs are complements. Finally, the authors conclude that ETFs provide an alternative investment vehicle to investors who want to split their money between two investments tracking the same index.

Studies also investigate international ETFs from various perspectives. For example, Rompotis (2010) examined the bid-ask spreads of the German actively and passively managed ETFs between 2001 and 2006. The findings show that passive ETFs have higher average spread than active ETFs. Furthermore, the passive and active ETFs have the same average daily returns but, surprisingly, passive ETFs are more volatile and have greater tracking error than active ETFs. The author also documents that the passive ETFs are more tradable and trade at a higher discount rate relative to active ETFs.

Sanchez and Peihwang (2010) study the bid-ask spread, the information component of the spread, and the holding period of 77 ETFs between April and June 2004. They find that broad-based ETFs exhibit lower spreads and the information component of the spread is lower for ETFs than stocks. However, the overall liquidity of ETFs is not better compared to their top holding stocks. The frequent trading of ETFs appears to agree with the suggestion of Poterba and Shoven (2002) that ETFs tailor to the needs of short-term traders.

Blitz, Huij, and Swinkels (2012) investigate the performance of European index mutual funds and ETFs listed in Europe that track the major stock market indexes. The evidence indicates considerable differences in performance between the funds and shows that the expense ratio is an important determinant of relative fund performance. The authors also document the index funds and ETFs underperform their benchmarks index and performance differences between passive funds tracking different benchmark indexes are unrelated to their expense ratios. The study concludes that the underperformance of passive funds that track the major stock market indexes may result from having relatively high taxes on dividends in these regions.

Drenovak, Urošević, and Jelic (2014) examine the tracking performance of 31 Eurozone sovereign debt exchange-traded index funds between 2007 and 2010. The authors assess the tracking performance by using four different tracking error models. Although the findings show that funds underperform their respective benchmarks, substantial variation exists among actively managed funds. The authors also document important changes in the tracking performance due to the changing characteristics of EU sovereign bonds since the start of the sovereign debt crisis.

Several studies also investigate why bond ETFs sell at a premium relative to NAV, whether seasonality in bond ETFs occurs, and whether the cash flows to funds affect fund performance. Fulkerson, Jordan, and Riley (2014) document and explain why bond ETFs sell, at least on average, at a premium to NAV using data from the CRSP mutual fund database for all bond ETFs between January 2007 and December 2011. The authors examine the relationship between premiums/discounts and some unique characteristics of bond ETFs and find that premiums/discounts are related to standard liquidity measures. Thus, the lack of liquidity in the underlying bond portfolio drives the premiums and discounts, which generally cannot be quickly eliminated by arbitrage activities of the authorized participants.

Agrrawal and Skaves (2015) extend the seasonality analysis to include 10 different ETFs across multiple asset classes between 2005 and 2014. The findings reveal mixed evidence of seasonal anomalies. First, the authors detect no significant evidence of the January effect. Second, the study finds that the months of December, March, and April generate higher total returns than January. An analysis of data anomalies for nonstock asset classes, including bonds, real estate, and gold and provides evidence of a robust Halloween effect in all ETFs.

Fulkerson, Jordan, and Travis (2015) investigate the characteristics that drive cash flows to and from bond ETFs. Their data include a sample of bond ETFs from the CRSP database between 2008 and 2013. The findings show evidence of return chasing in the net flows of Treasury Inflation-Protected Securities (TIPS), investment grade corporate, and international bond ETFs. Additionally, the authors find that flows are larger for funds with higher expense ratios but are inversely related to fund size. Net flows rise with increases in price/NAV, indicating larger premiums. Other findings include lightly shorted funds exhibiting both lower inflows and net flows and the exchange characteristics of an ETF greatly influencing its subsequent cash flow.

Summary and Conclusions

U.S. registered investment companies managed almost $20 trillion at the end of 2016. Among these companies, mutual funds, CEFs, and ETFs have increased their net AUM between 2011 and 2016. The composition of total net assets has also changed dramatically with both mutual funds and CEFs experiencing a decline while ETFs experiencing a sharp increase in its share. Furthermore, consistent fund flows to bond funds occur as demand for bond mutual funds continues to increase partly due to the aging of the U.S. population. Investors can gain exposure to fixed income in several ways including open-end bond mutual funds, closed-end bond mutual funds, and ETFs. Investors should understand the recent trends in the sector, performance of each fund group, and factors influencing their performance.

This chapter provides an overview of the academic literature in bond mutual funds, CEFs, and ETFs. Overall, academic research reveals mixed results involving the performance of these funds. Most studies compare fund groups with their benchmark index and report widespread underperformance. Several studies report little evidence of a difference in risk-adjusted returns favoring bond funds. However, other studies contend that these funds can be a valuable source of portfolio risk reduction. Some studies report a statistically significant cost associated with actively managed funds. Overall, the empirical research on fund performance is inconclusive given that different conclusions often result from using diverse methodologies or taking dissimilar perspectives.

Discussion Questions

1. Explain the difference between an open-end fund and a closed-end fund.
2. Explain the differences between a mutual fund and an ETF.
3. Identify the factors responsible for the growth of funds and net assets of ETFs between 1998 and 2016.
4. Compare the empirical evidence between studies involving international and U.S. bond mutual funds.

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18

Other Bond Products

Social Impact Bonds, Death Bonds, Catastrophe Bonds, Green Bonds, and Covered Bonds

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Introduction

The investing options for the bond investor have expanded considerably over time. The purpose of this chapter is to review some of the less common bond structures including recent developments in securitization of nontraditional assets and risk factors. This chapter discusses social impact bonds, death bonds, catastrophe bonds, green bonds, and covered bonds. It describes the cash flows, risk transfer, and tax treatment of each bond as well as their advantages and disadvantages. The chapter is intended to familiarize bond investors with newer bond products that do not fit the main stream characterization of traditional bonds. Many of the bonds discussed have little in common with traditional corporate bonds that have become the foundation for global financial markets.

Social Impact Bonds

A *social impact bond* (SIB) is a form of financing in which private individuals, foundations, corporations, or other similar investors provide funds to government organizations to address social challenges such as homelessness and youth recidivism (i.e., the tendency of a convicted criminal to reoffend) for the betterment of society. Once the investment is made and benefits are realized, the positive social outcome of the investment should provide cost savings to the government. Investors receive the original investment and a small profit. This unique financing creates a "win-win" situation in which investors profit and the government provides a social service that would not have been funded otherwise thereby generating cost savings for the government entity. This series of events creates a positive result for all parties—the government, investors, and society. The private organizations assume the risk of the government failing to use the funds prudently and thus failing to generate the cost saving to allow for the repayment of the initial investment.

Many consider SIBs as a new silver bullet to effect social changes by governments. Government budgets are often limited, and taxpayers may feel that the government should not pay for social programs that do not directly affect those contributing the tax dollars. SIBs have emerged as a potential solution to resolve these inherent conflicts and simultaneously fund these projects, without the taxpayer bearing the program's cost.

Examples of Social Impact Bonds

To illustrate the concept of a SIB, consider an organization providing financing for a new power plant. Suppose an older generation power plant serves a community, university, hospital, or other organization by generating electricity at a cost of $0.15 per kilowatt hour (kwhr). The same capacity power plant using state-of-the-art technology may generate electricity at a reduced rate of $0.10 per kwhr. A new plant will be a costly investment, perhaps more expensive than the entity can afford to pay directly or finance. Making this investment and selling electricity to the end user at $0.125 per kwhr benefits all parties. The end user saves $0.025 per kwhr on electricity costs and $0.025 per kwhr is available to repay the original investors. SIBs use the same concept but in a more abstract setting. The key to understanding the concept of a SIB is that if the financing is made available, a SIB benefits society and investors for their capital commitment. The power plant example would typically be financed through conventional municipal bond offerings. In contrast, SIBs are commonly used for widespread social programs that would not be financed through traditional means because cash flows are unavailable to repay investors.

Parties to a Transaction

The six major parties to the transaction are: (1) the intermediary, (2) investor(s), (3) independent assessor, (4) service provider(s), (5) government, and (6) community served. The needs of the community and the implicit responsibility of the government to provide support drive the process. The challenge is for the government to finance large social projects to address the community needs. Rather than raise taxes on an entire community to pay for a potentially narrow target or program, the government can issue SIBs in connection with the private sector. Private sector investors buy the bonds thereby providing the upfront financing. The government can then use the proceeds from the bond sale to make the societal investment and a small fee can be charged (if deemed appropriate) to those in the community (presumably a substantial number of citizens) who take advantage of the service.

The administrative parties involved are equally important. This group consists of the intermediary, service provider, and independent assessor. The intermediary is the organization that raises funds from investors and chooses the service providers to implement the intended project, manages payments to all involved parties and helps determine the objectives and how those objectives are measured (e.g., change in literacy rates).

The service provider receives the financing and disburses the funds to implement the intended objectives. The service provider is typically a nonprofit organization and may be one or more organizations working together to accomplish the intended goal. The service providers are directly responsible for the success or failure of the programs implemented. The providers are selected based on their experience and expertise in the field in which they operate to ensure the completion of bond goals. The service providers are the only parties to the transaction that have direct interaction with the community and thus are responsible for its success or failure. Therefore, they are the face of the project.

The independent assessor plays an audit role and represents a critical component in measuring a project's success or failure. The primary purpose of the independent assessor is to determine if the outcomes are met and if payment to investors should be made after determining the proper performance metric and measuring the outcome. Figure 18.1 summarizes the interactions among the parties of the SIB structure.

Advantages of Issuing Social Impact Bonds

An advantage of SIBs is that they can be targeted broadly to society or to the individuals who will use the improved service. For example, programs that result in fewer criminal acts of violence can reduce the cost burden on local police budgets and justice system expenses through decreased usage of tax dollars to police, prosecute, and imprison offenders of the law.

Another advantage of SIBs is that they can be issued without using tax dollars and in situations where conventional financing would be unavailable. SIBs are typically structured such that funds are invested upfront and the repayment of principal plus the potential profit is awarded after the execution of a social program with no intermediate cash flows. This structure is similar to zero-coupon bonds in which investors receive the entire cash flow at the end of the maturity period.

SIBs can also provide follow-up funding to successful programs. Although SIBs are typically associated with new concepts and unproven programs, they can be used to scale up existing programs that require additional funding. SIBs tend to facilitate innovation in the social services sector. By appealing to private investors who have a higher willingness to bear risk, SIBs can fund promising but unproven concepts that would otherwise not get the attention of government agencies.

Challenges of Social Impact Bonds

Although SIBs have great potential, these multi-party, cross-sector financial investments are complicated. Not surprisingly, the structure has its own challenges. A critical concern is how to determine the payback to the investors and measure the effectiveness for

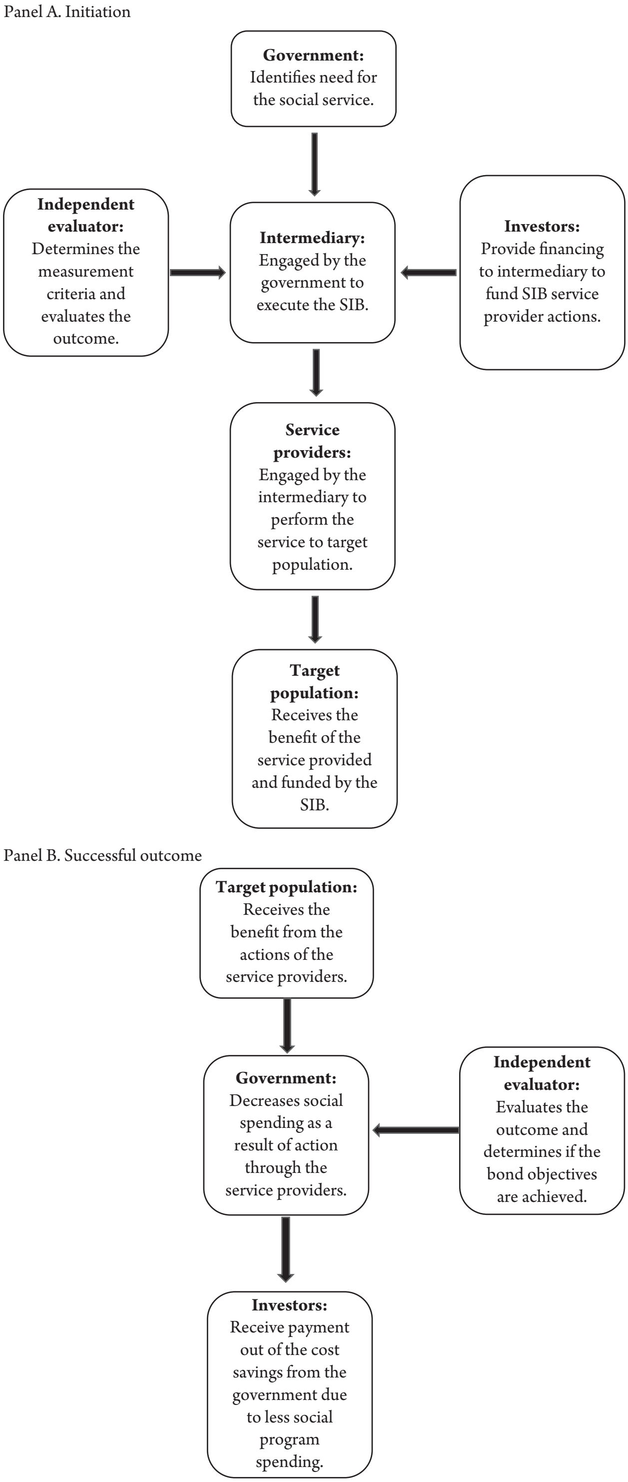

Figure 18.1 Continued

Panel C. Unsuccessful outcome

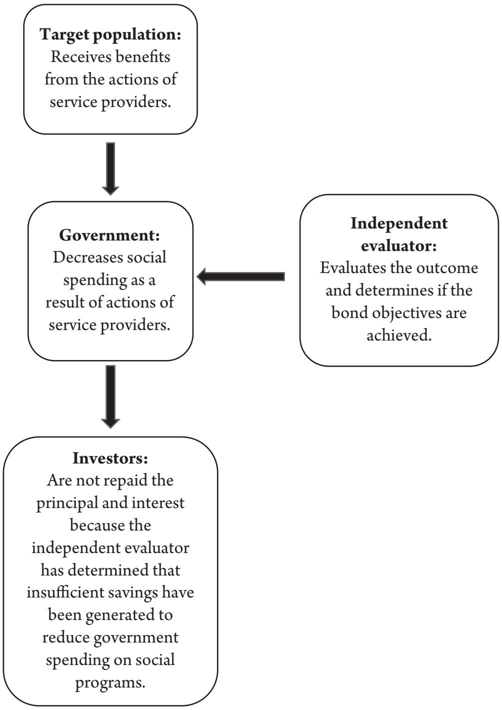

Figure 18.1 Social Impact Bond
This figure shows the typical structure of a social impact bond.
Panel A. Initiation
Source: Adapted from Liang, Mansberger, and Spieler (2014)
Panel B. Successful outcome
Source: Adapted from Liang et al. (2014).
Panel C. Unsuccessful outcome
Source: Adapted from Liang et al. (2014).

society. The payback to investors is some function of the realized savings to the government. This criterion can be difficult to quantify, considering the many factors that affect the budgets of local, state, and federal governments. Poor financial management and implementation can make generating the payments to investors difficult. This situation could potentially create a conflict with the community members whose tax dollars must fund the payments to the investors. For this reason, using an intermediary and independent assessor is instrumental to determining the bond's success.

Additional challenges that can arise with SIBs are selectively choosing both projects and result providers, which could positively skew the outcome. If only projects with easily predictable outcomes are selected for financing, then SIBs are likely to succeed. However, the underlying nature of the social issues associated with these bonds makes determining success or failure difficult. The projects need to target a wide ranging and diverse population. For example, consider a program to reduce criminal recidivism. Any prisoners that fit a criterion for service should be included or selected from a random sample of the relevant population. Screening criminals for compatibility with the program would bias the results upward.

Another challenge of SIBs are their implementation costs. This challenge stems partly from the difficulty in determining the measurable outcome and the involvement of multiple independent agencies to procure the financings. Although using conventional financing methods could potentially avoid the burden of such expensive administrators, such financing does not transfer the risk of the project's success to the investors. In a conventional financing, the government entity is required to repay despite whether the project succeeds or fails. The ability to repay only in the event of a successful outcome requires the administrative personnel to supervise the project's execution, determine success, and decide whether the conditions for repayment are fulfilled.

Another challenge of social projects and by association SIBs is the geographical proximity of the target audience. Despite advances in technology communication, administering a social program beyond the target audience can still be challenging. Social programs are targeted at specific groups of people. The ability to stay engaged in these people's lives and provide the services needed for a successful program outcome can be difficult beyond a certain geographical area. Further, the program's ability to succeed hinges on the participants' desire to remain engaged. Helping people that do not want to be helped is difficult, if not impossible.

The final challenge for social impact programs is a project's duration. Most social programs require a long time horizon to create the societal benefit that would merit the repayment to an investor. However, the longer the term, the greater is the repayment required. Currently, projects tend to be shorter term in nature. In the future, this situation may change if SIBs become more accepted as vehicles to affect social change and jump start social programs. Program length leads to a high liquidity risk for investors as most of the project durations are in the three- to 10-year time frame. Since an active secondary market is currently unavailable, exiting an investment in a SIB may be prohibitively expensive.

Social Impact Bonds versus Other Traditional Forms of Financing

Although market participants generally view SIBs as low risk investments, several factors are important to consider for investment purposes. First, the risk of loss for SIBs is higher than in traditional bond financings. With traditional bond financing, loaning funds involves some underlying collateral or recourse. If the borrower defaults or fails to meet payment obligations as described in the indenture, the lender can retain the collateral as compensation for not receiving payments of interest or principal. Market participants generally consider government bonds as low risk instruments due to the unlikely possibility of default. Since the government could tax its citizens and, in some cases, simply print currency, the possibility of default is low. Although many consider resorting to these measures as imprudent, the probability of a government default is relatively low compared to other borrowers.

Although SIBs are generally motivated by government entities, their potential for profit and return of principal are based strictly on the outcome of the social program enacted. This circumstance makes the associated payoffs similar to derivative investments in that their outcome is tied to a separate event and not the government's ability to repay their debt obligations (Liang, Mansberger, and Spieler 2014).

Origin of Social Impact Bonds

The original concept for a SIB is credited to the Council on Social Action, a United Kingdom think tank commissioned by Prime Minister Gordon Brown, with the goal of exploring funding solutions to the U.K.'s social dilemmas. The council concluded that large scale social programs can be successful and provide benefits for society but can also be expensive. Typically, the cost is more than a government can or is willing to fund on its own. The Council's solution was to spread the cost of funding these programs to private investors by issuing bonds to fund the projects. The repayment of the bonds is directly linked to the project's outcome to provide an incentive for all involved parties to provide oversight and minimize wasted funds. This arrangement reduces the burden placed on taxpayers for large social programs and shifts the burden of financing to private investors.

Tax Treatment

Although SIBs provide a societal benefit, they do not receive any preferential tax treatment (Mazur 2017). The underlying social causes for the bonds' funding do not fall under the guidelines of a qualified tax-free or tax advantaged investment. At the investor level, SIBs do not provide any preferential tax treatment. For the typical bond investment, three methods of favorable income tax treatment are available: (1) reduced rate of tax on the bond proceeds, (2) outright tax exemption, and (3) upfront deduction. Since no preferential tax treatment of the bonds exists, any investment profits from SIBs would be taxed as ordinary income. Because a SIB is classified as a bond, not equity, despite the possibility for investors to lose their capital contribution if the project is unsuccessful, this tax treatment may dissuade investors from buying SIBs.

To qualify for a tax exemption, no portion of the bond may benefit a private business, person, or other private organization. Numerous administrative requirements exist to the tax exemption. States or government entities issue most tax-exempt bonds to finance physical projects. Because their execution does create or improve physical property, SIBs do not qualify for a tax exemption.

Current tax laws also allow immediate deduction for any contribution to a charitable organization. SIBs do not fall into this category because the intention when investing in a SIB is to return the principal and earn a profit. Given that SIBs are issued for the betterment of society, providing no preferential tax treatment is unusual. Politicians should carefully consider preferential tax treatment for SIBs to incentivize future investment and spur the social benefit that can come from larger scale use of these instruments.

Examples of Social Impact Bonds

As SIBs have become more popular, the number of available bonds has increased. This section provides a discussion of some notable SIBs including prisoner rehabilitation and early child development and reviews both successful and unsuccessful bonds.

HMP Peterborough, Peterborough

In the United Kingdom, HM Prison Peterborough enacted the first SIB program. The program's intent was to provide counseling and social support to adult male offenders who had served sentences of less than 12 months. The program resulted in a reduction in re-incarceration by about 8.4 percent through August 2014 (Ganguly 2014).

The U.K. Ministry of Justice assumed overall responsibility for the program and instituting the SIB concept. The Ministry of Justice along with funding from the U.K. Big Lottery Fund were responsible for making payments to the investors if the project was successful. Although the payments would come from the Ministry of Justice, the ultimate cost savings would come from a reduced burden on the local law enforcement and court systems, which do not all necessarily fall under the Ministry of Justice.

The Big Lottery fund is a fund used for social causes that is funded with the purchase of lottery tickets in the United Kingdom. A portion of the proceeds collected from lottery ticket sales is allocated to the Big Lottery Fund and used to invest in societal improvement. Lottery winners receive the balance of the funds, less the costs needed to operate the agency. To illustrate the number of parties to implement the social aspects of the bond, the service providers and functions are listed below:

- St. Giles Trust. Provided case workers to deliver services.
- Sova. Provided unpaid volunteers to support members.
- Mind. Supported prisoners with mental health issues.
- Ormiston Families. Provided support to prisoners and their families to deal with mental issues.
- John Laing Training. Provided construction skill courses to prisoners to provide useful life skills.
- RAND Europe. Reviewed performance and determined if the desired outcome have been achieved.

The program operated in two phases or "cohorts." The first group consisted of 1,000 prisoners and ran from September 2010 to June 2012, with the post-release support ending in June 2013. The second group consisted of another 1,000 prisoners and ran from July 2012 to June 2014, with the post-release support ending in June 2015. The target for the program was a reduction in the re-incarceration rate by 7.5 percent average from both cohorts combined.

Rikers Island

The correctional facility at Rikers Island in New York City enacted a similar recidivism program. The Adolescent Behavioral Learning Experience (ABLE) program focused on adolescent inmates. This initiative was similar to the Peterborough prison in that it aimed to educate inmates in decision-making and reduce their re-incarceration rate. The program used Moral Recognition Therapy, a type of cognitive behavioral therapy, to educate the inmates about personal responsibility, education, training, and counseling. The program targeted about 3,000 inmates between 16 and 18 years old, a demographic that historically returned to jail within one year of release. The following discusses the program's structure (Cohen and Zelnick 2015):

- An 8.5 percent reduction would have triggered repayment of the initial investment in a lump sum.
- A 10 percent or greater reduction would generate profit between $500,000 and $2,000,000 depending on the recidivism rate.

The parties to the SIB were as follows:

- The City of New York organized the program.
- Goldman Sachs purchased the SIB lending the City of New York $7.2 million dollars.
- Bloomberg Philanthropies guaranteed the bond purchase/loan up to $6 million dollars.
- The Vera Institute of justice acted as the independent evaluator for the program.

In July 2015, the Vera institute concluded that implementing the program did not reduce the rate of recidivism. As a result, the program was terminated in August 2015. The Bloomberg Foundation had guaranteed much of the Goldman Sachs investment, so Goldman did not incur the maximum possible loss. The failure of the program, however, raises many questions about the effectiveness of SIBs such as: Why did this program fail? Who, if anyone, is specifically responsible for the failure? Were the programs effectively executed? Did a specific area of the social impact bond structure fail? Although this program failed, does this outcome provide direction about outcomes for future programs?

Pre-Kindergarten Education

In October 2014, The Goldman Sachs Social Impact Fund and Chicago Mayor Rahm Emanuel announced the launch of a $17 million SIB to fund pre-kindergarten education for 2,620 Chicago public school children (Goldman Sachs 2014).

In contrast to the ABLE SIB, the bond financing was successful. A report issued by SRI International, the independent evaluator, confirmed that 59 percent of the children who participated in the program had kindergarten readiness ratings that met or exceeded national averages at the start of the kindergarten school year. This result exceeded expectations.

Life Settlement Securitization (Death Bond)

A life settlement securitization or a "death bond" is a security composed of packaged life insurance settlements that are sold to investors. In the modern world of securitization, virtually any type of cash flow stream can be securitized, packaged, and sold to investors. In the traditional definition of securitization, risk can be transferred to investors who are willing to bear it and capital can be provided to those who desire it.

Origins and Future Growth Prospects

Death bonds can trace their roots back to viatical settlements, popular in the 1980s and early 1990s. Many AIDS patients sold their life insurance policies for upfront cash. As AIDS patients lived longer due to advances in treatment, the popularity of viatical settlements declined. The aging and eventual passing of the baby boomer population in the United States has led to a belief that the death bond market is poised for growth due to the aging of a large demographic. The aging of this population could provide for a large base of policies to fund death bonds (Thismatter 2007).

Composition of Life Securitization Settlements

A *life securitization settlement* is the combination or securitization of the cash flows from life insurance policies. The following section uses a simplified example to discuss how this security is created.

A life insurance company sells an insurance policy to an individual. The company selling the policy assumes liability for the policy in exchange for an annual premium. When the insured person no longer desires the proceeds from the insurance policy, typically because this person has lived to an age with reduced need from the original motivation for buying the policy, the policyholder can monetize the policy by selling the future payout for cash immediately. The new beneficiary from the policy provides an upfront cash payment based on actuarial mortality assumptions. Packaging many such transactions creates a new security.

The first step is to collect funds from investors, which are then provided to the individuals holding the life insurance policies in exchange for the policy payouts when the policyholder dies. The funds provided to the policyholder are available for immediate use. The insured person continues to make payments to the insurance company. Once the insured dies, the insurance company payment is remitted to the pool of bond purchasers. A varied stream of payouts on many different policies makes up the yield on the security. The payout consists of the life insurance policy settlement being forwarded to the investor at the passing of the insured. This situation is conceptually similar to a zero-coupon bond in which all the yield is collected when the principal is returned when the bond matures. Upon the initial purchase of the life insurance policy payout, some assumption is made about the length of time until the policyholder dies. The funds provided to the policyholder are a discounted value of the policy payout based on the time from the initial provision of funds to the policyholder to the assumed time when the insured dies. Figure 18.2 provides an overview of the cash flows in a death bond.

Risks of Investing in Death Bonds

A death bond is constructed in a similar fashion to many other securitized pools. The combination of the cash flows from the individual life insurance policies determines

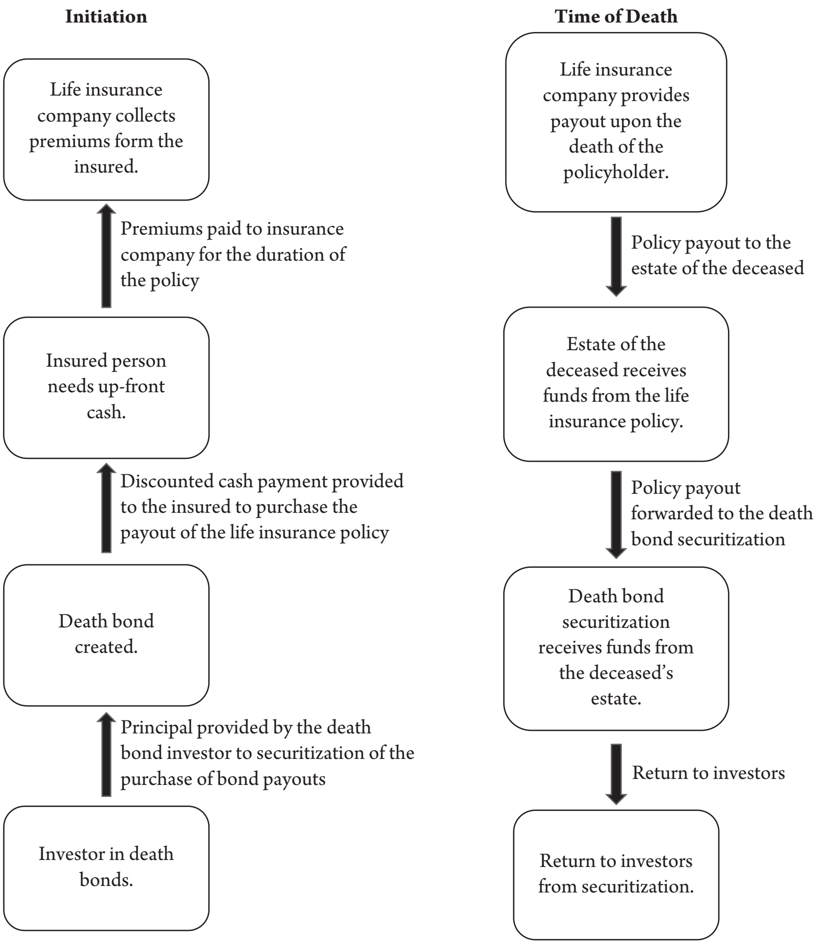

Figure 18.2 Death Bond Structure
This figure shows the typical structure of a death bond at initiation and upon the insured's death.
Source: Authors' illustrations.

the periodic yield on the security. Thus, death bonds are exposed to many of the same risks inherent in other securitizations. The most notable is *longevity risk*, which is the risk of the insured living longer than anticipated. Rapid advances in medical technology make accurately determining the life span of an insured individual difficult. If the insured person dies more quickly than predicted, the yield of the bond increases because the original agreement assumes a particular life expectancy. If the insured person lives longer than expected, the return on the bond declines simply due to the passing of time and compounding of interest (Ishmail 2009). If a payment is made later than expected, the present value of the payment diminishes.

Interest rate risk is another factor in a death bond investment. When forming a pool, an interest rate is assumed and used to calculate the bond's value at the insured's eventual death. If interest rates increase during the period from bond issuance to the eventual death of the insured, then the security may experience an interest rate loss. This loss results from a relative underperformance of the death bond vis-à-vis other investments. Conversely, if interest rates decrease, the value of the death bond investment increases relative to other investments because the interest rate used to calculate the bond payout is no longer available for instruments of a similar risk level.

Death bonds face different risks than other bonds because of their unique collateral. Specifically, since the market is relatively small and lightly regulated, death bonds are ripe for frauds and scams (McDermott 2011). Further, with healthcare for the insured continually improving, payouts on death bonds can generally be expected to take longer than originally anticipated, which would drive down the yield by extending the time to payout. Recent industry trends show death bonds faring poorly due to the insured individuals living much longer than anticipated (Ishmail 2009).

An individual knows more about his own health than an outsider resulting in asymmetric information between the insured and the investor. Hence, an additional risk is that the insured person may claim to be in worse health than in reality. This claim would lead investors to think that the policy is likely to pay off sooner and result in the insured receiving a larger up-front payout, due to the assumed shortened time period between the payout of the bond and the payment to insured. This risk is known as *dirty sheeting* (Thismatter 2007).

Advantages of Investing in Death Bonds

Yields on death bonds tend to be relatively high due to the large discounts that are provided when the insured received the cash. An important characteristic of death bonds is the low correlation with other asset classes because the mortality rate is largely independent of other economic activity. Death bonds can be an attractive investment in recessionary times because the insured would typically have a greater need to monetize an insurance policy. The insured tends to be an individual who is no longer in need of a life insurance policy possibly because the original beneficiaries are financially independent. The profile of an individual selling a life insurance policy tends to consist of an older, retired person living on a fixed income. If interest rates decline, as would be typical during a recession, these individuals would have less income and a greater need for cash. Thus, demand for death bonds increases because the insured has a greater need for upfront cash.

Tax Treatment

No tax advantages are associated with life settlement investments. Because no clear societal benefit or property is created when purchasing a death bond, all gains from these investments are taxed as ordinary income.

Catastrophe Bonds

A *catastrophe bond*, or cat bond, is an instrument created by an insurance company to spread the risk of natural disasters, acts of God, or other catastrophes to investors (Evans 2017).

Insurance companies operate profitably by collecting premiums from a large number of policyholders over broad, diverse areas and populations with the expectation that they will pay out only a small percentage of claims over the policy's life. At a high level, if the premiums and returns generated by the premiums exceed the amount paid out to claimants, the insurance company remains solvent and profitable. Insurance companies take great care to not issue policies to individuals who may be exposed to the same common risk factors. For example, a health insurance company ideally underwrites policies for a diverse set of policyholders to prevent older individuals in declining health from straining the company's cash flow by paying many claims in a concentrated time period.

In some situations, insurance companies cannot avoid this type of policy structure. For example, consider the eastern shore of Florida or areas of California located along the San Andreas fault. Individuals living in these areas are uniquely exposed to the risk of a total loss from natural disasters that are nearly impossible to forecast. Thus, issuing policies in these areas is very risky, even with increased premiums for additional risk. A single incidence of a natural disaster can trigger thousands of policyholders to file large claims. These claims can easily exceed the premiums paid by the policyholders in aggregate.

To diversify the risk of these events, insurance companies can issue catastrophe bonds. These bonds are issued through an investment bank and purchased by investors willing to bear that risk of the catastrophe occurring within the specified timeframe. If the catastrophe does occur, investors lose their principal. If the catastrophe does not occur, the insurance company compensates investors with the return of principal and interest. Given the nature of these investments, they are inherently risky but can generate high returns (coupons) if no event occurs. Although analysts can examine historical trends to determine the likelihood of catastrophes, these events are still very difficult to predict.

Unique Characteristics of Catastrophe Bonds

Catastrophe bonds and SIBs are similar in that neither fits the classic definition of a debt security. Although both bonds are issued with a standard principal and a specified coupon rate, no implicit collateral or ownership claim exists against the entity issuing the bond. As a result, little recourse is available for receiving any compensation in the event of a catastrophe.

The characteristics described above suggest that catastrophe bonds are high risk investments that are relatively short term (e.g., 3 to 5 years) and offer commensurate coupon payments. The bonds offer floating rate coupons based on a standard benchmark rate plus a spread to compensate for the risk. Given that the proceeds of the bond are held in reserve to be used in the case of a specific event, catastrophe bonds are typically issued through a special purpose vehicle (SPV), created solely to issue the bonds. Finally, since no tangible property is created, catastrophe bonds are fully taxable and receive no tax exempt or tax deferred status.

Advantages of Investing in Catastrophe Bonds

Although catastrophe bonds bear substantial risk, they offer an important diversification benefit. The level of economic activity or other market forces do not influence the occurrence of a natural disaster. However, a natural disaster could have a devastating local and regional economic impact such as Hurricane Katrina that struck New Orleans in 2005.

Catastrophe bonds are relatively new financial instruments and trace their origin to Hurricane Andrew in 1992 in Florida and the Northridge Earthquake in the San Fernando Valley of Los Angeles in 1994. Both events caused widespread damage and left many insurance companies looking for a means to further diversify their exposure to such events, beyond traditional re-insurance.

Figure 18.3 illustrates the cash flows and major parties in a catastrophe bond. Similar to other off-balance structures, the sponsor (insurance company) directs premiums to the SPV which, in turn, issues notes and makes required payments to investors .

Green Bonds

A *green bond*, short for a Qualified Green Building and Sustainable Development Bond, is traditionally a tax-free bond offered by a municipality or government. These bonds focus on energy efficiency, pollution prevention, clean transportation, protection of ecosystems, and other sustainable development type projects. The goal of green bonds is to generate a financial return and provide a positive environmental and societal impact (Panerai and Lo Giudice 2016). Unlike SIBs, green bonds result in the development of physical property.

Origin of the Green Bond Market and Market Development

The green bond market began in 2008 when the World Bank issued a bond to raise funds for projects to mitigate climate change. Since 2008, the green bond market has increased exponentially, and this trend is expected to continue. In 2017, issuers offered more than $150 billion for green bond projects, which represents a $70 billion increase from 2016 (Climate Bonds Initiative 2018). Large multinational corporations, including Apple (Volcovici 2017), emerging market governments, and international financial institutions have issued green bonds. Currently, about one-sixth of all assets under professional management in the United States is allocated toward some form of sustainable investment (Tyson 2015).

Green Bond Awareness and Types of Projects

Technological advancements paved the way for the development of many green projects over recent years. An increase in energy prices and focus on reducing the carbon footprint have increased the motivation to undertake efficient and environmentally focused projects. For example, in the power generation field, the advent of transistors and power converters makes wind and solar power more feasible for major development. The mass production and economies of scale for power inverters that convert the DC power generated by solar panels into AC power has allowed the mass production and implementation of residential solar power. Wind power has also benefited from the reduction

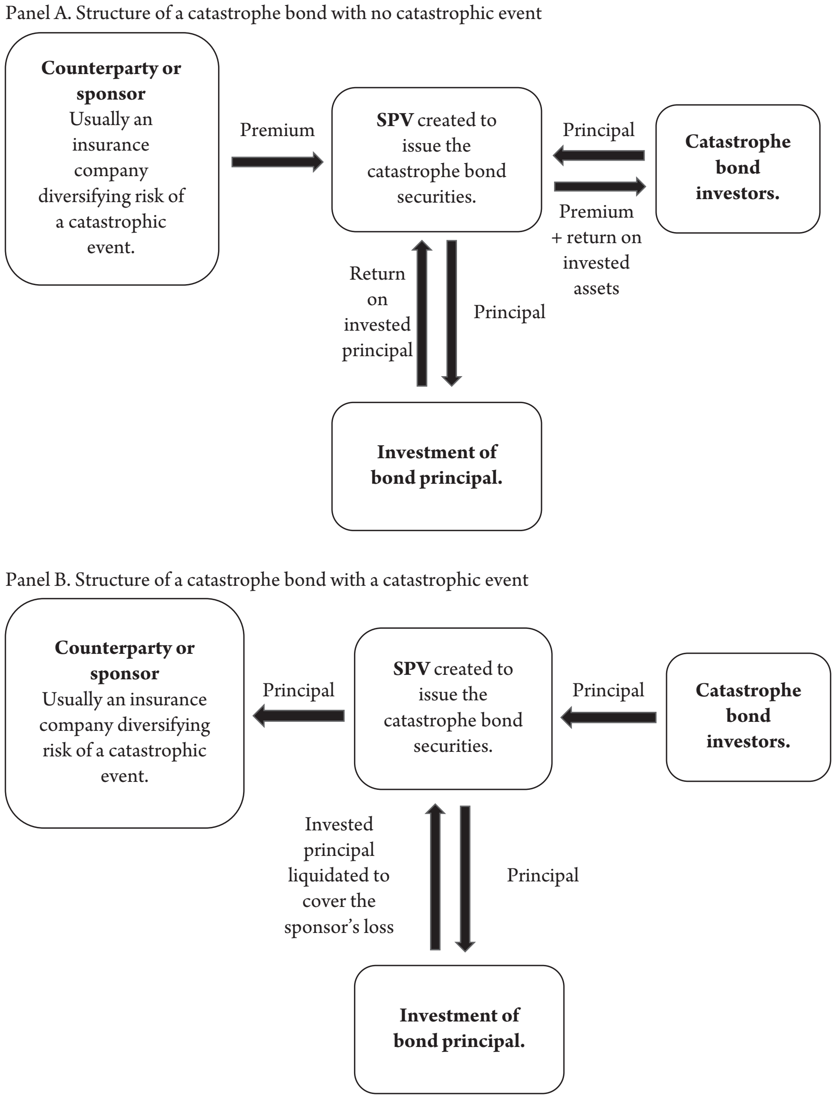

Figure 18.3 Catastrophe Bond Structure
This figure shows the typical structure of a catastrophe bond.
Panel A. Structure of a catastrophe bond with no catastrophic event
Source: Adapted from Evans (2017).
Panel B. Structure of a catastrophe bond with a catastrophic event
Source: Adapted from Evans (2017).

in power conversion costs. Using power converters allows wind turbines to provide power to the utility grid under any load conditions.

With respect to power generation, issuers can also use green bonds to finance new, high efficiency combined cycle natural gas power plants. These plants use a single, clean fuel source in the form of clean-burning natural gas to power a jet engine. The exhaust heat from the jet engine is then used to drive a steam turbine. These new plants have a *thermal efficiency* of more than 50 percent (i.e., 50 percent of the energy input into the power generation process is recovered in electrical generation). The other 50 percent is lost to heat losses, but this percentage still compares favorably to the nearly 25 percent thermal efficiency for antiquated coal burning utility plants. Green bonds can also fund district combined heating, cooling, and power generation plants. These plants also burn natural gas and generate electricity. However, whereas a typical utility plant loses 50 percent of its thermal energy, district plants recover this waste heat from the electrical generation process and use it for heating and cooling processes. Using waste heat results in a total process efficiency of up to 90 percent.

In the construction industry, many opportunities are available to finance energy and cost savings projects such as thermal storage plants, where cooling plants make ice using cheap off-peak hours electricity and then use the ice during on-peak demand hours to provide air conditioning. Although this process is a net energy consumer, it helps shift electric load to off-peak hours and smooths out the swings in the power grid. Gray water systems are also gaining popularity. These systems harvest rain water and use it for nonpotable water uses such as flushing toilets and irrigation.

The pollution prevention industry can also benefit from green bond financing. Projects such as wastewater treatment plants can provide tremendous benefits to communities and help provide clean water by treating wastewater and sewage before discharging it to local waterways. Construction of these plants helps provide affordable access to clean water.

Clean transportation projects would also fall under the scope of green bonds. Green bonds can also finance projects such as electrified commuter rail systems and purchasing hybrid buses and other transport related projects.

Advantages of Investing in Green Bonds

Green bonds offer several advantages to investors. First, the performance of energy savings projects is insensitive to the health of the overall economy and provides diversification benefits. For example, even if commodities prices fluctuate, electricity prices remain relatively stable. So, the returns from green bonds tend to be relatively less correlated with the general economy. Second, these bonds tend to invest in projects that have dedicated revenue streams. For example, they invest in plants that provide solar energy that can be sold to end users. This type of investment contrasts sharply with an investment in cleaning up trash on the side of the road. Although this activity is socially beneficial, it does not generate revenues.

More organizations are prioritizing environmental, social, and governance (ESG) factors in their investment decisions. This philosophy focuses on long-term investment performance and net benefits to society as opposed to generating a short-term profit. Considering ESG factors is particularly relevant because most investment evaluation approaches incorporate present value calculations of future cash flows.

Tax Treatment

Green bonds are generally tax exempt. The traditional requirements for tax exemption are that the bond must be issued by a municipality or government organization and the proceeds of the bonds sale must be used to finance the construction of physical property. Green bonds typically meet both of these requirements.

Covered Bonds

Although similar to a traditional bond, a *covered bond* is secured by a pool of assets that can be used to repay or "cover" bondholder claims in the event of an issuer's default. The assets used to cover the bond are essentially a form of collateral even though the assets remain on the company's balance sheet. By contrast, traditional collateral may be isolated, ring-fenced (i.e., creating an economic separation between collateral and originator), and/or used to repay bondholder claims as dictated by the courts in bankruptcy proceedings.

The assets used to cover the bonds have no effect on the cash flows to the bondholder. This situation contrasts sharply with a typical securitization where the performance of the assets determines the cash flows for the bond. The covered bond is issued in a similar fashion to a conventional bond, with the exception that the asset pool is available only in the event of default. Therefore, covered bonds can be considered a form of secured debt and has priority above conventional debt in the firm's capital structure. Hence, in the event of default, the debt holders have a claim to the company's assets, but they cannot take possession of assets that have been pledged as collateral to more senior claims.

As a result, most covered bond issues tend to be very high quality and with lower risk compared to their uncovered equivalent bonds. Typically, the assets used to secure covered bonds are relatively safe assets such as mortgages, loans, public debt or similar high-quality assets. Maturities can range from 1 to 30 years. Financial institutions mainly issue covered bonds.

Covered Bond Origins and Market

Although covered bonds have recently gained popularity, they are not a new product. The concept of covered bonds dates to the Prussian Empire and King Frederick the Great. The Prussian Empire issued covered bonds to finance agriculture production and pledged the land as the collateral to the bond purchasers. The issuer used the proceeds of the bond sale to pay workers and buy equipment. If the harvest provided insufficient funds to repay the bond holders, they could take ownership of the farmland (Pinedo and Marlatt 2017).

Despite existing for centuries, the role of covered bonds in corporate financing is becoming more common. These bonds are considerably more popular outside the United States due to a lack of alternative means to gain funding for mortgage-backed securities. In the United States, government sponsored entities (GSEs) provide an active secondary market for mortgages, thus making the issuance of covered bonds somewhat unnecessary. As a result, the U.S. government never enacted legislation for a more active covered bond market. After the financial crisis of 2007–2008, this mindset changed considerably, and covered bonds have thus become more popular due to the liquidity crisis faced by the GSEs and the specific requirements for banks to sell mortgages to the GSEs.

Covered Bonds Issuance

Covered bonds in the United States are typically issued using a tiered structure. As an example, consider a bank issuing a covered bond. The bank would issue the bond, receive the funds, and then loan the funds as mortgages or other types of loans. These loans are then sold to a SPV, which would hold the mortgages for the bond holders in the event of a default. This SPV is technically consolidated onto the bank's balance sheet but allowed to be held separately to cover losses incurred by bond holders if the bank defaults.

Outside the United States, mostly in the European Union, banks issue covered bonds without the SPV structure. The financial institution maintains the mortgage bonds and issues the covered bonds directly without any type of third party structure holding the bonds. In countries using this type of structure, legislation defining the rights of the bondholder and the requirements to issue a covered bond are documented to ensure the process works as intended.

Summary and Conclusions

Given the rapidly changing financial landscape for bond holders and the advent of securitization, having a steady increase in the number of bond products available to investors is not surprising. The definition of the conventional bond issuance is continually being expanded and challenged. The bonds discussed in this chapter are a few examples of how new products are brought to market to help those who have funds to lend, invest them where their funds are most needed, and provide a strong return, fulfilling the purpose of global capital markets. Going forward, more issuances of all the products discussed in this chapter are likely to occur as are more opportunities for nontraditional investments.

Discussion Questions

1. Explain how a SIB is structured and why it may be issued in lieu of conventional financing.
2. Explain the advantages and risks of investing in death bonds.
3. Explain the unique characteristic of catastrophe bonds and SIBs.
4. Discuss some projects that can be financed by green bonds and explain why investing in green bonds can be mutually beneficial to society and investors.

5. Explain why an organization would issue a covered bond and use an example of a mortgage origination to demonstrate the process. Also, explain why covered bonds issuance in the United States has recently increased in popularity.

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19

Inflation-Linked Bonds

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Introduction

Discussions surrounding inflation have been at the forefront of political and economic forums for decades. Targeted inflation goals set forth by central banks often influence crucial decisions about economic and political policies such as international trade, foreign relations, and monetary and fiscal policy. The disparate nature of national economies as characterized by their size, maturity, and natural resources, among other factors, creates different incentives and solutions to address domestic inflation. Therefore, central banks are unlikely to implement homogenous policies to set the appropriate level of inflation for a healthy economy. Investors understand that inflation erodes real asset returns and is an inherent risk in domestic and international portfolios.

Allocations in certain asset classes such as commodities, stocks, and real estate provide some level of protection against inflation, but all are limited in their ability to perfectly hedge inflation. Commodities are a broad category that includes agricultural products, precious metals, minerals, and energy, which generally increase in price at a rate similar to inflation. However, the costs associated with storing and transporting commodities limit their effectiveness as an inflation hedge. Although stock prices tend to exhibit a positive correlation with long-run levels of inflation, unexpected changes in inflation may result in increasing costs for businesses and trigger a decline in valuations. Similar to stocks, real estate income in the form of rent and leases tends to be positively correlated with inflation. However, unexpected changes in inflation or persistently high inflation increases financing costs and consequently puts downward pressure on real estate values. Investors often find inflation-linked bonds to be the best product to effectively manage inflation risk.

This chapter begins with a brief introduction to inflation concepts and theory as well as the effects inflation has on different types of investor portfolios. The remainder of the chapter focuses on the fundamentals of inflation-linked bonds including issuers, pricing, and measuring inflation expectations. The chapter discusses how inflation-linked bonds reduce inflation risk and identifies the type market environments that would favor investments in inflation-linked bonds compared to nominal bonds.

Understanding Inflation

In 1969, Milton Friedman proposed the Friedman rule as the guiding principle of an optimal monetary policy (Friedman 1969). This rule suggests that the loss of purchasing power over time—the cost of holding money—should equal the social cost of creating money. Under the current monetary system, the social cost of creating money is equivalent to the production cost of printing paper money, which is quite low. Since fiat money can essentially be created by running a printing press with low operating costs, the opportunity cost of holding money is also low. In the United States, the historical long-term average interest rate averages about 3 percent a year (Huber 2013). Thus, in order for the opportunity cost of holding money to equal the cost of creating money, the economy must experience deflation of about 3 percent a year. The Friedman rule ultimately suggests that deflation of 2 percent to 3 percent would increase the overall welfare of the economy over time.

Although the Friedman rule may hold in economic models, in practice the consensus on optimal monetary policy has leaned toward slightly positive inflation with the Federal Reserve's inflation target typically around 2 percent a year. To understand why the current monetary policy approach differs from the academic perspectives of the 1970s requires understanding the effects of inflation and money demand.

First, inflation erodes the purchasing power of money. When the purchasing power of consumers diminishes, so does their real consumption in the economy. The decrease in real consumption can be translated into a reduction in real corporate earnings. Analogous to the reduction in real corporate earnings, firms experience increasing cost pressures as they are also subject to diminishing purchasing power. Higher cost pressures eventually lead to higher unemployment as wages increase, and lower economic growth as capital becomes more expensive and businesses have difficulty finding profitable investment opportunities. Thus, a study of historical data should reveal a negative correlation between inflation and real output, real consumption, and productivity, as well as a positive correlation between inflation and unemployment.

Many studies report a negative correlation between inflation and the real economy that is weak over the long term. However, similar studies document a strong positive correlation between inflation and unemployment. On the surface, these studies may suggest that inflation only affects the levels of unemployment and does not spill over into other aspects of the economy such as consumption and productivity. Unfortunately, these studies do not capture the effects of changes in inflation (Huber 2013).

After the fall of the Bretton Woods Monetary System in 1971, the Nixon administration pursued low-interest-rate policies to bolster economic growth in the short term. The implementation of low-interest-rate policies and a focus on short-term economic growth led to a period of rising inflation. From 1975 to 1985, U.S. data show a positive correlation of 0.94 between inflation and unemployment and a negative correlation of –0.83 to –0.98 between inflation and real consumption, real output, and productivity (Huber 2013). As such, when examining the shorter time period, the expected directional correlations are observed (i.e. a strong positive correlation exists between changes in inflation and unemployment and a strong negative correlation occurs between changes in inflation and real consumption, real output, and productivity). The difference in the observed outcomes between long- and short-term studies indicates that abrupt changes in the rate of inflation in the short term historically have a negative effect on the real economy.

The complexity of the economy and its dynamic nature make formulating robust economic theories and policies challenging. Would an increase in inflation similar to the 1970s have the same effects today? Economists generally believe this would not be case. The reason is tied to the *quantity theory of money*, which states that a direct relation exists between money supply and price level. The theory is described by Equation 19.1:

$$MV = PT \tag{19.1}$$

where M is the money supply, V is the velocity of money, P is the price level, and T is the volume of transactions in the economy. Money demand is equal to 1/V—the higher the velocity of money, the lower the demand for money. In this situation, money demand does not refer to the desire to accumulate wealth, but instead the desire to hold wealth in highly liquid assets such as cash.

The modern economy has experienced many developments including improvements and innovations in financial technology and growth of financial intermediaries that have augmented the traditional supply of liquidity through new forms of credit. Better access to credit has led to a more fluid flow of capital throughout the economy. The higher velocity of money in the economy has resulted in a lower demand for money relative to historical levels. For this reason, a rapid rise in inflation can be expected to have less of an impact on the real economy today compared to the 1970s. However, as a result of the financial crisis of 2007–2008, central banks have implemented policies, such as substantial cuts to nominal interest rates that have increased the demand for money. Lower nominal interest rates can be translated into lower cost of holding money, which in return increases the demand for money.

In today's economic environment, increases in the demand for money are primarily attributable to central bank intervention. Yet, noting that the demand for money is still much lower than historically is important. Regardless, an increased demand for money creates a balancing act in economies such as the United States where the Federal Reserve is expected to raise interest rates through 2019. As the cost of holding money increases, the demand for money is likely to fall and the velocity of money to increase. Therefore, investors may spend money on other financial assets. If the overall money supply in the economy is not simultaneously reduced at a commensurate rate, the result could be a rapid change in inflation.

Effects of Inflation

When examining the effect of inflation on a portfolio, investors can be separated into two general categories: private (individual) and institutional. The fundamental differences between private and institutional investors demonstrate the impact of inflation on their respective portfolios.

Private Investors

Private investors encompass different investor types from small retail investors to accredited investors. The effects of inflation vary from one investor to another depending on their sources of income and the diversification of their portfolios. Although private investors may hold some assets similar to institutional investors, such as stocks and bonds, the investment philosophy behind asset selection of private investors depends on their required rate of return relative to their risk tolerance. This relation is an important because the effect of inflation on private investors is primarily dependent on their asset allocation.

Pensioners exemplify how asset allocation choices determine the extent to which inflation will affect investors and their portfolio performance. Inflation generally affects pensioners more adversely than the currently employed population. The rationale is that pensioners receive a steady stream of income that is fixed at a nominal value, while salaries of the working public are adjusted for inflation, albeit with a time lag. Often the income pensioners receive in retirement comprises the majority of their portfolio in which their purchasing power is exposed to inflation. In contrast, a portfolio with heavier allocations in stocks and commodities may perform better in inflationary periods. However, the volatility of stocks and commodities makes them risky investments for investors with limited time horizons.

Institutional Investors

Institutional investors include pension funds, university endowments, and insurance companies among others. These investors are typically more likely to match assets with liabilities. For example, a university endowment may issue a long-term bond to fund a large construction project on campus. The manager of the university endowment may simultaneously hold a portfolio of bonds or other assets that are expected to generate a sufficient return to cover, at a minimum, all future interest and principal payments on the endowments liability. During an inflationary period, the real value of the endowment's assets and liabilities both diminish. However, if the endowment's liabilities have a shorter average duration than that of its assets, the real value of the liabilities will decrease more than the real value of the assets, resulting in a net gain.

Inflation reduces the value of most asset classes, particularly assets with fixed (nominal) rates of return such as nominal bonds. However, inflation also reduces the real value of liabilities with fixed nominal interest rates. Remember that every liability is an asset to some counterparty. The net effect is dependent on average duration of the financial investments relative to the average debt duration. If the average debt duration is longer, the earnings from the decline in the real value of liabilities may offset, if not exceed, the real loss of the value of the assets. In other words, the net effect of inflation may be value-increasing in the context of the entire portfolio. To fully grasp this concept requires understanding the fundamentals of duration to be discussed later in this chapter.

Inflation-Linked Bonds

The effects of inflation vary among investors and should be examined in the context of a well-diversified portfolio. Although some traditional asset classes provide limited inflation protection, inflation-linked bonds are the only asset class that is specifically structured to hedge the erosion of real value. An *inflation-linked bond* is a niche asset class in which a fixed real return is guaranteed at the time of issuance. In the context of a portfolio, the effect of holding inflation-linked bonds depends on the portfolio's average duration. Whether an investor would be better off holding nominal bonds relative to inflation-linked bonds depends on the current market environment and forward-looking inflation expectations. The remainder of this chapter focuses on the basics of inflation-linked bonds and the relative performance versus nominal bonds.

Understanding Inflation-Linked Bonds

Conventional bonds are issued with a coupon based on a guaranteed nominal interest rate and par value. In contrast, inflation-linked bonds are issued with a coupon and par value that is based on a guaranteed real return. Although two ways are generally available for adjusting inflation-linked bonds for inflation, neither method yields guaranteed real returns to investors. The fundamentals of inflation-linked bonds are the same as conventional bonds with a series of coupon payments and par value paid at maturity. However, since inflation-linked bonds offer a guaranteed real rate of return, a periodic adjustment is needed for changes in inflation.

The first method to adjust for inflation makes a direct adjustment for realized inflation in the bond's coupon rate. With this method the bond's par value or redemption value is fixed at issuance and remains constant throughout the bond's life. The second method, called the "Canadian Model" for index-linked bonds, involves indexing the bond's par value to realized inflation. Under this method, the bond's coupon rate remains fixed, but the coupon payment in dollar terms fluctuates based on changes in the bond's par value. Not surprisingly, most sovereigns including the United States and United Kingdom currently use the Canadian Model. The key difference between the two countries is the index used to track inflation (Romanchuk 2016).

Who Issues Inflation-Linked Bonds?

The practice of linking a bond's return to inflation dates back more than 230 years when the State of Massachusetts issued the first inflation-linked bond. Between 1775 and 1783, the United States had been fighting the American Revolutionary War, which the government financed by substantially increasing the supply of Continentals in circulation. As a result, inflation rates rose to nearly 30 percent annually. With a weakened currency and skyrocketing inflation, Massachusetts linked its bonds' cash flows to a representative basket of consumer goods to incentivize investors. In 1981, the United Kingdom led the way as the first industrial nation to issue an inflation-linked bond. In 1997, the United States issued the first Treasury Inflation-Protected Security (TIPS) followed by Germany in 2006. Today, 13 of the largest 20 countries based on gross domestic product (GDP) are active in the inflation-linked bond market including Australia, Japan, Canada, France, Italy, and Sweden, where the largest issuers are the United States, United Kingdom, and Brazil (Huber 2013).

By contrast, few inflation-linked corporate bonds are available. This market has been slow to develop and is unlikely to reach the size of the inflation-linked government bond market primarily because investors who buy inflation-linked bonds typically have high levels of risk aversion. In contrast, corporate bonds are considered riskier investments than most government bonds, especially relative to Treasury bonds. The lack of investor appetite helps to explain the relatively few issuances of inflation-linked corporate bonds.

Aside from the extra risk associated with corporate bonds, few companies have business models that benefit from issuing inflation-linked bonds. The reason is because inflation has similar effects on both businesses and consumers in which it erodes real purchasing power. Typically, few corporations issue debt that accrues larger interest payments while their real earnings are simultaneously reduced. However, issuing inflation-linked corporate bonds could be sensible in some industries. For example, during inflationary periods, grocery stores and supermarkets can generally pass on inflationary pressures through short-term price increases. Additionally, utility service companies generally have regulated prices that are tied to inflation. In both circumstances, corporations can increase prices in the short term and offset the effect of inflation on their real earnings. In these industries, issuing inflation-linked bonds could be beneficial because they could issue lower-interest-rate debt compared to conventional corporate bonds. Historically, the United Kingdom has the only developed market for inflation-linked corporate bonds with supermarkets and utilities as the main issuers.

Inflation Indices

Nominal interest rates are based on the real interest rate and supplemented with various risk premia such as liquidity risk, term risk, default risk, inflation risk, and volatility risk, as well as a premium for expected inflation over the bond term. *Inflation risk* compensates investors for bearing the risk that realized inflation over their holding period might exceed their initial inflation expectations when purchasing the bond. Many of these risk premia are irrelevant for inflation-linked bonds. For example, the inflation risk premium and term premium are mitigated through the inherent mechanics of inflation-linked bonds that adjust for realized inflation. Additionally, the default risk premium is negligible because governments are the primary issuers of inflation-linked bonds. Generally, governments such as the United States are assumed to be able to make interest and principal payments, thus eliminating default risk. An inflation-linked bond's interest rate is thus primarily comprised of the real interest rate, expected inflation, and a liquidity risk premium.

Inflation-linked bonds provide the most effective hedging position against inflation. However, such bonds do not perfectly eliminate inflation risk due in part to how inflation is calculated. Inflation-linked bonds are generally indexed to the issuing country's Consumer Price Index (CPI) or Retail Price Index (RPI). In the United States, TIPS are indexed to the non-seasonally-adjusted Consumer Price Index for All Urban Consumers (NSA CPI-U). Calculating changes in the index requires time to collect data and perform the calculation, resulting in an indexation lag during a short period at the end of the bond's term. During the indexation lag, complete protection from inflation cannot be guaranteed. The average indexation lag is about three months with a greater effect for shorter term bonds. In markets with volatile inflation rates, accounting for the seasonal component of inflation is critical. For example, in France inflation rates are lower in January due to strong retail sales. However, because the lower inflation may not be observed until three months later, bonds maturing in April net lower returns than bonds that mature in other months throughout the year. Theoretically, this phenomenon should be priced into the forward interest rate curve, although this situation is not always the case in practice.

Although the concept of indexing a bond's cash flows to inflation is similar across all sovereign issuers, the practice of actually indexing the cash flows to inflation may differ between issuers. For example, each issuer uses an inflation index that reflects inflation in its own country. Additionally, the length of the indexation lag may differ between issuers. Table 19.1 summarizes the key features of inflation-linked bonds across various issuers.

Pricing Inflation-Linked Bonds

Inflation-linked bonds are very similar to plain vanilla bonds except that yields for inflation-linked bonds are expressed in real terms whereas yields on plain vanilla bonds are expressed in nominal terms. Pricing inflation-linked bonds can be best understood by breaking down the process into three concepts.

1. Pricing inflation-linked bonds should be approached in the same manner as pricing plain vanilla bonds, except in an environment of "real prices."
2. Translating nominal prices from the "real price" world to the nominal world requires using the monthly inflation time series, which is similar to a currency exchange rate.
3. In the "real price" world, the only units of time are monthly. Since bonds should be priced on a daily basis in the nominal world, publication delays in inflation data should be considered. This task is generally accomplished by linear interpolation of monthly inflation data to a daily conversion factor.

Table 19.1 **Key Features of Inflation-Linked Bonds**

Index	*Known As*	*Inflation Index*	*Indexation Lag (Months)*	*Deflation Floor Protection*
United States	TIPS	US CPI Urban NSA	3	Yes
United Kingdom	IL gilt	UK RPI	3	No
Brazil	NTN-B/ NTN-C	IPCA/IGP-M	N/A	No
France	OATei/i	Eurozone HICP ex-tobacco/French CPI ex-tobacco	3	Yes
Italy	BT Pei	Eurozone HICP ex-tobacco	3	Yes
Germany	Bundei/OBLei	Eurozone HICP ex-tobacco	3	Yes
Japan	JGBi	Japan CPI	3	No
Mexico	UDIBONOS	UDI	N/A	No
Turkey	TURKGB CPI	Turkey headline CPI	2–3	Yes
Canada	CANi	Canada CPI NSA	3	No
Sweden	SGBI	Sweden CPI	3	Yes
South Africa	SAGB I/L	South Africa CPI	3	Yes
Greece	GGBei	Eurozone HICP ex-tobacco	3	Yes
Israel	Galil	Israel CPI	1	No
Australia	CAIN	Weighted average of eight capital cities	6	Yes
Argentina	AGRENT-DIS	Argentina CER Spot	N/A	No
Korea	KTBi	Korea headline CPI	3	Yes
Thailand	iLB	Thailand headline CPI	3	Yes
Hong Kong	iBond	Hong Kong headline CPI	N/A	Yes

This table lists the major issuers of inflation-linked bonds, names of their inflation-linked bonds, respective index used to adjust for inflation, length of the indexation lag, and whether the bonds include a deflationary floor.

Source: Kramer (2017).

To illustrate these concepts, consider an example with a series of TIPS that have a maturity of 10 years, a par value of $1,000, and a coupon rate of 1.25 percent at issuance. By convention, TIPS are paid semi-annually. At the time of issuance, the expected inflation is 2 percent annually. If realized inflation equals expected inflation at the time of the bond's issuance, the bond's par value needs to be adjusted upward by 1 percent. When the first coupon payment is paid in six months' time, the bondholder will receive $6.31. To adjust for inflation, the bond's par value is increased by 1 percent to $1,010, which results in a semi-annual coupon payment of $6.31 (1.25 percent/2 × $1,010).

Although this method for pricing inflation-linked bonds may appear straightforward, it assumes the bonds are priced at the clean price, which does not include accrued interest. Bond pricing involves three distinct concepts of value: (1) face value, (2) clean price, and (3) dirty price. Although bonds are commonly discussed in terms of face value and quoted in the clean price, the dirty price includes accrued interest and is the actual amount sellers receive and buyers must pay, ignoring bid-ask spreads. Converting from face value to the clean price is same for inflation-linked bonds as it is for conventional bonds. Converting from the clean price to the dirty price, also called the *invoice price*, is what differentiates pricing inflation-linked bonds from conventional bonds.

To convert the clean price of an inflation-linked bond to the dirty price requires going back to the world of "real prices," which only has months as units of time. To translate the cash flows in the world of "real prices" to the world of nominal prices involves multiplying the cash flows by an exchange rate referred to as the indexation factor. The *indexation factor* is a monthly time series that reflects changes in inflation and can be linearly interpolated. Linearly interpolating the indexation factor enables accounting for accrued interest not only between coupon payments, but also on a daily basis in between the release of monthly inflation data.

In practice, transactions do not always settle on the same date inflation data are reported. This situation distorts bond prices and is further compounded by the fact that inflation data are reported with a time lag. To mitigate the first issue, set a reference value equal to the indexation value on the first day of the month. Therefore, through the second day of the following month, the indexation factor requires calculating by linearly interpolating the reference value on the first month to the reference value on the first day of the succeeding month. To deal with the second issue generally involves using reference values from three months prior. Assuming no lag in inflation data, in September (a 30-day month), the value of the indexation factor on September 16 should be approximately equal to the average of the reference value on September 1 and October 1, because an equal number of days occurs between the two reference dates. However, given the lag in inflation data, the reference values used should be based on the CPI index values from three months before June 1 and July 1.

Duration

Duration refers to the average time capital is tied up in a bond, which can also be translated into the sensitivity of a bond's value relative to changes in interest rates. Although multiple variations of duration are available, the most precise measure of the sensitivity of the value of a bond or a bond portfolio to changes in interest rates is key rate duration. *Key rate duration* captures changes in each individual cash flow from a change only in the interest rate of the corresponding maturity along the yield curve. This measure of duration can be used for individual bonds, but it is more commonly used in a portfolio context of bonds with varying maturities.

Calculating duration in terms of inflation-linked bonds requires using real cash flows as opposed to nominal cash flows. Generally, an inflation-linked bond has a longer duration than a conventional bond with a nominal interest rate because the reimbursement for inflation is captured at maturity when the bond's nominal value is redeemed. The duration of a conventional bond cannot be directly compared to the duration of an inflation-linked bond because the duration of a nominal bond is sensitive to the duration of both inflation and real interest rates. Since inflation-linked bonds adjust for changes in inflation, duration is only sensitive to the duration of real interest rates. In practice, duration can be adjusted with an inflation beta, which measures the sensitivity between real and nominal yields, allowing for the comparison of nominal and real bond durations.

To fully round out the discussion of duration and inflation-linked bonds, consider the following example. A bond portfolio is comprised of four bonds with equal allocations in one-, five-, 10-, and 25-year maturities. The key rate durations for each maturity are represented by $D_1 = 0.9$, $D_5 = 3.7$, $D_{10} = 5.8$, and $D_{25} = 9.2$, each reflecting the exposure to interest rate risk at the single respective point on the forward yield curve. Equations 19.2 and 19.3 show the model to estimate the percentage change in price based on changes in the yield curve:

$$\frac{\Delta P}{P} \approx -D_1\Delta_{r_1} - D_5\Delta_{r_5} - D_{10}\Delta_{r_{10}} - D_{25}\Delta_{r_{25}} \tag{19.2}$$

$$\frac{\Delta P}{P} \approx -(0.9)\Delta_{r_1} - (3.7)\Delta_{r_5} - (5.8)\Delta_{r_{10}} - (9.2)\Delta_{r_{25}} \tag{19.3}$$

where $\frac{\Delta P}{P}$ is the percentage change in price of the bond portfolio and Δ_{r_i} is the change in the interest rate at maturity. Now assume a scenario where a change in inflation expectations occurs that results in the following change in interest rates on the forward yield curve: $r_1 = -0.5$ percent, $r_5 = -0.1$ percent, $r_{10} = 0.3$ percent, and $r_{25} = 0.7$ percent. Based on these changes in the forward yield curve the percentage change in price of the bond portfolio can be calculated as follows:

$$\frac{\Delta P}{P} \approx -(0.9) - (3.7)(-0.1\,\text{percent}) - (5.8)(0.3\,\text{percent}) - (9.2)(0.7\,\text{percent})$$

$$\frac{\Delta P}{P} \approx -7.36 \text{ percent}$$

This example focuses on the duration of a portfolio of nominal bonds, but the duration of a portfolio of inflation-linked bonds would be calculated in the same way except the changes in interest rates would be based on the real yield curve. Although beyond the scope of this chapter, the real yield curve can be extrapolated from the nominal yield curve with methods such as bootstrapping.

The Deflation Floor

Inflation-linked bonds may provide investors with an efficient hedge against inflation. However, what would happen to the returns on inflation-linked bonds in a deflationary environment? In a scenario in which deflation persists for a length of time, bond holders may receive less than par value at maturity. For this reason, many inflation-linked bonds have a deflation floor that guarantees a minimum amount to be repaid at maturity, which is often set to par. The deflation floor adds an extra layer of protection for bond holders analogous to being long a put option on the principal component of the bond. The bondholder's put option is in-the-money when the CPI index falls over the bond's life. The "put option" is only on the principal payment and not on the coupon payments. Loss of principal is still possible if an investor buys the bond at a price greater than the deflation floor. The built-in capital protection comes at a cost to bond holders in terms of lower interest rates. However, circumstances exist in which incorporating a deflation floor into a bond issue is economically infeasible. For example, in a country such as Japan, where the economy has been in a long period of deflation, the costs for the additional layer of protection would be too high and likely result in negative yields. The United Kingdom, Brazil, Canada, and Mexico are some countries that do not incorporate the deflation floor.

Break-Even Inflation Rate

When analyzing the relative attractiveness of inflation-linked bonds versus traditional bonds, analysts commonly use a metric known as the break-even inflation rate. The *break-even inflation rate* is the implicit constant rate of inflation for the term of the bond based on current market expectations. In other words, the break-even inflation rate is the spread between the yield of a nominal bond and the real interest rate ignoring all other liquidity and risk premiums. When computing the break-even inflation rate, investors should use nominal and real yields for bonds with equal maturities. Conceptually, if the break-even inflation rate is greater than expected inflation, an investor would be better off holding nominal bonds. If the break-even inflation rate is less than expected inflation, an investor would be better off holding inflation-linked bonds.

For example, the Fed H.15 data for the end of January 2018 reported the 10-year nominal Treasury at a yield of 2.58 percent and the 10-year TIPS yield at 0.54 percent. Remember that Treasury bonds and TIPS are quoted in nominal and real terms, respectively. The spread between the two values indicates a break-even inflation rate of 2.04 percent. If an investor expected inflation over the next 10 years to be less than 2.04 percent, the investor would be better off holding the 10-year Treasury and vice versa. Assuming financial markets are efficient, traditional and inflation-linked bonds should be priced so that break-even inflation rates are equal to unbiased expectations of the inflation rate.

The break-even inflation rate is a hold-to-maturity concept. When analyzing inflation-linked bonds versus traditional bonds over a holding period that is shorter than the time to maturity, the difference between the inflation rate relative to the initial break-even inflation rate may be insufficient to infer relative performance. For completeness, an analyst should consider expected pricing at the end of the time horizon. For example, if inflation is higher than the break-even inflation rate over a period that is less than the time to maturity, inflation-linked bonds could still underperform if nominal yields are compressed due to other economic factors (Christensen, Dion, and Reid 2008).

The concept of the break-even inflation rate is based on the *Fisher hypothesis*, which maintains that the spread between nominal and real interest rates should provide a reasonable measure of inflation expectations. In practice, however, various assumptions and issues exist with the Fisher hypothesis and the practicality of the break-even inflation rate. First, one assumption is that the decomposition of interest rates only results in two components: the real interest rate and expected inflation. Ignoring all other liquidity and risk premiums can distort the break-even inflation rate across various term structures and issues. Second, when comparing a coupon-paying inflation-linked bond to a coupon-paying nominal bond with similar time to maturity, the analysis is complicated because the cash flows are mismatched. In a period of rising inflation, an increase in the coupon payments from the inflation-linked bond occurs while the payments from the nominal bond are constant. Although this situation is by design, the two bonds have different sensitivities to the expected path of real interest rates and real interest rate risk (Christensen et al. 2008). Third, an issue arises when analyzing the break-even inflation rate with short-term bonds. In an environment where the term structure of inflation expectations is not flat, a bias is introduced into the break-even inflation rate because bonds with shorter times to maturity are more sensitive to changes in inflation. Understanding the effects of this issue is critical because inflation expectations are much more likely to be volatile in the short term relative to the long term. In a period with an *inflation shock* (i.e., a rapid change in inflation), the break-even inflation rate may be severely distorted.

Market Environments

Although multiple variables must be considered when analyzing whether investors would be better off holding inflation-linked bonds or nominal bonds, changes in inflation expectations primarily drive relative performance. For the purpose of discussion, consider three possible scenarios that may occur over the holding period. The initial inflation expectations are set upon purchasing the bond. This fact is important because inflation expectations at that time may differ markedly from inflation expectations when issuing the bond. For simplicity, the following examples assume a holding period from issuance to maturity.

The first scenario assumes that realized inflation exceeds initial inflation expectations. Under this scenario, inflation-linked bonds should be expected to outperform nominal bonds. For example, assume that a 10-year Treasury and a 10-year TIPS bond are issued with yields of 2.8 percent and 1.0 percent, respectively. The 10-year Treasury bond yield is quoted in nominal terms while the TIPS bond yield is quoted in real terms. At the time of issuance, the break-even inflation rate is 1.8 percent. In 10 years, both issues mature and the average annual inflation over the term was 2.0 percent. An investor who held the 10-year Treasury bond from issuance to maturity received a total of $280 in coupon payments plus par value of $1,000 for a total of $1,280. An investor who held the 10-year TIPS bond from issuance to maturity received about $112 in coupon payments plus the par value of $1,119 for a total of $1,331. However, over the 10-year period, an additional 0.2 percent annually eroded the purchasing power of the investor who held the nominal Treasury bond. After receiving and adjusting for inflation all coupon and principal payments, the investor who held the 10-year Treasury bond has a purchasing power equivalent to $1,072, compared to the investor that held the TIPS bond with a purchasing power equivalent to $1,100. In other words, the investor who held the Treasury bond earned a real return of 0.8 percent, compared to the investor that held the TIPS bond and earned a real return of 1.0 percent. Table 19.2 summarizes the cash flows for the both bonds in nominal and real dollars. Note that the cash flows for the TIPS bond remain constant in real terms compared to the Treasury bond whose cash flows decrease after adjusting for inflation. Since inflation over the holding period exceeded inflation expectations that were assumed at issuance, the TIPS bond outperformed the Treasury bond by 20 basis points.

Table 19.2 **Treasury versus TIPS When the Realized Inflation Exceeds the Break-Even Inflation Rate**

	In Nominal Dollars		*In Real Dollars*	
Period	*10-year Treasury*	*10-Year TIPS*	*10-Year Treasury*	*10-Year TIPS*
0	–1,000.00	–1,000.00	–1,000.00	–1,000.00
1	28.00	10.20	27.45	10.00
2	28.00	10.40	26.91	10.00
3	28.00	10.61	26.39	10.00
4	28.00	10.82	25.87	10.00
5	28.00	11.04	25.36	10.00
6	28.00	11.26	24.86	10.00
7	28.00	11.49	24.38	10.00
8	28.00	11.72	23.90	10.00
9	28.00	11.95	23.43	10.00
10	1,028.00	1,231.18	843.32	1,010.00
Rate of return	2.80%	3.00%	0.80%	1.00%

This table shows the cash flows and rates of return for a Treasury and an inflation-linked bond during a period where realized inflation over the holding period exceeds the break-even inflation rate at the beginning of the holding period.

The second scenario involves realizing initial inflation expectations over the holding period. Under this scenario, nominal and inflation-linked bonds should be expected to generate identical returns. For example, assume a similar scenario where a 10-year Treasury and a 10-year TIPS bond are issued with the same yields of 2.8 percent and 1.0 percent, respectively. At the time of issuance, the break-even inflation rate is still 1.8 percent. However, 10 years later both issues mature and the average annual inflation over the term were equal to the break-even inflation rate at the time of issuance of 1.8 percent. An investor who held the 10-year Treasury bond from issuance to maturity received the same coupon and principal payments totaling $1,280. An investor who held the 10-year TIPS bond from issuance to maturity received $111 in coupon payments plus the par value of $1,195 for a total of $1,306. After receiving and adjusting for inflation all coupon and principal payments, the investor who held the 10-year Treasury bond has a purchasing power equivalent to $1,100, which is identical to the purchasing power of the investor who held the TIPS bond over the same period. In other words, the investor who held the Treasury bond and the investor who held the TIPS bond both earned a real return of 1.0 percent. Table 19.3 summarizes the cash flows for both bonds in nominal and real dollars. The cash flows for the TIPS bond remain constant in real terms. Although the cash flows of the Treasury bond are diminished in real terms, the

Table 19.3 **Treasury versus TIPS: Realized Inflation Equals Break-Even Inflation Rate**

	In Nominal Dollars		*In Real Dollars*	
Period	*10-Year Treasury*	*10-Year TIPS*	*10-Year Treasury*	*10-Year TIPS*
0	–1,000.00	–1,000.00	–1,000.00	–1,000.00
1	28.00	10.18	27.50	10.00
2	28.00	10.36	27.02	10.00
3	28.00	10.55	26.54	10.00
4	28.00	10.74	26.07	10.00
5	28.00	10.93	25.61	10.00
6	28.00	11.13	25.16	10.00
7	28.00	11.33	24.71	10.00
8	28.00	11.53	24.28	10.00
9	28.00	11.74	23.85	10.00
10	1,028.00	1,207.60	860.03	1,010.00
Rate of return	2.80%	2.80%	1.00%	1.00%

This table shows the cash flows and rates of return for a Treasury and an inflation-linked bond during a period where realized inflation over the holding period equals the break-even inflation rate at the beginning of the holding period.

real return of the two bonds remains equal because realized inflation over the holding period was equivalent to the inflation expectations that were priced in at issuance.

The third scenario is one in which realized inflation over the holding period is less than initial inflation expectations at the time of issuance. Under this scenario, nominal bonds should be expected to outperform inflation-linked bonds. For example, again assume a similar scenario where a 10-year Treasury and a 10-year TIPS bond are issued with the same yields and the break-even inflation rate is still 1.8 percent. However, 10 years later both issues mature and average annual inflation over the term was 1.4 percent. An investor who held the 10-year Treasury bond from issuance to maturity received the same coupon and principal payments totaling $1,280. An investor who held the 10-year TIPS bond from issuance to maturity received $108 in coupon payments plus the par value of $1,149, for a total of $1,257. After receiving and adjusting for inflation as well as all coupon and principal payments, the investor who held the 10-year Treasury bond has purchasing power equivalent to $1,130, compared to the investor who held the TIPS bond with purchasing power equivalent to $1,100. In other words, the investor who held the Treasury bond earned a real return of 1.4 percent, compared to the investor who held the TIPS bond and earned a real return of 1.0 percent. Table 19.4 summarizes the cash flows for the both bonds in nominal and real dollars. Although the cash flows of the Treasury bond are

Table 19.4 **Treasury versus TIPS When the Break-Even Inflation Rate Exceeds Realized Inflation**

	In Nominal Dollars		*In Real Dollars*	
Period	*10-Year Treasury*	*10-Year TIPS*	*10-Year Treasury*	*10-Year TIPS*
0	–1,000.00	–1,000.00	–1,000.00	–1,000.00
1	28.00	10.14	27.61	10.00
2	28.00	10.28	27.23	10.00
3	28.00	10.43	26.86	10.00
4	28.00	10.57	26.49	10.00
5	28.00	10.72	26.12	10.00
6	28.00	10.87	25.76	10.00
7	28.00	11.02	25.40	10.00
8	28.00	11.18	25.05	10.00
9	28.00	11.33	24.71	10.00
10	1,028.00	1,160.65	894.57	1,010.00
Rate of return	2.80%	2.40%	1.40%	1.00%

This table shows the cash flows and rates of return for a Treasury and an inflation-linked bond during a period where realized inflation over the holding period is less than the break-even inflation rate at the beginning of the holding period.

diminished in real terms, they decrease at a rate less than the inflation expectations that were priced in at issuance. As such, the Treasury bond outperformed the TIPS bond by 40 basis points.

Summary and Conclusions

Investors of all types face the risk that inflation erodes the real value of their portfolios. They should understand the risks associated with inflation, particularly with respect for the unexpected changes in inflation. Although assets such as commodities, stocks, and real estate provide some inflation protection, their unique characteristics and correlation to other aspects of the economy prohibit their ability to act as a perfect hedge. Nominal bonds offer protection from expected inflation but fail to provide protection from unexpected inflation. Inflation-linked bonds are one of the few products that offer an absolute hedge from unexpected inflation. Although the difference between expected inflation and realized inflation primarily drive the relative performance of nominal bonds versus inflation-linked bonds, investors must also consider the risk of changes in the real interest rate. The market for these products has grown considerably over the last few decades with most issues now as being liquid as their nominal counterparts. Ultimately, investors must be proactive in their risk management strategies and allow their portfolios to remain dynamic, so they can adapt to changing market environments.

Discussion Questions

1. Explain the difference between the inflation protection that investors receive from nominal bonds compared to inflation-linked bonds.
2. Describe the effect of deflation on inflation-linked bonds and the type of protection offered by a deflation floor. Identify the economic environment that deters issuers from offering deflation protection.
3. James Jameson inherited a $1 million stock portfolio. He is concerned with the current valuations in the stock market and his primary goal is to maintain the portfolio's purchasing power while earning a minimal return. In 10 years, the individual plans to liquidate the entire portfolio. He is considering investing the entire portfolio in either 10-year Treasuries or 10-year TIPS. Discuss the factors that should guide his choice.
4. Jameson decides to ask his neighbor Michael Clay for advice. Clay tells Jameson that since Treasuries and TIPS are both risk-free securities, he should invest in Treasuries because of their greater yield. Convinced by his neighbor, Jameson decides to invest the entire $1 million portfolio in 10-year Treasuries with a yield of 3.0 percent, instead of 10-year TIPS with a yield of 1.2 percent. Identify why Clay's statement is incorrect with respect to comparing the yields of Treasuries versus TIPS. Calculate the break-even inflation rate at the time of Jameson's investment. If average inflation over the next 10-years is greater than the break-even inflation rate, which investment will have better performance?

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PART V

SECURITIZED PRODUCTS

20

Securitization Process

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Introduction

Securitization is the transformation of one set of contractual cash flows into a different set of cash flows. This process of pooling relatively illiquid assets such as loans and selling slices or tranches of those pools as bonds dramatically increased the credit available to consumers and businesses over the past several decades. Securitization continues to connect users of capital (borrowers) to a larger set of capital providers (investors). Where banks and private lenders previously provided liquidity to borrowers, securitization gave access to hedge funds, pension funds, insurance companies, and other institutional bond investors, effectively lowering the cost of capital for borrowers and offering a higher return, and diversified exposure to otherwise difficult-to-access asset classes.

Beginning in the 1970s, the rise of securitized assets gave firms wanting to raise capital an additional venue for raising funds or meeting liquidity requirements. When compared to more traditional methods, the formation of these newer securities provided potential benefits for both borrowers and investors. Borrowers gained access to lower financing costs or increased liquidity and investors obtained increased access to otherwise inaccessible assets while providing diversification and attractive potential yields. These benefits are derived through a complex security structure of transforming illiquid assets into liquid securities, often requiring the cooperation of numerous entities including originators, trustees, servicers, and special servicers with varying responsibilities and incentives. This complex structure can be tailored on a case-by-case basis to meet the needs of both borrowers and investors, generating an end product desirable for both parties.

Overview of the Securitized Market

The securitized assets in today's market can be traced to 1970 with the issuance of the first mortgage-backed security (MBS) issued by the Government National Mortgage Association (GNMA), better known by its nickname "Ginnie Mae" (Cowan 2003). The pass-through structure paid MBS bond investors out of collections of principal and interest from a pool of mortgage loans. As the market grew, so did the complexity of securitization structures. Issuers floated pools with multiple tranches or slices of bonds with different duration, yield, and risk profiles. Government agency issues soon opened the door for non-agency or private label securitization. Government sponsored enterprises (GSEs) such as Ginnie Mae, Fannie Mae (Federal National Mortgage Association), and Freddie Mac (Federal Home Loan Mortgage Corporation) issued agency MBSs. Private financial institutions issued non-agency MBSs and saw large demand leading up to the financial crisis of 2007–2008. Originating in the single-family mortgage loan market, securitizations and structured products have expanded into commercial real estate, credit cards, student loans, receivables, leases, and other contractual cash flow assets that can be pooled and sold in tranches. Securitized products are generally grouped into residential mortgage-backed securities (RMBSs), commercial mortgage-backed securities (CMBSs), asset-backed securities (ABSs), and other synthetics including collateralized debt obligations (CDOs), collateralized loan obligations (CLOs), and credit default swaps (CDSs). The process of securitization continues to grow and evolve to meet the changing demands of regulators, borrowers, and investors.

According to the Securities Industry and Financial Markets Association (SIFMA), outstanding volume of U.S. agency and non-agency MBSs, CMBSs, and other ABSs was roughly $10.3 trillion in 2016, with additional issuance of $2.2 trillion helping to offset maturing securities, providing an overall growth of 1.3 percent over 2015. On average, the daily trading volume of these securities was $209.9 billion (SIFMA 2017a). Other ABS categories such as automotive loans, credit card receivables, and student loans comprised $193.6, $130.5, and $188.6 billion of outstanding balance, respectively. Non-agency CMBSs and RMBSs comprised $531.5 and $853.4 billion of outstanding balance, respectively, while agency MBSs totaled about $6.5 trillion (2017b, 2017c).

The markets for all these security types have grown tremendously since their origins. Agency MBSs surpassed the $100 billion total balance outstanding milestone by 1980, $1 trillion by 1990, and $5 trillion by 2009. In contrast, non-agency MBSs surpassed the $100 billion total balance outstanding by 1987, $1 trillion by 2001, and a peak of roughly $3.5 trillion in 2007. However, the total value pulled back dramatically post-2007 due to negligible subprime issuance during the recession. As for other ABSs, they surpassed the $100 billion total volume outstanding by 1992, $1 trillion by 2004, and hit a peak of nearly $2 trillion by 2007. The total market has retreated since 2007 as private subprime RMBS and CDO issuance fell close to zero and CMBSs went dormant for several years before rebounding slowly starting in 2011 (SIFMA 2017b, 2017c).

Benefits and Drawbacks for Borrowers and Lenders

For borrowers, the main benefits of securitization fall into two categories: lower owner financing costs and greater liquidity. The securitization process in some cases allows a firm to raise capital at a lower cost than might otherwise be achieved with a plain vanilla corporate bond issuance or bank loan. For example, consider a commercial real estate investor wanting to finance the purchase of a large building. Before securitization, the investor would most likely seek a loan from a bank or insurance company. Interest rates and availability of credit for the investor would be affected not only by the property's intrinsic value and risk but also by the bank or insurance company's capital requirements, asset liability management needs, and risk limits. The growth of securitization added another lender group to the market whose rates and loan terms were determined by the market rates or bond spreads achievable in the securitized market. By increasing the amount of capital provided by a broader set of investors, securitized lenders can offer loans at lower cost to borrowers across the risk spectrum. A bank or insurance company might price the loan at 5 percent whereas a securitized lender might be able to sell a diversified pool of loans with a 4 percent weighted average coupon and can therefore price the single loan at 4.75 percent. This diversification benefit also reduces the cost of capital to higher risk loans as strong borrowers or properties decrease the weighted average coupon required by bond investors.

Securitization also increases liquidity in previously illiquid markets. Investors can generally buy and sell stocks and bonds on an ongoing basis. However, the same does not necessarily apply to other assets. Loans with large principal balances, such as mortgages or corporate loans, can be difficult to liquidate without selling at a substantial discount to par value. Securitization alleviates this issue by allowing a lender to sell loans into a securitization at competitive prices and recycle that capital over time instead of just lending once and collecting over a long period. Continuing with the same example, before securitization, a lender would originate the loan on the property and hold that loan on its balance sheet for the loan's full term, possibly up to 30 years. Portfolio lending groups within banks and insurance companies still originate loans to hold on their balance sheets in order to fund long-term liabilities but securitization has added a whole new sector of lenders and investors in these debt markets. Compared to the balance sheet lenders, securitized lenders have different goals: to maximize revenue and profits while taking minimal long-term balance sheet risk. In this example, a securitized lender can originate a loan, place it into a larger pool of similar loans, and sell the pool into the securitized bond market. This process allows the lender to lend the same money two or three times per year, aiming to make a small percentage profit each time on the loan amount. Securitization also transfers the risk of the loan from the lender to the bond investors so the lender only carries the balance sheet risk for the short time between loan origination and securitization.

One key determinant of a firm's cost of financing is the firm's credit rating. These credit ratings are calculated through a host of criteria, including a firm's history of meeting its obligations, current capital structure, and general outlook for future operations. An unfavorable credit rating, such as being labeled below investment grade by one of the three largest rating agencies—Moody's, Standard & Poor's, and Fitch—leads to higher financing costs. Securitization can help a lower-rated firm raise funds at a lower cost of capital through the use of bankruptcy remote, off-balance sheet entities commonly referred to as special purpose vehicles (SPVs) or special purpose entities (SPEs). In many instances, a firm looking to raise funds from securities to be issued from an SPV approaches a credit rating agency with a proposed structure of credit ratings for each security class. The firm and agency then work in tandem to achieve the desired ratings for each security through negotiating the credit enhancements or protections for each class to achieve desired ratings (IOSCO Technical Committee 2008). While lowering the cost of capital for the issuing firm, this process can also raise conflict of interest questions since the issuer of the securities is paying the rating agency to rate the securities.

Increased liquidity is beneficial to banks in particular, assisting in tasks such as asset and liability management and capital recycling. Banks often use securitization to correct a duration mismatch between assets and liabilities used to fund them, where shorter-term liabilities such as deposits and certificates of deposit (CDs) are used to fund longer-term, less-liquid assets such as commercial loans or mortgages. Whereas larger banks may experience less pressure from mismatches due to diverse operations, smaller and medium-sized banks can resort to securitizing assets to raise cash when necessary to meet liabilities or fund new assets. As a result, they can carry less cash or liquid investments during normal operations (Loutskina 2011). Overall, the possibility of securitizing assets, especially mortgages, helps to reduce risks of insolvency and leads to increasing leverage and profits for banks (Jiangli and Pritsker 2008).

Although securitization offers many potential benefits, firms resorting to issuing securitized assets may encounter several drawbacks, mostly due to the same structure complexity that helps drive the benefits. For example, the creation of a securitized asset entails many more parties than the issuance of traditional fund-raising methods using stocks or bonds. These parties, such as trustees and servicers, must oversee the operations of the securitized assets to assure the investors receive promised payments. Each party has an associated cost that, when combined with the costs of marketing the securities through underwriters, may lower the benefits provided by the securitization process.

Benefits and Drawbacks for Securitized Bond Investors

For investors, the securitization process has resulted in benefits including diversification and access to new assets with unique risk, return, and duration profiles. In purchasing a securitized asset, an investor is buying a share of the underlying asset pool, which may be comprised of assets such as credit card receivables, automobile loans, or student loans. All of these investments are relatively difficult to access directly. By buying a tranche of a pool of assets, the investor benefits by accessing the sector without taking the risk of lending to a specific borrower. The larger and more diverse the pool, the greater are the diversification benefits and likely the lower the yield an investor can demand. For example, consider a pool of single family mortgages. A bond investor does not have the expertise, infrastructure, or time to build a platform to originate and service single family loans. However, that bond investor may have an appetite to invest in the single-family mortgage market given the high risk-adjusted returns and long durations, thus that same investor would pay a higher price for a piece of a well-diversified, high credit pool with geographic dispersion, high average credit scores, and strong loan structures. In contrast, a high yield bond investor might be willing to take the risk of buying into a lower rated tranche of the same pool or a different, riskier pool. Investors can gain exposure to the appropriate amount of risk through both pool and structure selection.

Structuring the Securitization

Structuring is the technical engineering behind securitization. It entails building the pool of assets, forecasting cash flows, and slicing those cash flows into different bonds. During the structuring process, securities of varying risk, return, and duration profiles are created based on market demand and rating agency feedback. The tranching process creates a senior-subordinate structure between the respective bonds in the securitization. This process is often referred to as a "waterfall" structure. The *waterfall structure* indicates that principal and interest flow from the top of the list of bonds, also known as the *capital stack*, to the bottom. Losses, conversely, flow from the bottom of the stack to the top. As a result, the top of the stack consists of higher rated, lower yielding bonds while the bottom of the stack is lower rated and higher yielding with a greater probability of loss. The risk profile of each security can be customized further through various credit enhancements such as *overcollateralization*, where the asset balance is greater than the bond balance, creating a capital cushion to absorb losses before the bond holders.

The resulting yield of a securitized asset can offer a sizable spread over a traditional corporate bond with the same credit rating. The varying risk-return profiles appeal to different investor types: the safer classes to large-scale institutional buyers such as insurance companies and pension funds and the riskier classes to more speculative investors such as hedge funds and private equity.

In addition to default risk, interest rate and reinvestment risk can be higher for securitizations relying on cash flows from amortizing assets without prepayment restrictions. Securitized assets backed by amortizing loans, such as traditional fixed-rate mortgages, have continual principal and interest payments with an expectation of timely principal payments gradually amortizing the loan balance over time. If interest rates suddenly drop, however, some mortgages could be refinanced, leading to an unexpected influx of principal repayments at a time when returns on possible reinvestment options are dropping. The underlying asset selection could also suffer from misaligned incentives stemming from an originate-to-distribute model. For example, issuers knowing they will not bear the risk of default may become lax or even negligent in their credit underwriting standards and procedures, which contributed to the financial crisis of 2007–2008 (Blankenheim, Jones, Lindner, and Segoviano 2013).

Origination

Before securitization occurs, a securitized issuer needs to identify and perhaps purchase the assets from which the ABS or MBS derives its value. The most common forms of securitization are based on various types of loans. When the financing firms originate the loans to be securitized, the underlying assets need not be purchased, as they already exist on the balance sheet of the firm repackaging them for sale. Moving these assets off their balance sheet via the securitization process is a strategic decision to free capital that the firm may then deploy in further originations.

Although loans form the largest class of assets that are repackaged in securitized assets, any contract that generates cash flows can be used in this fashion. *Bowie bonds* are an example of an esoteric asset used in securitization in which investment bankers used David Bowie's royalties and other income generated from his 25 albums issued before 1990 to secure the bonds' interest payments (Bird and Stubbington 2016). *SPVs*, legal entities that exist to manage and distribute the cash flows from an underlying pool of assets, are also common when packaging bonds and other securitized assets. Some SPVs publish a prospectus outlining the assets that they intend to package and how the cash flows from those assets are to be distributed, and then seek investors to raise the capital to buy those assets. Originators themselves also create vehicles to move these assets off their balance sheet. These legal constructs are typically classified as trusts that get special tax treatments as "pass through" entities (Fish and Moser 2011).

Many products constitute ABSs such as CDOs, CLOs, and CBOs. In each case, the construction relies on a pool of other assets from which the new products derive their value. Some specific and important types are discussed in the following sections.

Residential Mortgages

The residential mortgage market is one of the largest sources of securitization. Mortgages are "pooled" by their originators based on some internal classification scheme, and then repackaged as securitized assets known as RMBSs for sale in a secondary market, with the proceeds from these sales used to finance further mortgage issuance. Classification schemes for pooling might include the credit ratings of the borrowers, type of residence collateralizing the mortgages, maturity dates on the mortgages, whether the rates are fixed at origination or float, or level of loan documentation. In the early 1990s, Norwest Mortgage had special pools for loans that had deficiencies in their closing and execution documents. These pools were rarely sold to other investors due to these deficiencies. Although individual mortgages are fraught with idiosyncratic risk, pools of mortgages tend to follow predicable patterns of prepayment, late payment, and default, allowing for relatively simple valuation and risk analysis. Figure 20.1 shows the outstanding principal balance for residential and commercial MBSs between 2013 and the third quarter of 2017, which is roughly \$3 trillion for each period. The outstanding balance levels show relative stability because as older mortgages and their MBS mature, new issues take their place.

Commercial Mortgages

Commercial mortgages are another popular asset class used in the creation of ABSs. These mortgages differ from residential mortgages across several dimensions. The properties serving as collateral for the loans are more heterogeneous than single family houses and the structure of the loans themselves are much more complex and unique from loan to loan. Originators of these assets are more likely to split their deals into

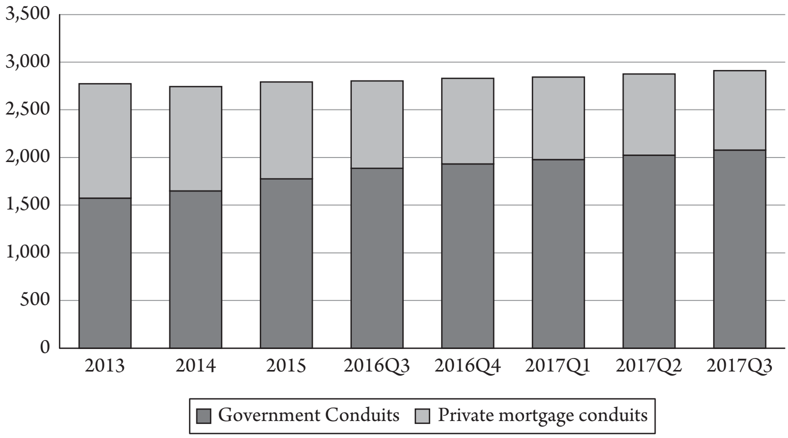

Figure 20.1 End-of-Period Data from the Federal Reserve on Mortgage Pools and Trusts
The figure shows the outstanding principal balance of RMBSs in billions of dollars between 2013 and the third quarter of 2017.
Source: Board of Governors of the Federal Reserve (2017).

loans they want to keep on their balance sheets and those they want to securitize. The latter group is more uniform. CMBS loans routinely have strict prepayment limitations due to their size in relation to the securitized pool of assets. One CMBS loan prepaying can have a large effect on bond holders' returns. Compared to an average RMBS deal that can have thousands of loans, an average CMBS deal has 50 to 100 loans so each loan has a larger effect on the deal as a whole. The CRE Finance Council (CREFC) publishes considerable information on CMBSs and the various market participants in that market (CMSA 2007).

Credit Cards and Student Loans

Consumer credit cards and student loans are routinely used in the construction of ABSs. Figure 20.2 provides data from SIFMA on the principal associated with ABS issuance since 1985. In this context, MBSs are placed in the CDO classification. Figure 20.2 relates to new issuance of all ABSs, while Figure 20.1 indicates all outstanding principal for just the RMBS subset of the ABS market.

More Esoteric Sources

Included in Figure 20.2, "All other sources" is the "Equipment" class, contributing roughly 10 percent to that category. Capital-intensive equipment such as aircraft, bulk shipping containers, mining equipment, and heavy construction machinery are often leased or otherwise financed. These contracts are pooled and securitized in much the same fashion as the other ABSs. Even receivables for large companies can be securitized to accelerate the realization of cash for the firm. The overall theme here remains the

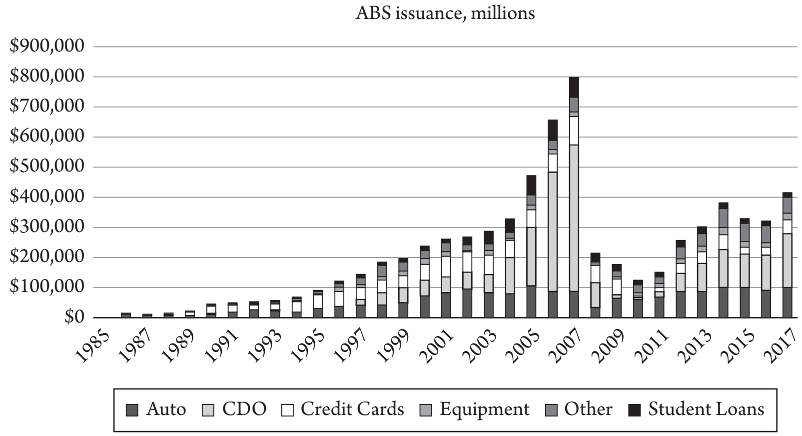

Figure 20.2 Data on ABS Issuance by Asset Class

The figure shows the amount of new issuance of securitized products in billions of dollars split between CDOs and all other types. It shows how prevalent CDO issuance was leading up to the credit crunch in 2008.

Source: SIFMA (2017b).

same—similar contracts that exhibit idiosyncratic risks and low liquidity can be pooled and repackaged as assets with more predictable risks and greater liquidity. Each separate asset class exhibits its own set of risk profiles that are attractive to different market segments.

Market Participants

Any healthy market has natural buyers and sellers for each product. The supply side consists mainly of companies that originate capital-intensive contracts. These firms often monetize these positions and move them off their balance sheets, effectively generating new capital to focus on their core competence in originating more contracts. The companies include banks and other lending sources for mortgages and student loans, banks and credit card companies for credit card debt, and equipment manufacturers and their financers for equipment leases. Investment banks also contribute to the supply side, pooling bonds and commercial loans for their sell-side clients and carefully constructing CDOs and CLOs to match the risk appetites of their buy-side clients.

Perhaps less obvious is the demand side for these assets. The pools of contracts that are used in creating an ABS rarely result in a monolithic product: each pool ends up as the partial source for several different products, each with its own set of risk profiles. This structuring process is discussed in the following section and is central in identifying the demand side participants. Investors faced with restrictions on the credit quality of their investments such as pension funds and insurance companies gravitate toward the safer pieces of the ABS that are issued from a pool, seeking yield and risk exposures that might not be readily available in more traditional debt. Hedge funds often buy the riskier pieces that remain. They are looking for specific risk exposures particularly in their areas of expertise, where they can have a more precise view on the risks for these products and required returns to bear that risk. Some investment banks many buy many similar ABSs and then use those products as a pool for a secondary securitization, such as a CDO-squared (Adelson and Whetten 2005). A *CDO-squared* is an investment in the form of a SPV with securitization payments backed by CDO tranches. Pricing and risk management of these products is highly complex. Regulatory mechanisms are also in place to ensure that the issuers of ABSs retain some of the first loss risk in each product to ameliorate the problem of misrepresenting the risks inherent in the products that they construct.

Structuring: Creating the Securitization

At the core of securitization is repackaging the cash flows from the underlying contracts for their ultimate owners. This process is known as *structuring*, which is why many ABSs are classified as structured products. Important features of these structured products include scheduled payments from interest and principal in the pooled contracts and fees for the structuring vehicles. These cash flows form the basis for the waterfall structure for the structure. Not surprisingly, some contracts fail to perform as promised, delinquencies occur, and possibly defaults. Structuring can provide protection from losses for lower risk investors and higher possible returns for investors willing to take greater risk.

Tranching

The most fundamental role in structuring is termed *tranching*. In structured finance, a *tranche* is one of a number of related securities offered as part of the same transaction. The word tranche is French for slice, section, series, or portion. Each pool of contracts results in at least two tranches. Each tranche is assigned a credit rating and exhibits its own set of risks. More senior tranches have higher priority on the cash flows that the pool generates and generally bear less exposure to the erosion of principal due to delinquency and default. The idea is to create at least one "credit enhanced" tranche that is attractive to investors who are unable to participate in riskier investments but desire exposure to the underlying risk factors in the pool. Figure 20.3 illustrates how risk averse investors might choose a more senior and lower risk tranche. Each ratings class has an attached notional (principal exposure) and periodic coupon rate promised. The more senior portions have first rights to the interest payments in the pool, until the promised periodic interest payment is satisfied, at which point interest payments are allocated to the next junior tranche, and so forth.

At the same time, the most junior tranches face the first default risks, which would reduce the notional amount their promised interest payments would be calculated against, as well as limiting the ultimate return of invested principal. Principal is generally paid in the same order as mentioned above for interest, from the top of the structure downward. This situation can lead to prepayment risk (contraction) at the top end of the securitization and extension risk at the lower end of the structure. Structurers often include planned amortization class (PAC) bonds in a structure that is largely protected

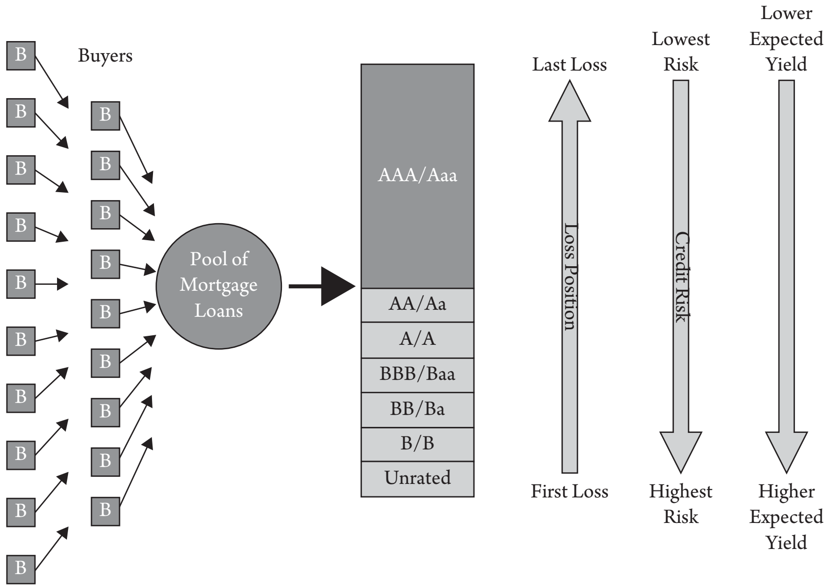

Figure 20.3 Graphic Representation of Different Risk and Return for Investors in a Mortgage-Backed CDO

This figure is a simplified visualization of the securitization process, including the pooling of assets, tranching of bonds, and risk-return trade-off in different parts of the capital stack. Each ratings class is a tranche.

Source: Splettstoesser (2009).

from prepayment. A PAC bond generally requires a support bond in the structure that can absorb the unplanned prepaid principal amounts up to a pre-specified limit. Because the weighted average coupon, or loan rate, of the underlying pool of assets is often higher than the yield required by senior bond buyers, structurers often include one or more interest only (IO) bonds to profit from this arbitrage. These bonds have notional balances based on a percentage of the outstanding principal balance of the deal or of specific tranches. The bonds pay interest on the outstanding notional balance but pay no principal. As a result, they are priced well below their notional balance but, because no principal is attached to these tranches, proceeds from the sale of IO bonds are pure profit to the issuer. The issuer's goal is to structure the securitization in a way that satisfies bond investor demand while maximizing bond sale proceeds.

Credit Enhancement

Credit enhancement of a tranche is the percentage loss the tranche can withstand before that tranche suffers a principal loss. The higher up in the capital stack, the higher a bond's credit enhancement needs to be. Consider a $100 million pool of mortgages securitized and sold in two tranches: (1) A (Senior) with $70 million principal, and (2) B (Junior) with $30 million principal. The A tranche has a credit enhancement of 30 percent while the B tranche has no credit enhancement. The pool would have to experience more than 30 percent in collateral loss before the A class absorbs any losses. As a result, the A bond generally is rated higher than the B bond, offers a lower yield, and may be priced above par depending on the risk and weighted average coupon of the underlying pool.

Pension funds and other institutional investors, including university endowments and insurance companies, often have strict limitations on the types of fixed-income investments they can buy. At the same time, they want to diversify their risk profiles, while enhancing their yields. Structured products are sometimes tailor-made for this purpose. Clients approach investment banks to structure a completely bespoke (customized) deal to match a desired risk profile, often including a specific rating. Investment banks also put together deals knowing the kinds of risk profiles their clients prefer, and the limitations that their clients have on investment vehicles. As a result, the ratings agencies may be consulted to help achieve those goals. The most senior tranches can be highly rated due to their insulation from shortfalls in expected interest payments from delinquencies and defaults. In contrast, the more junior tranches bear this risk and exhibit enhanced yields to compensate. Determining the exact cutoffs between tranches and hence credit ratings is highly sensitive to assumptions about the performance of the contracts that comprise the pool. Here again the ratings agencies may be involved. *Overcollateralization* helps in this process. That is, the principal attached to the underlying pool often exceeds the notional principal attached to the collective tranches that are sold to provide additional insulation from the credit risks inherent in the underlying assets.

Equity Participation

The most junior tranche derived from an ABS pool is often referred to as the *equity tranche, residual tranche*, or *B piece* in structures with few tranches. This most junior portion of the securitization represents an equity stake in the SPV that comprises the whole pool. Poor performance has a disproportionate impact on its value as first-loss position, and positive performance provides much greater returns than the more senior tranches. Regulations guarantee that the issuer (i.e., the owner of the SPV) retains a portion of the pool as an agency mechanism. This situation creates another set of goals to be considered in constructing the overall waterfall. The equity tranche has rights only to the cash flows after satisfying the promised payments to the more senior tranches.

Synthetic CDOs

Synthetic CDOs are closely related to cash flow-based ABSs. Where true ABSs rely on the cash flows of actual contracts that are bundled and managed by an SPV, synthetic CDOs have cash flows that are determined by the performance of CDSs. In fact, the CDSs do not even have to be purchased to serve as the basis for cash flow payouts. In essence, a virtual portfolio of CDSs is created, and then sliced into tranches that represent the default exposure to the underlying pool. Each CDS has a reference bond. If that bond defaults, the protection seller is required to provide a "make-whole" payment to the protection buyer, who pays a periodic coupon for that privilege. If no default occurs, the seller simply earns that coupon until the contract matures with no contractual payment. With a pool of CDSs as the reference, the state of the underlying bonds can be tracked, and tranches against that pool can be constructed with notional levels that refer to the remaining, non-defaulted principal for the reference pool of bonds. When a default occurs, the loss portion of that bond's notional is charged against the most junior tranche, and the recovery portion—determined in the bond auction after default—is charged against the notional in the most senior piece. In this setting, very specific risk profiles can be constructed as the entire capital structure need not be sold. Hence, the pool of assets contributing to the CDO is completely virtual, and the notional exposures are computed via simple accounting of payments, if any, in the CDS market. The synthetic CDO market grew and collapsed in much the same pattern as the mortgage-backed CDO market. New issuance of synthetic CDO has been sparse since 2008, dropping to only $20 billion in notional in 2015. A small resurgence of shorter maturity, full capital structures has reached $100 billion in 2017 (Alloway 2017).

Hedging Considerations

Originators and issuers of securitizations may hedge their interest rate risk between origination and securitization depending on the particular product. Banks and other issuers who originate loans or other contracts with the goal of securitizing them bear interest rate risk on those assets in the period between origination and securitization. When a bank prices and originates a loan based on prevailing interest rates and ABS bond yields, if those yields go up (sending bond prices down) before securitization, the bank could end up selling that loan into a pool at a loss. Most issuers that warehouse loans before securitization exercise some interest rate hedging during this time of *warehouse risk*. Issuers most commonly use interest rate swaps and CDS to cushion any adverse interest rate movements between loan creation and securitization.

Hedging instruments may also be included in a securitization, especially in more esoteric products such as CDOs because these ABSs have constituent contracts that have considerable interest rate exposure, hedging those risks is routinely done via standard interest rate products such as swaps and swaptions. Considering the overall portfolio's duration and whether the cash flows represent fixed or floating payments helps to guide the selection of hedging instruments. How sensitive the assets comprising the pool are to parallel shifts of the yield curve compared to changes in steepness in that curve further informs the type of hedging instruments included in the securitization. Other risks must also be considered. For example, do the underlying contracts face prepayment risks? What factors drive those risks? What factors drive default risk? Sometimes appropriate hedging instruments are obvious, but in many instances assets that exhibit sensitivity to the same factors must be carefully sought out. Perfect hedging is virtually impossible because some risk must be borne to earn returns that exceed the risk-free rate. A careful understanding of risks that cannot be hedged in a given product should guide and inform the investors that seek to add these products to their portfolios.

Executing the Securitization

The process of transforming assets into securitized products and the ongoing servicing, including collection of loan payments and day-to-day communication with borrowers, entails numerous interconnected entities that must work in unison to assure investors that the process is likely to run smoothly and protect their interests. At the onset of a securitized asset issuance, the interrelations and responsibility of all parties involved are outlined in documentation referred to as the pooling and servicing agreement (PSA). Of the many entities, the most important parties overseeing the securitization include: the trustee, depositor, master servicer, special servicer, operating advisor, and B-piece buyer.

Pooling and Servicing Agreements

The *pooling and servicing agreement* is a document available to all investors of a securitized asset. If the issuance includes a public placement, the PSA is also filed with the Securities and Exchange Commission (SEC). The PSA outlines all steps within the securitization of assets, such as the creation of a trust to hold the collateral, the method of transferring assets to the trust, and the responsibilities and obligations of each party in servicing the securitized assets. Alongside the responsibilities are the criteria for when a party is considered to be failing in its obligations or in default and accompanying steps to remedy the issue, such as assigning another party or transferring responsibilities. Compensation rates and other associated fees to be collected by each party as payment are also outlined for investors to review.

The PSA sets out the rules around collecting and allocating cash flows from underlying assets to each class of securities in the particular deal. The PSA also outlines the treatment of asset maturities, since an asset's effective maturity can differ from the one originally stated due to changing circumstances. Examples include additional mortgage principal payments resulting in a shorter maturity or a defaulted asset that liquidates early through restructuring or bankruptcy proceedings. The PSA includes stipulations for how servicers handle bankrupt assets, often requiring outside party valuation of a distressed or defaulted loan before it is transferred between servicers to help protect investors' interest.

The securitized asset can be offered via a public or private placement with slight differences between the two. A public placement entails a general prospectus, which may include the PSA as one document, to be created and offered to all interested investors looking to purchase the product. A private placement entails two rounds of memoranda to be created: an initial memorandum to gauge interest and demand of prospective investors before the pricing of the securitized assets and a second memorandum following the pricing. Any single securitized asset issuance is not limited to only a public or private placement though, as both methods could be used in tandem to source demand for the entire issuance.

Trustee

The trustee's main obligation is to oversee investors' interest within the securitized asset by supervising the assets within the trust. The trustee oversees the transfer of assets to the final SPV, where they are subsequently pledged as collateral for the securitized pool. During this transfer, the trustee must confirm that all transferred assets have the proper titles and associated documents and are free of potential residual claims that may interfere with investors' interests. During normal operations, the trustee is responsible for collecting status reports on underlying loans and instances of defaults or other adverse events from servicers to compile and circulate to relevant entities, such as investors and credit agencies overseeing the securities. Should the party tasked with originating the assets fail to fulfill its obligations in supplying those promised, the trustee notifies investors and begins seeking corrective actions. Once the assets are pooled and the securitized assets begin to be serviced, the trustee must oversee that the servicers fulfill their obligations. Although the other servicers are responsible for collecting principal and interest payments from the underlying pooled assets, the trustee is responsible for subsequent payment calculations and distributions to investors. Should the servicers fail to fulfill their obligations, the trustee may be forced to replace the servicer as per the stipulations of the PSA. In this case, the agreement may already outline another servicer to assume responsibilities or in the case that another servicer cannot be found, the trustee may assume the responsibilities and act as a servicer as well.

Depositor

After the sponsor and other originators accumulate the underlying assets, the depositor acts as the transfer agent to execute the transfer of assets into the issuing trust or SPV. The depositor acts as the pooling entity to collect all underlying assets and facilitate the *true sale* of assets from the sponsor or originators to the final issuing entity. A true sale means that the seller has no more contractual claim or liability associated with the sold assets. A true sale means the connection between the seller and buyer is completely severed. The true sale helps guarantee bankruptcy remoteness and ensures proper taxation and accounting standards for the issuing entity. While in control of the assets, the depositor generally oversees the tranching process and the creation of the various classes of securities, during which the different securities are assigned their respective credit ratings. Once finished and passed to the issuing entity, the securities are ready to be sold to the end-market investors. The depositor also oversees the creation of the issuing entity, which could ultimately assume many forms and may entail more than one entity as per the bespoke conditions of each issuance.

Master Servicer

The master servicer is responsible for the general administration work involved in managing the securitized assets, including supervision of all assets and borrowers, maintaining all legal documents relating to assets in the trust and enforcing debtor's obligations as needed. The master servicer is responsible for collecting payments on behalf of the trustee and establishing escrow accounts to handle relevant expenses. In instances of delinquent payments from underlying assets such as mortgages, the master servicer typically covers the first four payments and respective expenses until the asset hopefully resumes normal operations. The master servicer receives compensation (around 20 bps) for these outlays later, through catch-up payments with accrued interest from the delinquent borrower or through bankruptcy proceedings (Cordell, Dynan, Lehnert, Liang, and Mauskopf 2008). With respect to the underlying assets, the master servicer is responsible for maintaining the accounting records, such as principal balances, interest rates, and necessary payments from borrowers, and periodically reviewing the credit risk of borrowers to report to investors and credit rating agencies. A securitized issuance may involve other servicers as well, referred to as *sub-servicers* that provide many similar functions and are overseen by the master servicer.

Special Servicer

Unlike the master servicer who handles the general administrative work, the special servicer is called upon to handle nonperforming assets or special situations. The special servicer handles nonperforming loans as per the rights and remedies outlined in the PSA. The special servicer's mandate is to maximize the present value of recoveries to bond investors including actions through foreclosure, loan modification, loan sale, or discounted payoff. Ultimately, the special servicer is required to act in the best interest of all investors. Checks and balances help ensure the interests of the investors such as requiring approval of the subordinate security investors, sometimes referred to as the *controlling class representative* (CCR). In many cases, the CCR selects the special servicer and, in some cases, chooses a related entity or subsidiary to exercise more control on the securitization. In general, the criteria for an asset to be transferred to the special servicer's control are outlined at issuance within the PSA. Common triggers include late payments and deteriorating financial performance of the borrower or collateral asset.

Operating Advisor

The operating advisor became common in post-crisis securitizations, especially CMBSs, and acts as an independent party overseeing the operations of the special advisor to assure that its decisions consider the best interest of all investors. Since the special servicer and CCR roles can sometimes have interrelated interests, the operating advisor is responsible for mitigating and sometimes eliminating this conflict of interest. The operating advisor provides feedback on the special servicer's operations on a periodic basis, normally in the form of an annual audit. For loans assigned to the special servicer, the operating advisor may review calculations and valuations as well as provide consultation in the case of asset transfers. For its services, the operating advisor is entitled to prespecified annual compensation, additional fee revenue from consulting services, as well as limited expense reimbursement.

B-Piece Buyer

The B-piece of a securitization consists of the bonds rated below investment-grade (BB+ or lower). B-pieces are in a first-loss position, meaning they are the least senior bonds and are first to absorb losses. As a result, investors who buy these securities—referred to as B-piece buyers—focus on the integrity of each underlying asset backing the securitization. B-piece buyers are keenly focused on all assumptions used to determine the original asset value. Should a sizable amount of assets appear problematic from the beginning, the B-piece buyers are likely to be less inclined to purchase the subordinate securities. B-piece buyers exert great influence over the formation of the securitized asset, the potential payout, and the composition of the asset pool. If the number of B-piece buyers is low, as was the case for initial securitized assets with varying tranches, they can drive up the bond yields and request excluding certain loans from the pool. B-piece buyers have very high pre-loss yield requirements to compensate for the assumed defaults and losses. Given the speculative and long-term nature of this investment, B-piece investors are often hedge funds, private equity, or subsidiary funds of special servicers with expert knowledge and experience in dealing with the particular securitized asset class.

Summary and Conclusions

After the Great Recession of 2007, the public perception of securitization and structured products was negative. Subprime mortgage securitizations along with the second and third derivative CDO and CDS instruments were one of the driving forces of unsustainable house prices and inadequate underwriting standards that eventually led to the economic downturn. Despite the negative perception, the market recovered and continues to recover as a result of low interest rates, economic growth, increased regulatory scrutiny, and improved risk management processes within securitized lenders. Overall, the benefits of securitization far outweigh the drawbacks. The process of pooling, structuring, and selling illiquid, idiosyncratic assets provides dual benefits to the capital markets. Investors gain access to otherwise inaccessible asset classes, return levels, and diversification. Borrowers gain access to a broader and more competitive source of financing. Securitization leads to lower costs of capital that increases asset values and to greater velocity of capital movement within the economy, allowing businesses to grow faster and the economy to expand rapidly. Excesses have occurred in the past and as with any business cycle, they are likely to recur in certain sectors and product types. Despite the excesses that might occur in some securitization markets, continued innovation paired with reasonable oversight is likely to promote efficient pricing and drive the market forward in the long term.

Discussion Questions

1. Discuss the main benefits of securitization for lenders/issuers and borrowers.
2. Identify potential drawbacks to the securitization of assets.
3. Describe the general structure of a securitization in terms of risk, reward, and ratings.
4. Identify the important executing parties in a securitization and their general duties.

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Mortgage-Backed Securities

Mortgage Pass-Through Securities

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Introduction

Mortgage-backed securities (MBSs) have served as an important tool for banks and thrifts to manage risk and increase liquidity by shifting some or all prepayment risk of residential mortgages and credit risk of commercial loans to MBS investors. However, MBSs and the securitization of subprime mortgage debt played a key role in the financial crisis of 2007–2008. Increased securitization and the shift of risk from originators to investors gave rise to incentive, moral hazard, and asymmetric problems (Keys, Mukherjee, Seru, and Vig 2010). These issues incentivized banks to issue mortgage loans that they normally would not, increasing the riskiness of the underlying assets of the MBS. Nevertheless, MBSs possess unique features: low correlation with equities, higher risk-adjusted returns than U.S. Treasuries, and high liquidity, which make them an appealing investment alternative, especially to investors seeking exposure to real estate. Today, MBSs continue to be one of the largest classes of fixed income securities, representing about 25 percent of the total outstanding U.S. bond market debt (SIFMA 2018a). Therefore, understanding both the benefits and the risks associated with this type of investment is essential.

This chapter provides an overview of MBSs. It begins with a brief history of MBSs, followed by a discussion of the current MBS market in terms of its market size and liquidity. Next, the second section discusses the securitization process of MBSs and the benefits of securitization to issuers and investors. The third section introduces three common metrics for MBS pools: the weighted average coupon (WAC), weighted average maturity (WAM), and weighted average loan age (WALA). The fourth section provides an overview of the subtypes of MBSs, including agency and private-label MBSs, pass-through securities, and collateralized mortgage obligations (CMOs). The fifth section discusses primary risks in MBS investments, with a focus on prepayment risk for residential MBSs and credit risk for commercial MBSs. The final section provides a summary and conclusions.

MBS History and the Current Market

Buyers generally use a mortgage loan to help finance the acquisition of a commercial or residential real property, whereby the lender places a lien on the property as a security for its claim. Existing property owners who want to monetize some of the equity in their property can also use mortgage loans. A *mortgage-backed security* is a security whose underlying assets are mortgage loans.

Early examples of MBSs date back to the nineteenth century with the use of railroad farm mortgage (RRFM) and the RRFM-backed securities (Riddiough 2013). However, the substantial growth and proliferation of these securities did not occur until the late 1970s when the U.S. government authorized the Federal National Mortgage Association or FNMA (known as Fannie Mae) and the Federal Home Loan Mortgage Corporation (FHLMC), known as Freddie Mac, to purchase private mortgages. Bank of America issued the first private-label pass-through in 1977. It was also the first mortgage security designed to address the prepayment risk associated with residential MBSs by introducing tranches with specified maturity and credit characteristics, rather than simply passing through interest and principal payments from the underlying mortgages. A *tranche* represents a slice of an MBS with distinct cash flows, priority of payment and maturity. MBSs can have multiple tranches with varying degrees of risk, appealing to different investors. In 1978, Salomon Brothers established the first mortgage finance department on Wall Street, which marked the beginning of the era of the MBSs and ended with the financial crisis of 2007–2008. During the MBS era, the MBS market quickly expanded from about 5 percent of the U.S. bond market debt in 1980 to more than 30 percent in 2006 (SIFMA 2018a). MBSs were the largest fixed income asset class between 1999 and 2010.

Agency MBSs versus Private-label (Non-Agency) MBSs

The U.S. MBS market consists of two major sectors: (1) agency MBSs, created by one of the three government-sponsored organizations—the Government National Mortgage Association (GNMA or Ginnie Mae), Fannie Mae, or Freddie Mac and (2) private-label (non-agency) MBSs. According to the Securities Industry and Financial Markets Association (SIFMA 2018b), the outstanding volume of MBSs was around $9.3 trillion as of 2017. Figure 21.1 shows that the MBS market size expanded quickly in the first years of the new millennium from about $5 trillion to more than $9 trillion in 2007. Between 2008 and 2012, the volume of outstanding MBSs decreased slowly to around $8.7 trillion in 2013 and then recovered to gradually reach a level similar to that of its pre-crisis peak in 2017.

The financial crisis of 2007–2008 did not appear to affect the size of the MBS market. Rather, its effect was to diminish the role of private-label issuers and substantially decrease the size of the non-agency market. In contrast, the volume of agency securities increased from $4.5 trillion to about $7 trillion between 2007 and 2017 (SIFMA 2018b). Examining the annual issuance of MBSs in Figure 21.2 provides further insights in the dramatic growth and decline of the non-agency MBS market between 1996 and 2016.

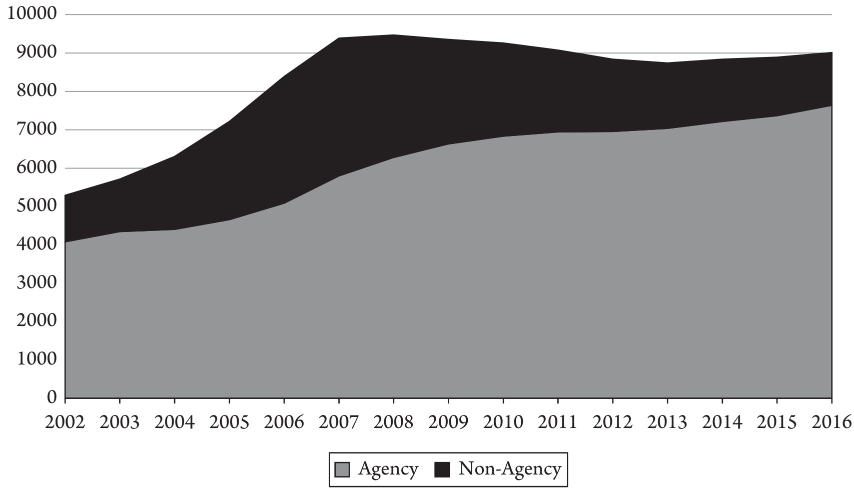

Figure 21.1 Annual Mortgage-Related Securities Outstanding
This figure shows the annual value of mortgage-related securities outstanding in billions of USD for the U.S. mortgage-related market between 2002 and 2016. Agency securities include MBSs and CMOs.
Source: SIFMA (2018b).

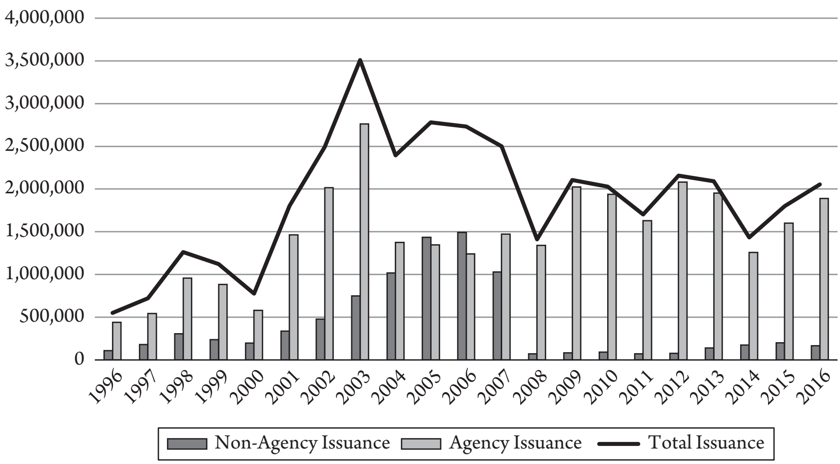

Figure 21.2 Annual Mortgage-Related Securities Issuance
This figure shows the annual issuance of mortgage-related securities in millions of USD for the U.S. mortgage-related market between 1996 and 2016.
Source: SIFMA (2018b).

The agency MBS market is both large and liquid. Table 21.1 presents statistics on the average daily trading volume between 2015 and 2017 in the agency and non-agency MBS markets versus daily trading volumes in the corporate, municipal, and Treasury bond markets. According to Table 21.1, the average daily trading volume of agency MBSs was about $280 billion versus only $110 billion for the corporate bond market,

Table 21.1 **Average Daily Trading Volume of MBSs versus Other Fixed Income Securities**

Year	*Agency MBSs*	*Non-Agency MBSs*	*Corporate Bonds*	*Municipal Bonds*	*Treasury Bonds*
2015	$266,239	$2,317	$103,564	$6,069	$475,165
2016	292,255	1,981	107,107	7,081	499,755
2017	285,692	2,191	119,581	6,969	487,429
Average	**281,368**	**2,163**	**110,023**	**6,705**	**487,450**

This table shows the average daily trading volumes of agency MBSs, non-agency MBSs, corporate bonds, municipal bonds, and Treasury bonds in millions of USD.

Source: Federal Reserve Bank of New York (2018).

which was much lower than the trading volume of Treasury bonds of around $487 billion. Relative to the agency MBS average daily trading volume, non-agency MBS volume represents less than 1 percent of trading activity in the MBS market, which is also reflective of the approximate proportion of outstanding non-agency versus agency MBSs. Finally, agency MBSs are associated with relatively low trading costs, based on the average liquidity cost score (LCS), which measures the cost to trade in a round-trip transaction. Although agency MBSs have a larger LCS than Treasury bonds, their LCS is much lower than that of U.S. corporate bonds.

To-Be-Announced Market

About 90 percent of the trading volume of agency MBSs takes place in a forward market, called the *to-be-announced (TBA) market*, which is an electronic trading market where standardized fixed-rate pass-through securities are traded on an over-the-counter (OTC) basis. In the TBA market, the actual securities to be delivered to buyers remain unidentified until the day of settlement. TBA market participants agree upon six general parameters of the securities to be delivered: (1) issuer, (2) maturity, (3) coupon, (4) price, (5) face value, and (6) settlement date. For the coupon rates of the trading MBSs, 50-basis-point increments exist between different coupon rates. For example, the first pass-through listed has a coupon rate of 3.0 percent while the next is 3.5 percent. Since the two parties do not specify the exact security to be traded, at the settlement day, the seller delivers a security to the buyer based on the *cheapest-to-deliver (CTD) rule*, which means the security delivered to the buyer must satisfy the six parameters of the trade and have the lowest price in the seller's inventory. The ability of mortgage originators to lock-in prices for new mortgages before these loans have been originated through the TBA market leads to lower and more stable interest rates (Vickery and Wright 2010).

Specified Pool Trading

Investors can also buy and sell MBSs in the alternative process called *specified pool trading*, which allows buyers to know the identity of the securities to be delivered and their characteristics at the time of the trade. Information on the pass-through securities characteristics includes the composition of collateral, WAC, WAM, geographic dispersion, averages of the outstanding loan balance, prepayment history, and CUSIP number (Taff 2003). Additionally, some pass-throughs are traded in this way because these pools have several nonstandard features, such as slower or more stable prepayment of the underlying loans, and so these securities are ineligible for trading in the TBA market. Specified pools typically trade at a premium to securities on the TBA market due to the certainty of the pool characteristics.

Dollar Roll

A *dollar roll* is a repurchase agreement for an MBS where the investor sells an MBS for settlement on one date and repurchases the same MBS at a later date (Lemke, Lins, and Picard 2014). This transaction allows the investor to maintain MBS exposure while receiving the cash to reinvest.

MBS Securitization

Securitization refers to the process of pooling illiquid interest-bearing or income-producing assets to create new, tradable securities, which are either interest bearing or sold at a discount to the investors in the capital markets. Examples of assets that can be securitized include from more traditional financial assets, such as residential and commercial mortgages, and corporate debt, to consumer credit, trade receivables, revenues from entertainer's concerts under contract (celebrity bonds), and revenues from royalties. Securities backed by these types of assets are generally referred to as *asset-backed securities* (ABSs), while securities backed by mortgage debt are distinguished as MBSs. In an ABS, the mechanism of cash-flow distribution is similar to that of traditional fixed income products. In the case of asset-backed bonds, the issuer pays a fixed interest to the security holders and the issuer retains any risk of prepayment or default of the underlying assets. Alternatively, interest and principal can be passed through to the investor in different schemes that could shift all or some of the interest rate, prepayment, and credit risk to investors.

The MBS securitization process has three steps. First, a financial institution originates a property loan, secured by placing a lien on the real property. Loans appear on the lender's balance sheet as assets. Although the institution receives interest on the mortgage loans, mortgage loans are long-term with typical maturities between 5 and 10 years (commercial) to 10 and 30 years (residential). This situation implies that lenders have limited ability to originate new mortgage loans because borrowers repay outstanding mortgages slowly and need to seek alternative sources to fund new loans.

In the second step, individual mortgage loans held by the lenders are bundled together into a mortgage pool, which serves as collateral for an MBS. The issuer of the security can be the loan originator or a third-party financial institution, such as an investment bank. Aggregators, such as a government agency or a government-sponsored enterprise (GSE), also issue MBSs. The process of bundling mortgages is at the core of the mortgage securitization as various mortgages with potentially different characteristics are combined to create homogeneous securities tradable in the secondary market.

Third, the MBS issuer sells the security to institutional investors, such as pension funds, insurance companies, mutual funds, hedge funds, or retail investors. For example, Freddie Mac's Direct Access Retail REMICs (DARTs) are designed to be offered specifically to individual retail investors. A *real estate mortgage investment conduit* (REMIC) is a federal tax-exempt special purpose entity (SPE) that holds mortgage loans in a trust and issue securities that can have different prepayment characteristics and maturities. The primary issuers of REMICs are Fannie Mae and Freddie Mac.

MBS Securitization Benefits

Securitizing mortgage loans provides lenders with increased liquidity and can reduce or eliminate interest rate, prepayment, and default risk. Lenders can submit similar mortgage loans to agency or private-label MBS issuers for securitization and receive an MBS in exchange in what is commonly referred as a "swap" transaction. The lender then could keep the MBS on its balance sheet (swap-and-hold transaction) or sell it (swap-and-sell transaction) (Fannie Mae 2017). In the first case, although the lender keeps the MBS on its balance sheet, MBSs are more liquid than individual loans. When backed by guarantees from GSEs, the credit risk of the underlying mortgages is transferred to the GSE in exchange for a guarantee fee. In the second case, the lender transfers away all risks immediately and receives new funds, which could be used to originate new loans. In the case when the originating lender retains servicing of the MBSs, the lender earns additional revenue through service fees.

For MBS investors, the mechanism of securitization provides both an opportunity to invest in mortgage loans and to increase portfolio diversification (Simkovic 2013). For example, mortgage loans can be pooled from different markets around the country increasing the geographic diversification of the mortgage security. Compared to other fixed income, non-Treasury vehicles, MBS investments are considerably more secure because these securities are backed by tangible assets and typically overcollateralized. *Overcollateralization* provides additional collateral above the security's face value. Additionally, some private-label MBSs offer credit enhancement treatment either in the form of a third-party guarantee or through the internal structure of the arrangement, which lowers default risk (Taff 2003).

Agency MBSs also offer additional benefits. First, the default risk is lower than private labels because agency MBSs are backed by GSEs' guarantee that investors will receive timely principal and interest payments, regardless of whether the cash flows from the underlying loans are sufficient to cover the payments on the MBSs. This lower risk combined with higher returns, relative to Treasuries, translates into an attractive risk-adjusted performance. Similarly, Mandinach (2015) discusses two major advantages of agency MBSs. First, they provide a high historical *Sharpe ratio*, which is the ratio of a portfolio's mean return in excess of the risk-free rate to its portfolio standard deviation, and consistent risk-adjusted returns compared to other fixed-income asset classes. Second, their returns have a low correlation with other risky assets among fixed income sectors, as their returns are primarily exposed to prepayment risk, rather than to credit fundamentals and market liquidity.

MBS Pool Characteristics

When analyzing individual mortgage loans, investors use financial ratios such as loan-to-value (LTV) and debt-to-income (DTI) as appropriate for measuring the inherent risk backed by a pool of mortgage loans. Thus, the MBS pool necessitates different metrics than for traditional fixed income securities including WAC, WAM, and WALA.

Weighted Average Coupon

The *weighted average coupon* (WAC) is one of the most important metrics that characterize an MBS pool. It represents the weighted average of the note interest rates on the underlying mortgage loans, where the weights are determined by the proportionate share of the outstanding balance on each loan in the MBS pool. Equation 21.1 represents the MBS WAC formula:

$$\text{WAC} = \sum_{i=1}^{n} I_i \left(Principal_i \,/\, \sum_{i=1}^{n} Principal_i \right) \tag{21.1}$$

where I_i is the note rate on the i^{th} loan in the mortgage pool, consisting of n mortgage loans, and $Principal_i$ represents the outstanding principal of the i^{th} mortgage loan.

Comparing WAC with current market rates indicates the borrower incentive to refinance. If the WAC is higher than the market rate, the borrowers of the underlying loans have a stronger incentive to refinance to take advantage of the lower current interest rates. When WAC is equal to or less than the current market rate, a lower refinancing activity of borrowers would be observed (Berliner, Quinones, and Bhattacharya 2016). WAC differs from the coupon rate on an MBS and is generally referred to as the "net coupon." In the case of pass-through securities, it is also called the "pass-through rate." The coupon rate on an MBS is lower than the WAC due to servicing and guarantee fees. The difference between WAC and the net coupon is referred to as the *servicing spread*.

Weighted Average Maturity

Another important MBS metric is the *weighted average maturity* (WAM), which indicates the remaining term of the loans in the MBS pool. WAM is calculated by weighting the remaining maturity in months of the underlying mortgage loans by their share in the MBS pool, based on their outstanding balance. Equation 21.2 expresses the formula:

$$\text{WAM} = \sum_{i=1}^{n} T_i \left(Principal_i \,/\, \sum_{i=1}^{n} Principal_i \right) \tag{21.2}$$

where T_i is number of remaining months in i^{th} mortgage loan; $Principal_i$ is the outstanding principal of the i^{th} mortgage loan; and n is the total number of mortgage loans in the pool.

Weighted Average Loan Age

The *weighted average loan age* (WALA) represents the weighted average number of months since the origination of the underlying MBS loans. Market participants use WALA to distinguish "seasoned" from newly issued MBSs. When WALA exceeds 30 months, the security is considered seasoned. Analysts use the degree of seasoning to estimate prepayment speeds, with greater prepayment predictability for seasoned loans. Many view WALA as providing a more precise assessment of the age of an MBS pool than WAM. Obtaining the average pool loans' age involves taking the difference between the original and current WAM of an MBS. However, when considering prepayments, this difference fails to provide an accurate measure of the average MBS age.

MBS Products

The MBS market can be divided in two sectors: *residential MBSs* (RMBSs), backed by residential loans, and *commercial MBSs* (CMBSs), backed by commercial real estate loans. The residential sector is much larger than the commercial one, with RMBSs representing historically more than 90 percent of the outstanding MBSs (SIFMA 2018b). Within the RMBS market, securities could be split in two main groups: agency and non-agency.

Agency versus Non-Agency RMBSs

Loans that satisfy the underwriting standards of GSEs, known also as *conforming loans*, are used to create RMBSs, referred to as agency MBSs. Historically, the agency MBS market has been considerably larger than the non-agency market and currently represents more than 80 percent of the outstanding MBSs (SIFMA 2018b). The underlying mortgage loans of the agency RMBSs must meet certain standards prescribed by the GSEs, including loan size, documentation, LTV ratios, credit scores, and minimum down payment among other factors. Fannie Mae and Freddie Mac generally guarantee timely payment of principal and interest payments. Given that GSEs are under the conservatorship of the U.S. Treasury, market participants view Fannie and Freddie's MBSs as backed by an implicit guarantee from the U.S. government. However, as both entities are private companies, their mortgage securities do not literally carry the "full faith and credit" of the U.S. government. In contrast, Ginnie Mae is a government-owned, publicly-managed agency, which only guarantees private pass-through securities issued by other originators, rather than issuing its own securities. The "full faith and credit" of the U.S. government backs Ginnie Mae's guarantees. Therefore, market participants view Ginnie Mae-backed securities as free of any default risk.

Private-label or non-agency MBSs refer to MBSs whose issuer is not a GSE. The underlying loans of these MBSs are nonconforming loans, including jumbo, subprime, and *Alt-A loans*, which are loans that do not meet the standard for prime loans but are better quality than subprime borrowers. Private-label MBSs cater to the unserved non-agency MBSs. Due to collateral restrictions on the underlying mortgages in agency MBSs, not all conventional mortgage loans are eligible for purchase by Fannie Mae or Freddie

Mac. Given that GSEs do not guarantee non-agency MBSs, private-label MBS issuers use various methods for credit enhancement such as obtaining bond insurance, using overcollateralization, and employing various senior/subordinate types of structures (Fabozzi and Berliner 2016). Credit agencies assign the credit ratings of private-label MBSs dependent on their structure, issuer, collateral, guarantees, and other factors (Taff 2003).

The non-agency market increased rapidly in size during the early 2000s, as private issuers rushed to securitize loans that were not meeting the securitization standards of GSEs. Lax credit standards during the years preceding the financial crisis and the proliferation of the subprime and Alt-A mortgage market further promoted the growth of this market. By 2006, the non-agency market reached about 40 percent of the total MBS market (SIFMA 2018b). Similarly, by 2006 around half of the annual issuance of non-agency RMBSs represented sub-prime backed loans, of which almost 80 percent consisted of adjustable-rate mortgages (ARMs) with low teaser rates and higher LTV ratios (Adelson 2016).

Since the financial crisis of 2007–2008, this market has decreased substantially in size compared to the pre-crisis period, with less than 15 percent of the MBSs representing non-agency securities (SIFMA 2018b). JP Morgan and Redwood Trust continue to issue a relatively small number of deals each year. Recently, more financial institutions, such as AIG and Wells Fargo, have increased issuing private-label MBSs (Greene 2017).

Mortgage Pass-Through Securities

A *mortgage pass-through security* (MPTS) is the simplest structure of an MBS and is also the dominant type of MBS traded in the secondary market. They represent an ownership interest in pools of residential mortgage loans, whereby principal and interest from the underlying mortgages are passed through to investors. Although the underlying loans are typically fixed-rate mortgages, ARMs can also be pooled to create pass-through securities.

The pass-through process involves two steps. First, borrowers make monthly payments on their mortgage loans and the servicer of an MPTS collects the cash flows from the mortgage pool (principal and interest payments). Second, the collected payments from the pool are "passed through" to the investors on a pro-rata basis net of any service and guarantee fees.

Investors in an MPTS are exposed to interest rate, default, and prepayment risk.

Mortgage Bonds

In contrast to other mortgage-related securities, mortgage bonds represent debt interest, not equity ownership interest. The two main types of mortgage bonds are a *mortgage-backed bond* (MBB) and a *mortgage pay-through bond* (MPTB). MBBs have a specified maturity and coupon rate. The issuer bears interest rate, prepayment, and default risks because the issuer retains ownership of the underlying mortgages. In contrast, mortgage pay-through bonds pay a stated coupon rate but pass-through principal. Hence, MPTB investors face prepayment risk. The riskiness of the underlying mortgages and the degree of *overcollateralization*, which is the practice of including more mortgages in the pool than the sum of securities issued against it, determines the credit rating of these debt securities.

Collateralized Mortgage Obligations

A *collateralized mortgage obligation* (CMO) is a debt instrument in which the issuer owns the mortgage pool, similar to a MBB, but principal and interest are passed through, similar to an MPTS and an MPTB. The difference between a CMO and an MPTS and an MPTB is in the formation of a complex multi-class structure that allows the construction of tranches with different maturities and priorities of payment of principal and interest and hence the creation of instruments that would be appealing to investors with various investment horizons and risk preferences. Since their inception in 1983 when Salomon Brothers and First Boston helped Freddie Mac develop the first CMO, these securities have grown to more than $1 trillion (SIFMA 2018b). CMOs provide a wider range of investment opportunities than simple pass-through securities, whereby various CMO tranches are designed to have specified maturity and cash flow patterns to meet investment objectives of different types of investors. The collateral of a CMO may be residential or commercial mortgage loans as well as pools of mortgage pass-throughs. Investors in CMOs include banks, hedge funds, insurance companies, pension funds, mutual funds, government agencies, and most recently central banks. For tax purposes, CMOs are generally set up as REMICs, which help to avoid potential "double-taxation" (Lemke et al. 2014). Given that all CMOs today are structured as REMICs, the two terms are used interchangeably.

The following represents a common cash-flow distribution structure of a CMO. First, cash flows received from CMO collateral are distributed to meet the interest obligations for all the tranches. Second, the principal repayments including scheduled and prepaid are distributed to different tranches according to a predetermined priority of the principal distribution schedule. When a tranche starts receiving principal repayment, it is called *active* or *currently paying*. The maturity date for a CMO tranche is the last day when investors receive all principal repayments. Before the start of the principal repayments, the period when investors only receive interest payments is known as a *lockout* period. For newly issued CMOs, investors take up to a month to "settle" due to the time required for collecting the collateral, depositing it to the trustee, and completing other legal requirements. Similarly, up to two months may pass before investors receive the first payment from the CMO. CMO pricing explicitly factors in this delay. After the first payment, investors typically receive monthly payments on a stated date. Since CMO investors rely on the distribution of payments from the underlying mortgage collateral, payment dates are usually later than the collection of cash flows (SIFMA 2009).

Residential mortgage securities are subject to prepayment risk, as the outstanding mortgage loans could be repaid sooner than the mortgage loans' schedule, due to refinancing, or simply selling of the mortgaged properties. With commercial loans, prepayment risk is much lower due to these loans generally being subject to prepayment restrictions and heavy penalties. The payment tranche structure of the CMO allows for the shifting of prepayment risk to investors in specific tranches, resulting in a more predictable cash flow pattern of senior CMO tranches than with a single-class pass-through MBS.

Sequential Tranche Structure

The most basic type of CMO uses a sequential tranche structure, also called *clean* or *plain vanilla* offering. This CMO structure allows the issuer to meet different maturity requirements of investors and to reallocate prepayment risk among tranches. The average life of each tranche varies with more senior tranches having shorter average life. For example, tranche A might have an average life of two to three years, tranche B might have five to seven years, tranche C for 10 to 12 years, and so forth (SIFMA 2009). Although the security servicer is responsible for collecting interest and principal on the underlying loans or mortgage pass-through securities, the issuer guarantees the timely payment of cash flows on the CMO. All tranche investors receive interest payments, but only the first tranche receives principal payments at the beginning of the payment sequence. Once the first tranche is retired, investors in the second tranche start receiving principal payments until this tranche is fully retired, and the process continues until the last tranche is retired.

Schedule Bonds

Although plain vanilla CMOs can reduce prepayment risk, these securities cannot avoid the uncertainty of repaying cash flows. Creating *schedule bonds,* which use supporting bonds to absorb the excess prepayments and make prepayments following a defined schedule, substantially reduces this uncertainty. Two ways of constructing tranches of schedule bonds are using *planned amortization class* (PAC) tranches and *target amortization class* (TAC) tranches.

PAC tranches have a more precisely defined cash-flow structure than the tranches of plain vanilla CMOs and provide better protection against prepayment risk. This structure is achieved by using two different prepayment rates—an upper bound on the maximum potential cash-flow rate and a lower bound on the minimum potential cash-flow rate. A narrower *collar* (i.e., the spread between the upper and lower bound of the prepayment speeds) facilitates estimating the tranche's expected life. PAC payment schedules also provide better investor protection by prioritizing the principal payments of the underlying mortgage loans to meet the needs of the PAC tranche. Non-PAC tranches absorb excess prepayments when principal repayments speed is higher than the PAC repayment speed collar. Non-PAC tranches are also called *companion* or *support tranches* because they support the PAC schedules. In special cases, a subordinate PAC tranche can act as a companion class. Finally, PAC tranches typically offer lower yields than conventional tranches because they have a higher degree of cash-flow certainty.

Similar to PAC tranches, TAC tranches provide protection against cash-flow uncertainty through a fixed principal payment schedule. However, TAC tranches differ from PAC tranches by only offering one-side protection for prepayment. TAC tranches also offer protection against extension risk when prepayment activities slow down. For this reason, TAC tranches offer higher yields than PAC tranches. TAC tranches pay based on a predetermined principal balance schedule, which is determined using a single prepayment speed, instead of a range of prepayment speeds as with PAC tranches. If prepayment speed is higher or lower than the defined rate, investors in TAC tranches may receive higher or lower principal payments than the scheduled payments. The CMO structure also affects the performance of TAC tranches because its priority of receiving principal payments depends on the PAC tranches.

Finally, Z-tranches, also known as *accretion bonds* or *accrual bonds*, have the longest average CMO life. Z-tranches are structured to start receiving principal and interest payments only after the other tranches in the CMO have been fully paid. Market participants view Z-tranches as the riskiest tranches of CMOs because investors receive no cash payments during the lockout periods. However, Z-tranches can help stabilize the cash flows in other senior tranches, making them more secure. Money managers often suggest using Z-tranches as an investment for tax-deferred accounts because investors do not pay a tax on interest until after receiving the interest payments.

Stripped Mortgage-Backed Securities

Stripped mortgage-backed securities (SMBSs) are a type of MBS that derives their cash flows either from principal only or interest only payments on the underlying mortgage loans. MBSs typically derive their cash flows from both principal and interest payments of the underlying mortgages simultaneously. Securities receiving principal payments only from the underlying loans are called *principal-only* (PO) *stripped mortgage-backed securities*. Similarly, MBSs receiving interest payments only from the underlying mortgage loans are known as *interest-only* (IO) *stripped mortgage-backed securities*.

POs are priced at a substantial discount from the bond's face value, with market value being very sensitive to prepayment speed changes. Conversely, IOs lack a specific face value, retaining only a notional principal amount (i.e., the principal balance used to calculate the interest amount due). Subsequent IO cash flows progressively decrease as the notional principal amortizes and prepays. The IO market value increases with a rise in market interest rates as home buyers slow down their refinancing activity and prepayment rates decrease, increasing the average life of the underlying mortgages.

Major Risks of MBS Investments

MBSs provide unique opportunities for real estate investors through increased liquidity compared to private investments as well as a large choice of investment products based on originators, underlying loans, interest and maturity structures, and pass-through of underlying loan cash flows. Yet these investments involve risks. The next section discusses the primary risks in MBS investments with a focus on interest rate risk, prepayment risk for residential MBSs, and credit risk for commercial MBSs.

Interest Rate Risk

MBSs generally expose investors to *interest rate risk*, which is the risk that changes in interest rates substantially affect a security's market value (Becketti 1989). Market participants use *duration*, the sensitivity of a bond's price to a change in interest rates, to measure the interest rate risk of bonds. A higher duration implies a bond has higher price sensitivity to interest rate changes. However, the interest rate risk of MBSs differs from that of Treasury securities because of the embedded prepayment option in the underlying residential mortgage loans in RMBSs. The prepayment option of mortgage loans enables homeowners to refinance their loans when interest rates fall and reduce or stop refinancing when interest rates rise (Malz, Schaumburg, Shimonov, and Strzodka 2014). Because of the uncertain prepayment behavior of mortgage loan borrowers, the traditional method to estimate duration for conventional bonds yields an inaccurate duration for a security backed by residential mortgage loans.

Prepayment Risk

Prepayment is the risk involved with the premature return of principal on a fixed-income security. It is the most important risk of RMBSs and is unique to mortgage securities. This risk is limited for CMBSs, as commercial real estate (CRE) loans typically have lockout previsions and impose substantial prepayment penalties. In contrast, RMBSs are backed by residential mortgage loans that generally allow borrowers to prepay or refinance before their maturity. RMBS cash flows are unpredictable as the timing and speed of principal repayments of the underlying mortgage loans are correlated with the changes in interest rates. For example, when interest rates fall, borrowers have an incentive to refinance their existing mortgage loans by borrowing at lower rates and repaying the existing loans, thus accelerating the principal repayments of the underlying mortgage loans. This situation is also referred to as *contraction risk* indicating the reduction of the time for repayment of principal on the underlying loans. In such cases, early repayments force MBS investors to reinvest cash flows at a lower yield, thus reducing their total interest income. In contrast, if interest rates rise, borrowers slow down their prepayments due to a reduced incentive to refinance. However, MBS investors are subject to *extension risk*, the possibility that borrowers prepay their mortgages slower when market interest rates increase, because slow prepayments result in a situation where investors receive below-market rate returns on their MBS investment for an extended period of time (Malz et al. 2014).

The prepayment feature of RMBSs results in *negative convexity*—when interest rates increase, MBS prices tend to fall at an increasing rate. Conversely, when interest rates decline, home buyers repay more MBS loans sooner and thus MBS prices rise slowly or remain relatively unchanged (Bennyhoff and Yan 2010).

The determinant factors of mortgage prepayment behavior include refinancing, relocation, and default (Becketti 1989). The most important factor affecting the speed of prepayment is *refinancing*, reflecting the fact that the level of market interest rates has a substantial influence on the incentive of home buyers to refinance their loans. The second most important factor determining prepayment behavior is *relocation*, also known as *normal housing turnover*. Relocation can be attributed to various life events of the home owner, including employment change, marriage, divorce, and change in family size. Finally, mortgage default would also accelerate prepayments due to the GSE guarantee on most RMBSs. Although default risk in the residential mortgage market has been historically very low, this risk can increase markedly during recessionary times.

Additional factors that influence prepayment speeds include *loan seasoning*, which refers to the age of the mortgage. Empirical research suggests that prepayment by home buyers follows a relatively predictable pattern based on the age of loans. For example, prepayment speed generally increases during the early portion of the loan, stabilizing after about three years (Thomson Reuters 2016). This prediction pattern led to the creation of the *Public Securities Association Model* (PSA Model). Developed by the Public Securities Association, the precursor of SIFMA, in 1985 and based on the Federal Housing Administration's prepayment experience, the PSA Model is a prepayment benchmark, representing monthly prepayment rates over time. Prepayment rates also tend to exhibit seasonality with higher prepayment rates observed during the summer. Finally, the pool may experience *refinancing burnout*, which is the tendency for decreased refinancing activity following increased refinancing activity, as borrowers who have previously refinanced have a reduced incentive to refinance again due to refinancing costs. Refinancing volume can pick up again once the reduction in interest rates is sufficiently large.

Measuring Prepayments

To calculate mortgage prepayments ex post simply requires taking the difference between the scheduled principal and the actual monthly principal received. Estimating mortgage prepayments is more challenging and involves three primary metrics (Hayre and Young 2004).

- *Single monthly mortality (SMM).* This rate is a monthly mortgage prepayment rate measure showing the percentage of the month's scheduled principal that has been prepaid.
- *Constant prepayment pate (CPR).* The CPR annualizes the SMM to represent cumulative prepayment rate over 12 months for a given SMM as shown in Equation 21.3.

$$\text{CPR} = 1 - (1 - \text{SMM})^{12} \qquad \textbf{(21.3)}$$

- *Public Securities Association (PSA) Convention—100 PSA.* The PSA baseline is referred to as 100 percent PSA or 100 PSA. The 100 PSA Model assumes a 30-year mortgage with monthly payments. Here, CPR increases 0.2 percent the first month, followed by 0.2 percent increases each succeeding month for 30 months until reaching 6 percent, after which it remains constant until maturity. Figure 21.3 illustrates the PSA prepayment model.

The changing prepayment speeds result in different cash flow patterns of the mortgage security. Figure 21.4 shows examples of the cash flow patterns of an MBS with

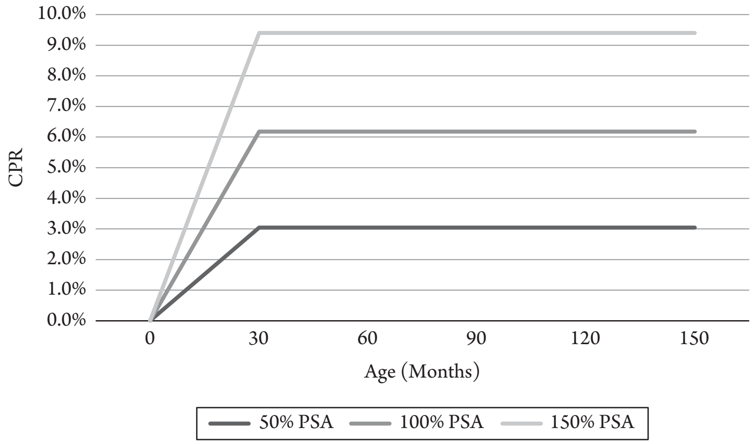

Figure 21.3 PSA Prepayment Model

This table illustrates monthly prepayment speed based on the model developed by the Public Securities Association. The PSA baseline is referred to as 100 percent PSA or 100 PSA. 100 PSA is based on a 30-year constant amortization mortgage with monthly payments. In the 100 PSA benchmark, CPR starts with an annualized 0.2 percent rate in the first month, followed by a 0.2 percent increase each succeeding month for 30 months until reaching 6 percent, after which it remains constant until maturity. The 50 percent PSA and 150 percent PSA versions illustrate variations of the benchmark, assuming 50 and 150 percent lower prepayment speed relative to the baseline, respectively.

Source: SIFMA (1999).

constant prepayments rates of 50 percent PSA, 100 percent PSA, and 150 percent PSA. The higher the prepayment speed benchmarks, the higher is the prepayment risk.

Credit Risk

Credit risk, the risk of default of the underlying mortgage loans, is the signature risk for CMBSs. For RMBSs, it is only an important risk for non-agency MBSs since one of the GSEs guarantees agency MBSs. With CMBSs, credit risk is substantially higher as the underlying CRE loans are much larger than residential loans and are partially amortizing with a bullet payment or interest only payments. This situation implies that at maturity CRE borrowers rely on their ability to refinance or sell the property at a sufficiently high price. Neither of these may be an option in a recession, as falling prices could lead to borrowers having negative equity resulting in greater difficulty obtain financing. CMBSs have a tranche structure similar to CMOs, with different tranches carrying different bond ratings. Through creating a tranche structure and using overcollateralization, higher rated tranches offer greater credit risk protection to their investors and carry lower interest rates. Large loan and conduit CMBSs typically have a third-party holder of a first loss position. The issuer also must retain at least 5 percent of the credit risk of the underlying mortgages. For non-agency RMBSs, the credit quality of the borrowers of the underlying loans and other factors such as the structure of transaction determines credit risk (Kitaychik, McKenna, Okongwu, and Renzi-Ricci 2016). As a result, a credit

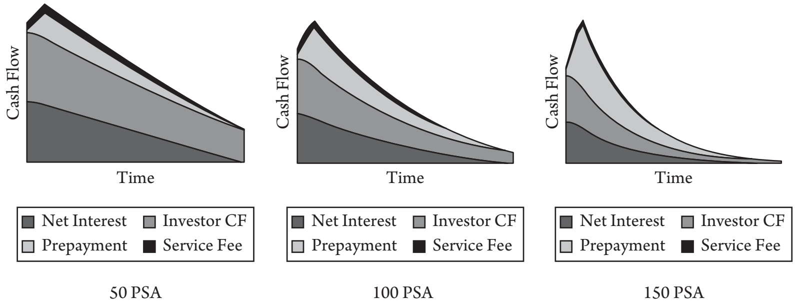

Figure 21.4 Cash Flow Patterns of Three PSA Models
This table displays cash-flow distribution among net interest, investor cash flows, prepayment cash flow and service fee, based on three different prepayment models: 50 PSA, 100 PSA, and 150 PSA, respectively. The PSA baseline is referred to as 100 percent PSA or 100 PSA. 100 PSA is based on a 30-year constant amortization mortgage with monthly payments. In the 100 PSA benchmark, CPR starts with an annualized 0.2 percent rate in the first month, followed by a 0.2 percent increase each succeeding month for 30 months until reaching 6 percent, after which it remains constant until maturity. The 50 percent PSA and 150 percent PSA versions illustrate variations of the benchmark, assuming 50 and 150 percent lower prepayment speed relative to the baseline, respectively.

enhancement is needed to provide non-agency MBS investors with more protection of credit risk and to help increase liquidity and pricing efficiency (Taff 2003).

Several internal and external methods of credit enhancement are available. The common internal credit enhancement methods include senior-subordinated structure, excess spread, and overcollateralization. With the senior-subordinated structure, non-agency MBSs are divided into two classes based on credit risk: a senior bond class (higher credit rating) and subordinated bond class (lower credit rating). The subordinated bond class can be further divided into different tranches based on levels of credit risk exposure of the underlying mortgages loans where junior tranches, called *mezzanine* tranches, are used to absorb the default risk to protect the senior bond class. Additionally, an excess spread, equal to the difference between the interest rate payments collected from the collateral and the coupon rate on the underlying bonds, is used to compensate for interest shortfalls and principal losses. The excess spread accumulates over time and any remaining funds are distributed to the equity tranche at pool expiration. Overcollateralization provides extra loan collateral beyond the face value of the bond security. It protects both senior and subordinated bonds from losses in default. Bond insurance is an external credit enhancement for MBSs, which uses mortgage insurance to cover the loss of principal and interest payments that exceeds the protection allowed by internal credit enhancements (Carron, Gron, and Schopflocher 2016).

Liquidity Risk

Market participants consider MBSs, particularly agency pass-throughs, to have low *liquidity risk*, which is the ability to sell an asset quickly without loss of value. However, the levels of liquidity risk differ across MBS types due to differing market characteristics where the securities trade (Bruegger, Chanyshev, and McHugh 2016). Market disruptions may cause settlement issues when lenders cannot deliver the securities to borrowers (Hayre and Young 2004).

Summary and Conclusions

MBSs have played an important role in the housing and financial markets, providing liquidity to mortgage originators and investment opportunities for investors. They have also been instrumental in setting minimum mortgage underwriting standards. This chapter provides an overview of MBSs as an investment tool by presenting an analysis of the MBS market, discussing the securitization process, describing the main MBS pool characteristics, presenting the different types of MBSs, and highlighting the major risks inherent to MBSs. The U.S. MBS market consists of RMBSs (agency MBSs and private-label MBSs) and CMBSs, with RMBSs representing about 90 percent of the total outstanding volume of MBSs.

The popularity of MBSs and growth of this market are due to several unique advantages of MBSs. First, the securitization process of MBSs enhances issuer liquidity. Second, the MBS market offers various MBSs based on terms of maturity, interest rate terms, private and agency labels that better meet different investment objectives. Third, the high liquidity and market depth of the MBS market lead to low transaction costs.

Although MBSs involve several major risks, most are similar to those of other fixed income securities. However, prepayment risk is unique for MBSs and represents the most important risk for RMBSs. To shift or eliminate prepayment risk, complex MBSs have been created that consist of various tranches, which are used to distribute the cash flows from the underlying mortgage loans according to a specified sequence payment structure and maturity of tranches.

Discussion Questions

1. Explain the MBS securitization process.
2. Discuss how WAC differs from an MBS pass-through rate.
3. Discuss the sources of prepayment risk of MBSs.
4. Discuss the difference between agency and private label MBSs.
5. Explain the benefits of a CMO structure relative to a traditional pass-through structure.

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22

Asset-Backed Securities

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Introduction

An *asset-backed security* (ABS) is a structured finance product collateralized by cash flows from a pool of securitized assets. ABSs have the highest priority claim on a specific and well-identified pool of assets legally segregated by the issuer of the ABS from the rest of the assets of the company. In contrast, corporate bonds represent a general claim on a company's business assets and cash flows.

Although the terminology that applies to ABS origination deals may vary from country to country, this chapter adopts the distinction, typical of the U.S. market, between *mortgage-backed securities* (MBSs), a term that refers exclusively to securities backed by a pool of high-quality real estate mortgages, and ABSs, a term that is generally employed to indicate securities that are backed by assets other than mortgages or by low-quality (subprime) mortgages. The different types of collateral assets that may be used to back ABSs are typically divided into two categories: (1) consumer financial assets and (2) commercial financial assets. The former includes automobile loans, home equity loans (HEL), student loans, and credit card receivables. The latter category includes computer leases, small business administration loans, agricultural machinery loans, or more generally equipment loans, and trade receivables.

The historical inception of the ABS market began in 1985 when Chrysler Financial issued the first public ABS contract backed by a portfolio of auto loans (Hayre 2001). The first security backed by credit card receivables occurred in 1987. During the 1990s, the market experienced dramatic growth with the development of several new types of contracts. Figure 22.1 shows the evolution of the ABS market between 1985 and 2016 in the United States, according to data from the Securities Industry and Financial Markets Association (SIFMA 2018). In 1985, $1.31 billion of securities were issued. In 1986, new issuances of ABSs accounted for more than $10 billion, which is about eight times greater than in 1985. In 2007, when the ABS

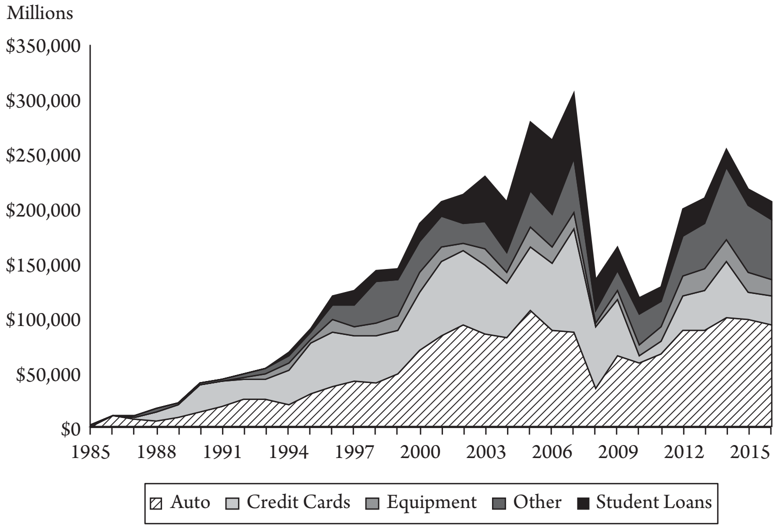

Figure 22.1 ABS Issuances in the United States between 1985 and 2016
This figure shows the number of new issuances in the ABS market between 1985 and 2016 in the United States.
Source: Securities Industry and Financial Markets Association (2018).

market reached its peak, a total of $300 billion of new ABSs had been issued. Notably, these numbers exclude the issuance of *collateralized debt obligations* (CDOs), which are securities collateralized by a pool of ABSs. Including CDOs, the total volume of new issuances in 2007 would have been close to $800 billion. The financial crisis of 2007–2008 had a devastating impact on the primary market of structured finance products. In 2008, only $133 billion of new ABSs were issued, approximately the same volume as in 1998. Although the market has recovered considerably, its size remains below its 2007 peak. In 2016, the new ABS issues totaled $205 billion, a slight decrease compared to 2015.

The most popular types of ABSs are those backed by automobile loans, credit card receivables, student loans, and residential ABSs. *Residential ABSs* are linked to subprime mortgages or *home equity loans* (i.e., second-lien mortgages where the homeowner borrows against the property's equity value). Therefore, this chapter describes the general features of ABSs and then focuses on its three largest segments—auto loan, credit card, and student loan ABSs.

Moreover, this chapter focuses on the U.S. ABS market, which is by far the largest and most liquid worldwide. To better understand this market requires reviewing data on ABS outstanding balances at the end of the third quarter of 2017. This amount was €1,193 million for the U.S. market and only €202 billion for the entire European market (Association for Financial Markets in Europe 2018). In the European market, Italy, with an outstanding balance of €54 billion, is one of the most active countries followed by the United Kingdom and Germany with €40 billion and €38 billion, respectively.

Key Characteristics of Asset-Backed Securities

Before moving to a detailed review of the most common types of ABSs, this section presents an overview of the general features of this asset class. Fender and Mitchell (2005) identify three key elements of the ABS structuring process. The first element is the creation of a pool of assets that is homogenous with respect to credit, maturity, and interest rate risks. As Giddy (2000) notes, a fundamental principle is to choose assets that, when viewed as a single portfolio, can receive a good rating, even when assessed in isolation from the originator's creditworthiness. Consequently, the assets in the pool should be well diversified in terms of the sectors represented, geographic areas of physical or legal existence, and type of borrower that matches the asset on the liability side.

The second crucial element in any securitization process is the separation of the pool's credit risk from that of the originator. This separation is termed *bankruptcy remoteness*. This objective is typically achieved through the sale of the assets to a *special purpose vehicle* (SPV). An SPV may take the form of a limited liability company, limited partnership, corporation or trust and its objective is to legally separate the assets that are being securitized from the *originator* (i.e., the company that originally owned the assets being securitized), so that the assets are not at risk of repossession and forced liquidation in case the originator becomes insolvent. In the United States, the Committee on Bankruptcy and Corporate Reorganizations (2000) emphasizes the pivotal role of bankruptcy remoteness in the process of issuing ABSs because it enables lowering a company's cost of financing with respect to *secured debt* (i.e., corporate bonds that are collateralized by specific assets). In case the originator files for bankruptcy, assets that have been sold to the SPV are not considered part of the bankruptcy estate but continue to be the collateral of the securities held by SPV investors.

Finally, the third distinctive element identified is the so-called *tranching*, which is the creation of different claims of the asset-backed security pool, typically one or more senior, "mezzanine," and junior tranches that follow different priority rules in terms of receivership of cash flow payments. In case of a cash shortfall, the holders of the senior tranches are repaid first. After satisfying all the obligations promised to the most senior security-holders, any residual cash flows are distributed to the investors in the "mezzanine" and then to the junior tranches. In practice, the senior tranches start absorbing losses only when the junior and mezzanine tranches are completely wiped out. This feature is a key form of credit enhancement used to provide protection to the holders of the senior ABS tranches, usually the most actively traded and with the largest outstanding notional amount. The chapter also provides a discussion of other credit enhancement techniques that offer protection against adverse events such as defaults on the assets in the pool.

Parties Involved in the Securitization Process

Understanding how the process of issuance of different types of ABSs works involves determining the most important actors. This section identifies and describes their roles. A single party often plays more than one role in the securitization process. For instance, the originator frequently acts as the servicer of the securitization.

- The *originator* is the company that owns the assets pledged as the collateral in the securitization process. The key feature that usually characterizes the originator is its status as an institution subject to regulatory constraints that force it to maintain a certain amount of capital on reserve depending on the assets that it holds on the balance sheet and that therefore may bear an excessive cost of funding (Giddy 2000). Such an institution should have a management team with sufficient expertise to undertake complex transactions. The institution should also maintain an internal database to obtain reliable information on the assets chosen as a collateral. In practice, ABS originators are typically commercial banks, captive financial firms such as Chrysler Finance, financial subsidiaries of large manufacturing groups, and independent financial firms.
- The *issuer* or *arranger* is a separate and bankruptcy-remote institution, typically called an SPV. It structures and issues the ABSs and buys the collateral assets using the proceeds coming from the sale of the notes.
- The *servicer* collects the cash flows (interest and principal repayments) generated by the asset pool, distributes the cash flows to investors, and monitors the occurrence of events such as *delinquencies* (i.e., failures to make a due payment) and/or defaults, or when some trigger conditions are activated.
- The *investors* purchase the ABS issued by the arranger.
- The *trustee* performs various administrative tasks of which the most important is monitoring the compliance of all parties to the obligations under the legal contracts that rule the transaction's execution.
- The *rating agencies* analyze the securities issued by the arranger and provide a rating to each tranche, which may differ. The agencies play an important role by helping investors assess the quality of the securities because of their complex structures and information asymmetry between investors and issuer.

Other parties may be involved in the securitization of ABSs, including independent certified accountants and lawyers, given the substantial amount of legal paperwork typically involved in the process. Although other parties, such as guarantors or monoline insurance companies, do not necessarily have to be called in to play a role, they may be involved in the transaction to provide additional credit guarantees. The next section discusses the details of such guarantees.

Cash Flow Structures

The cash flow structure of an ABS is determined by the cash flow structure of its collateral, which derives mainly from their payment schedule of the principal. The repayment cash flows deriving from the assets in the securitized pool consist of two types: (1) *regular cash flows* that are based on a precise amortization schedule until a fixed maturity; and (2) *irregular cash flows* that are not based on a regular amortization schedule and maybe derived from the fulfillment of obligations that do not carry a stated maturity (i.e., their life can be extended at any time as is the case for credit card receivables). Examples of the first type of collateral assets are automobile loans, home equity loans, and agricultural machinery loans. Examples of the second category of collateral are credit card and trade receivables.

This classification of the repayment cash flows arising from ABS collateral leads to different possible structures of the ABS itself.

- *Revolving structures.* As soon as principal repayments on the assets in the pool are made, the issuer (i.e., the SPV) buys additional assets to be placed in the pool to maintain a constant amount of collateral. The *replenishment amount*, which is the amount spent in order to purchase these new assets, is calculated as the sum of the principal repayments collected over the period. Depending on the contract terms, eligibility criteria may exist that the issuer needs to apply to maintain the credit quality of the collateral pool constant or above some minimal threshold.
- *Amortizing structure.* According to the priority of payments, the issuer redeems some of the notes before maturity, according to a predefined schedule. Depending on the contract features, the redemption amount may include the recovery of the outstanding amount of the defaulted assets in addition to all the principal payments executed in the period.
- *Mixed structure with controlled amortization.* A revolving period is followed by an amortizing one in which the principal is gradually repaid through constant flows.
- *Mixed structure with controlled accumulation.* At the end of the revolving period, cash flows intended to repay the principal are allocated monthly to a trust and kept until maturity, when final repayment occurs.

Additionally, ABSs are sometimes issued as sequential-pay securities in which the first tranche receives all the principal payments until it has been repaid in full, after which the principal repayments are allocated to the second tranche, and so on. Alternatively, principal repayments can be allocated pro-rata to each tranche: the first tranche receives a higher proportion than the second one, and the second higher than the third, and so on.

Prepayment Models

Besides their natural schedule (i.e., amortizing or non-amortizing), the cash flows from the assets are influenced by the so-called *prepayment risk*, which is the possibility that the lender receives all or part of the principal before it is due or expected, in case of assets that do not have a scheduled maturity, such as credit card receivables. A correct estimation of the *prepayment rate* of the assets in the pool, which represents the speed at which the principal is refunded to the lender beyond what is scheduled or expected, is crucial when structuring ABSs.

Depending on the type of assets in the pool, different market conventions exist that are adopted in order to describe the prepayment activity that characterizes an ABS pool. The conditional or constant prepayment rate (CPR) measures prepayments as a percentage of the current outstanding loan balance, which is typically expressed as a compounded annual rate. For instance, a pool with a 7 percent CPR means that on average, 7 percent of the pool's current loan balance is likely to be prepaid during the year.

On the contrary, the absolute prepayment speed (APS) represents the rate of prepayment as a monthly percentage of the pool's original loan balance and not of the current outstanding balance as the CPR. For instance, a 3 percent PS means that 3 percent of the initial loan balance is likely to be prepaid during the month.

Finally, the monthly (pre)payment rate (MPR) is used for asset pools that do not carry a scheduled maturity, such as credit card receivables. Therefore, the MPR should be interpreted more as a repayment rate than as a prepayment rate. The MPR is calculated as the sum of the interests and principal received during the month divided by the outstanding balance. Although different factors influence prepayment/repayment rates, the most relevant is the possibility to refinance the loan at a lower interest rate, which typically depends on the type of collateral.

Waterfall Structure and Loss Allocation

After acquiring the assets from the originator, the SPV usually issues notes with different seniority (i.e., with a different priority over the payments coming from the collateral). Notes that have the same priority over the payments from the pool are called *pari passu*. Therefore, payments follow the so-called *waterfall structure*, meaning that higher-tiered creditors receive the payments first, while lower-tiered creditors receive the payments only after higher-tiered creditors have been paid in full. Principal and interests may be distributed either through a single combined waterfall for both interest and principal or through separated waterfalls consisting of a principal waterfall and an interest waterfall, respectively. After senior fees have been paid, the remaining funds may be used to redeem the outstanding notes (amortizing waterfall) or to buy assets to maintain a fully collateralized structure (revolving waterfall). In case of separate waterfalls, only the funds remaining from the principal waterfall can be allocated to this objective.

When the principal amount outstanding from the pool is reduced due to a default, the loss is passed through to the note-holders in reverse order of seniority. This process means that senior notes suffer a loss only after losses have completely wiped out the subordinated tranche.

Credit Enhancement Mechanisms

Several credit enhancement mechanisms are available to provide security-holders with extra protection for a sufficiently high rate of default. These enhancements increase the credit quality of the notes and can potentially improve their rating. These mechanisms are usually divided into internal (i.e., those offered by the originator, servicer, or issuer) and external (i.e., those provided by third parties). The most important and common form of internal credit enhancement is the subordination structure or credit tranching. Other common internal credit enhancement mechanisms include the following:

- *Over-collateralization.* The total value of the notes issued is structured to be smaller than the value of the collateral asset pool, such that the first losses incurred by the assets are absorbed by the excess portion of the pool.

- *Excess spread* or *excess interest cash flow*. The fees paid to the note-holders are lower than the interest collected from the pool. The amount in excess is retained and deposited into a reserve account and can serve as a first line of protection against losses.
- *Cash reserve accounting.* A cash reserve is created when the ABS is originated and is available to cover losses affecting the pool.

External credit enhancement mechanisms include letters of credit from a highly-rated bank that agrees to pay a cash amount to cover losses that may arise in the pool, or insurance coverage, often provided by specialized companies, called monoline insurers.

Trigger Events

To protect investors, ABSs often have *triggers*, which are events that force one or more changes in the legal configuration of the notes. Triggers can be quantitative, in which the event is defined on the basis of a quantitative threshold, or qualitative, in which the event is considered to have occurred if a specific feature of the transaction changes. Some examples of triggers include the following:

- An *early amortization trigger* is a quantitative trigger that defines a set number of defaults after which the cash flow structure of the notes changes from revolving to amortizing.
- The *downgrade trigger* is a qualitative trigger that establishes that in case of a downgrade of the servicer, another party that has been identified in advance replaces the servicer.
- An *interest deferral trigger* is a quantitative trigger that defines a maximum number of delinquencies after which the interest payments on junior tranches are deferred or at least increase the likelihood of their imbursement of senior notes.

Different Types of Asset-Backed Securities

The remainder of the chapter offers a detailed analysis of the key features of the most important segments: auto loans and leases, credit card receivables, student loans, and residential ABSs. According to the SIFMA quarterly report (SIMFA 2018), auto loans and leases, credit card receivables, and student loans ABSs outstanding amounted to $500 billion at the end of the third quarter of 2017. Collectively, these three categories represent about 36 percent of the total market or 69 percent when excluding synthetic ABSs or CDOs.

Automobile Loan and Lease ABS

Auto loans were the first collateral type to be employed in a securitization. Auto lease ABSs became popular much later because of their more complex structure. By the end of the third quarter of 2017, outstanding notes collateralized by automobile loans and leases in the U.S. market amounted to $195 billion. This amount represented 14 percent of the total when including CDOs with auto loan ABS as their underlying and 27 percent when excluding CDOs. Therefore, after excluding CDOs, auto loan-backed securities currently represent the largest segment of the U.S. ABS market and are one of the most actively traded segments.

Automobile Loans

Auto loans originate via two channels: (1) *direct channel* in which the consumer receives financing directly from a financial institution, and (2) an *indirect channel* in which the dealer acts as intermediary between the consumer and financial institutions usually consisting of banks, captive finance subsidiaries of major manufacturers, or independent finance companies. In both cases, the lender analyzes the applicant's credit profile by collecting data about income, occupation, net worth, and credit scores from a credit bureau. In the case of the indirect channel, strong competition exists among financial institutions to gain business. Typically, a dealer entertains relationships with more than one intermediary to best serve its customer base and to maximize its own profit. That is, the dealer maximizes the so-called *dealer reserve*, which is the difference between the contractual rate and the rate that the lender receives. As a consequence, indirect lenders have been forced to develop standardized procedures to evaluate an applicant's creditworthiness in order to quickly return a credit decision to the dealer.

The performance of an auto loan pool clearly depends on the borrowers, who are typically classified as prime, nonprime, and subprime, depending on credit bureau scores and thus on their credit history. Borrowers are classified as *prime* when they have a strong credit history, denoted by an absence of past delinquencies. In contrast, borrowers with modest incidence of delayed or missing payments in their past are classified as *nonprime*. Finally, *subprime borrowers* are defined as borrowers with serious delinquencies or a limited credit history. Once a deal is closed, the servicer, who could be the lender, or a third party appointed by the lender, carefully monitors the transaction to ensure that borrowers fulfill their obligations. The servicer sends delinquency notices to the borrower in case of payment delays of 10 to 30 days. In the worst cases, with payment delays of at least 40 days, the lender may decide to amend the terms of the contract or expropriate the automobile to sell it in an auction to limit its losses.

Another factor that affects the performance of a pool of auto loans is the prepayment rate. The market convention to estimate the prepayment rate of a pool of auto loans is the APS, which contrasts with the metric adopted for many other amortizing assets, the CPR. Prepayment rates of auto loans are usually much lower than those of mortgages. Mortgages are usually repaid in advance when the possibility exists to refinance at a lower rate. However, vehicles are shorter lived than real estate assets and have a much higher depreciation rate. Therefore, the value of a vehicle declines faster than the outstanding balance of the loan, a situation that is referred to as *underwater loans.* In such a situation, finding a lender who is willing to lend an amount sufficient to refinance the loan is difficult. As a result, the prepayment of auto loans is typically not driven by refinancing and thus it is not strongly affected by changes in interest rates. In contrast, auto loan prepayments are a function of the business cycle, through borrowers trading in vehicles or paying off loans early, and casualty losses from insurance proceeds.

Features of Auto Loan ABS

Similar to other ABS structures, auto loan ABSs are also created through the sale of a pool of loans to an SPV in order to achieve bankruptcy remoteness from a possible default of the originator. Historically, for this type of ABS, two different structures have been used: (1) the pass-through, especially at the beginning, when the market was created, and (2) the pay-through. *Pass-through securities* are issued by a vehicle that takes the form of a grantor trust, which has an extremely limited ability to reinvest cash collections. Therefore, interest and principal repayments are immediately distributed to security holders. A grantor trust can only issue a single class of senior securities so that the issuance of tranches of sequentially paying ABS would be impossible under this structure. Because of these limitations, *pay-through securities* have become more popular as the market has evolved. The most common pay-through securities are those issued by an *owner trust*. In this case, the issuer has the ability to issue multiple tranches that are different in terms of both maturity and priority. The issuer also has the possibility to use *excess spread* (i.e., the interest paid by the collateral in excess of the fees that should be paid to ABS note-holders) to buy additional loans to over-collateralize the notes.

Finally, a potential feature that is typical of auto loan–backed securities is the clean-up call. *Clean-up call* is an option for the issuer to buy back at par all outstanding securities after the original obligors have paid a certain percentage, usually around 90 percent of the initial collateral in the pool. The main reason for the issuer to exercise this option is to reduce certain fixed administrative costs connected to the securitization such as servicing costs that may not be economically sustainable once the remaining outstanding balance in the pool is low. The clean-up call is an embedded option that is very difficult to evaluate as the probability of its execution depends on the administrative costs that the issuer is incurring, which are usually unknown. Although precise data are unavailable, historically a very high percentage of auto ABSs have had the clean-up call exercised (Fabozzi and Mann 2005).

Automobile Leases

The crucial difference between auto loans and leases concerns the actual ownership of the vehicle. In the case of vehicle purchases financed through loans, the ownership of the vehicle is transferred to the customer, although the vehicle is usually pledged to the lender. In the case of auto leases, the ownership of the vehicle during the leasing period is not transferred to the customer (the *lessee*), but to the company that is financing the purchase (the *lessor*). The lessor is usually a bank, an independent finance company, or a *captive finance company*, which is a subsidiary of the producer of the vehicle whose objective is to finance the purchase of the products of the parent company. At the end of the leasing period, both the customer and the *dealer* (i.e., the seller of the vehicle) have the option to buy the vehicle at a prearranged price, also known as the *residual value*. If neither the dealer nor the customer exercises the option, the financial company retains the ownership of the vehicle, which is usually re-leased or sold in an auction. Figure 22.2 summarizes this difference between a loan and a lease.

Customers tend to prefer leases to loans because of their lower costs. In case of a loan, the scheduled monthly payments are based on the entire value of the vehicle,

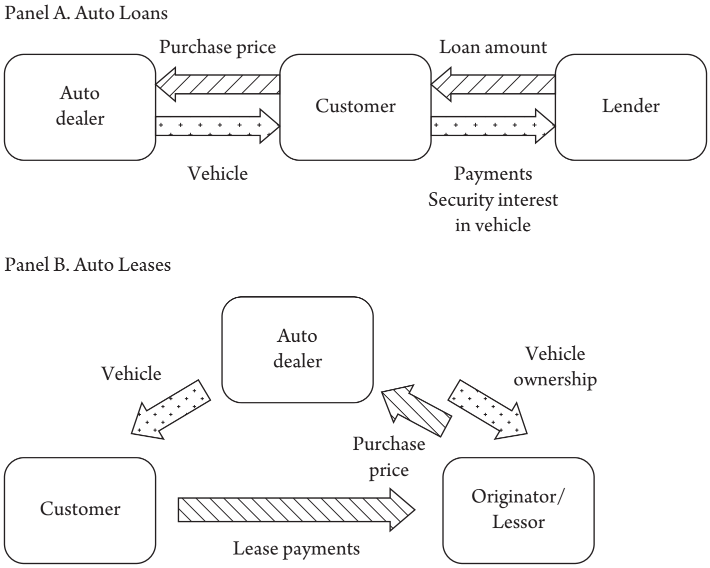

Figure 22.2 Key Differences between Auto Loans and Auto Leases
This figure shows the differences between a loan and a lease. In the case of vehicle purchases financed through loans, the ownership of the vehicle is transferred to the customer, although the vehicle is usually pledged to the lender. In contrast, in the case of auto leases, the ownership of the vehicle during the leasing period is not transferred to the customer (the lessee), but to the company that is financing the purchase (the lessor).
Source: Authors' illustration.

minus the down payment that is usually required. In contrast, lease payments are based on the value of the vehicle minus the residual value. No down payments are required in case of auto leases, which is also beneficial to the lessee.

Main Features of Auto Lease ABSs

Because the originator retains the ownership of the vehicle, the origination process of auto lease-backed securities displays major differences with respect to loan-backed securities. In fact, for auto leases, two assets need to be separated from the originator: (1) the lease and (2) the vehicle itself, which otherwise appears on the originator's balance sheet because the originator is the legal owner of the title of the vehicle. Otherwise, in case of default of the originator, the vehicle would be part of the bankruptcy estate, and therefore it would cease to provide a guarantee to the ABS holder in case of default of the lessee.

To accommodate this need, the titling trust structure represented in Figure 22.3 has been developed. A *titling trust* is an SPV, which is usually owned by the sponsor lessor directly or through other special purpose entities (SPEs); the titling trust purchases the leases directly from the dealer as soon as they are executed. The ownership of the leased vehicles is also transferred to the trust. Figure 22.3 shows that the lease originator is completely removed from the chain, although it will generally act as a servicer so

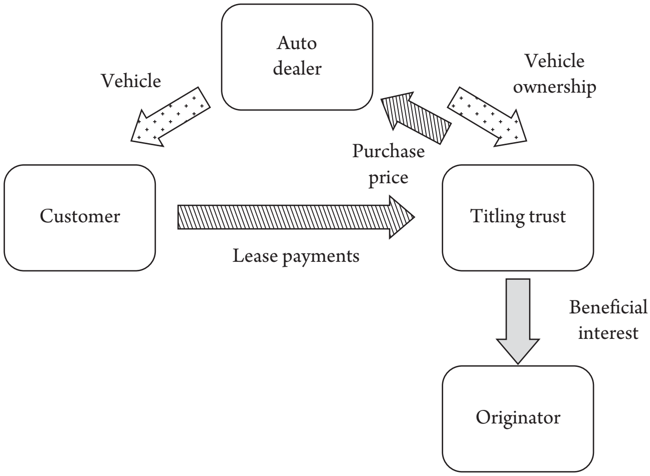

Figure 22.3 Auto Lease Securitization Process
This figure shows the structure of the securitization of a pool of auto leases. The vehicle and the lease are both transferred to the titling trust. The trust is now bankruptcy remote from the originator (auto dealer).
Source: Authors' illustration.

that lessees are unaffected by the securitization. However, the lease originator retains a beneficial and economic interest in the leases and the leased vehicles owned by the titling trust.

Because of the peculiar structure that characterizes lease securitization, lease-backed notes embed some specific risks. First, legal risk arises from the fact that in many countries including the United States, the vehicle's owner, which in this case is the titling trust, is responsible for the damage from automobile accidents and similar claims that occur when the vehicle was under the consent of the lessee. Therefore, insurance policies are usually compulsory when stipulating a lease contract. Another risk arises from the fact that the vehicle's fair value at the end of the lease may be lower than the residual value agreed in the leasing contract and therefore the lease originator may incur losses. This risk is generally known as *residual risk*. Because the residual value is hard to estimate, it is also difficult to securitize. Although a simple solution to this problem would be to deliberately underestimate the residual value, this practice would also impair the lessor's competitiveness. Consequently, this risk is usually addressed simply through proactive lease termination plans or residual value insurance.

Credit Card ABS

Credit card debt has been securitized since 1987, when banks were looking for alternative sources of funding besides traditional deposits. In the 1980s, regulatory capital requirements made securitization a useful technique to shrink the balance sheets of banks. Indeed, once the ownership of the assets is transferred to the SPV, the assets are literally removed from the balance sheet of the originator, which is typically a bank.

This process reduces bank balance sheets, thus improving their regulatory capital ratios. Moreover, the emergence of credit card securitization conduits proved fundamental to develop a competitive sector of credit card specialized institutions. By the late 1990s, this market represented the primary vehicle by which the credit card industry funded unsecured loans to consumers.

The success of this segment of the credit market reflects the popularity of credit cards, as consumers worldwide have come to rely on them as a convenient method of payment for an expanding universe of goods and services. According to a SIFMA quarterly report (SIMFA 2018), at the end of the third quarter of 2017, the credit card ABS market amounted to $127 billion in outstanding securities. Figure 22.1 shows that credit card ABS issuances grew at a 20 percent annualized rate between 1987 and 2007, reaching a peak of over $94 billion in 2007. Issuances then abruptly dropped to less than $6 billion only three years later as a result of the market freeze induced by the financial crisis of 2007–2008 and the collapse of several major players in the ABS market.

The most recent period reveals a moderate recovery, but the volumes issued and outstanding are still far below pre-crisis levels; for instance, issuances in 2016 totaled $27 billion. In 2017 this market seems to have been much more active, with $34 billion in credit card ABSs issued only in the first three quarters. Before the financial crisis, the credit card ABS market had grown to become the largest and most liquid ABS market in the United States, with 17 percent of the total outstanding at the end of 2007 (36 percent if CDO are removed). As of the third quarter of 2017, its weight declined to 9 percent of the total or 17 percent when excluding CDOs. This figure represents the third largest segment after auto loan and student loan ABSs. However, the recent uptick is an important sign of resilience, showing that the market is slowly returning to play a key role (SIFMA 2018).

The credit card ABS market has several structural peculiarities that reflect one basic but crucial underlying feature: credit card loans are non-amortizing and do not have a payment schedule set at the beginning of the contract, unlike mortgages or auto loans. Credit card debtors only need to make a fixed monthly payment and cannot exceed a pre-determined debt threshold because they can pay the loan at their discretion. Therefore, credit card ABSs differ from other types of ABSs in that the underlying assets can completely "turn over" every few months. That is, the balances of customers who are paying off their loans can be replenished by customers who are building balances through purchases or balance transfers. However, despite this source of technical complexity, the resulting ABS tends to be considered less risky than other asset-backed securitizations because of their generally high credit quality, liquidity, and transparency.

Securitization and the Trust Structure

The key mechanics of credit card securitization are very similar to the baseline described previously: the originator sells credit card loans to a trust, which issues securities backed by those receivables. Therefore, as typical in all securitization processes, the collateral is unaffected by bankruptcy of the originator. However, the structure of the trust used in this process has become increasingly complex over time. To illustrate, consider a card issuer that funds credit card loans to a group of 1,000 customers. Assume that each customer maintains a card balance of $2,000. The card issuer decides to securitize these customers' receivables by grouping their balances together and creating a $2 million "package." This package is sold to a trust created to buy the loans from the bank. Once the package is in the trust, the trustee creates bonds (i.e., notes, probably for less than $2 million, a form of credit enhancement) that are backed by the $2 million of card loans and sold to investors in blocks.

Before 1991, every pool of receivables used to be placed in its own legal repository, a classical stand-alone, bankruptcy remote trust. In 1991, the first examples of a new structure, the *master trust*, appeared. Although its underlying logic is similar, the master trust technically differs from a classic SPV and it is adapted to reflect the revolving nature of the credit card business. The master trust is based on a single trust able to receive a flow over time of numerous pools of credit card loans and to issue securities backed by the cash flows of all the receivables in the trust. Importantly, this process means that no asset in the trust is specifically segregated to support a single ABS security. The configuration implies obvious cost savings for both the issuer, who enjoys much more flexibility, and the investor, who can reduce the amount of time and resources to perform risk analysis of each single and new trust that had to be formed before. As the collateral pool evolves, its quality may become more heterogeneous. Yet, any change in a master trust would be more gradual relative to stand-alone pools. This characteristic is considered an attractive source of stability that ameliorates the perceived risk from investing in this type of ABS.

Another important but yet more complex credit card securitization structure is the *master owned trust* (MOT). The MOT issues a collateral certificate that represents an undivided interest in the receivables included in the trust. This procedure means that all the cash flows collected from the pools are distributed proportionally to the owner of the collateral certificate. The MOT receives these flows and then issues ABSs on the primary market. This process gives the issuer flexibility concerning the timing as well as the placement targets of each new issue. For example, due to the MOT, the subordinate tranches linked to a securitized credit card pool can be issued at different junctures and with different maturities relative to the senior tranches they support. In such a de-linked issuance structure, all the outstanding subordinated tranches back all the senior outstanding ones, which represent the shared enhancement series. This structure provides more internal credit enhancement to the senior tranches than would otherwise be possible and may lower the cost of highly rated funding.

Another feature of credit card securitization associated with master trusts is the fact that the card issuer is always required to maintain a residual ownership interest in the trust, which guarantees a rather basic but effective alignment of interests. The cash flows corresponding to the seller's residual ownership interest are *pari passu* with respect to the ones owed to the investors. This residual ownership interest retained by the originator absorbs cyclical fluctuations based on outstanding receivables and dilution from returned merchandise and ineligible claims. In many U.S. deals, the primary subordinated interest retained by the issuer is limited to the finance charge portion of the securitized receivables. In industry jargon, the issuer retains the right to the excess spread from its securitizations.

Cash Flow Allocation and Credit Card ABS Features

The MOT may tranche the securities issued into groups, which are used to allocate the cash flows to different investors. Usually trusts have only one group that includes all the issued notes. In case of two or more groups, securities are divided depending on several characteristics such as fixed versus floating interest rates paid on the card debt. Financial charges and principal are often allocated on a group basis.

Financial charges include all cash collections excluding the ones pertaining to principal repayment from the card receivables, including interests and fees. They are typically distributed to investors proportionally based on the outstanding principal of each series in the case of the prevalent type of the *non-socialized trust*. Other trusts may allocate financial charges on the cost basis of each series, which are called *socialized* trusts. How the trust uses the principal pay-down of the debt in the pool depends on whether it is in the revolving or in the amortizing stage. MOTs often foresee a multi-year revolving phase, followed by an amortizing one, under a range of alternative possible amortization schedules. For example, a credit card ABS with a five-year expected maturity might revolve for 48 months and then enter amortization for the final 12 months of its life. During the revolving period, principal repayments are used to acquire new credit card loans. During the amortization period, they are used to reimburse investors proportionally to the amount invested in each series within a group. However, the MOT can still use the excess principal to purchase new credit card loans. As an issuer's credit card business grows, accounts that meet the eligibility criteria can be added to the master trust.

The coupon of a credit card ABS note is typically tied to the rate of an index such as the London Interbank Offered Rate (LIBOR) plus a spread that reflects its rating and general market conditions. Interest on the notes accrues monthly. Since the underlying debt is subject to default, the likelihood and severity of default are factored into the price of the notes through a credit risk premium. Of course, the coupon rate that issuers pay investors depends on the class (tranche) of bond that an individual investor holds. Moreover, those who issue ABSs with very limited secondary markets must compensate investors with a liquidity premium for the difficulties investors might face if they want to find a buyer for the notes before expiry. Although the embedded prepayment option of the underlying assets of many ABSs can threaten to prematurely end the security's term and force investors to replace the security with another asset that may yield a lower rate, this situation is not a major factor in the case of credit card ABSs, that are revolving by their own nature. Because of the modest prepayment risk, the generally strong liquidity of this market, and of relatively "convenient" deal structures (e.g., characterized by lower duration, given their stated terms, because of frequent coupon payments), general evidence exists in the literature that credit card ABSs tend to display the tightest spreads among ABSs (Furletti 2002).

Student Loan ABSs

Student loan ABSs (SLABS) first appeared in 1990. Their popularity started to grow after 2000, especially between 2004 and 2006, when the annual origination flow averaged $60 billion. Specifically, as Figure 22.1 shows, $67.5 billion of new securities were issued in 2006, almost four times as much as in 2000 and 22.5 times as much as in 1995, when the federal-sponsored agency Sallie Mae issued its first student loan ABS. After the financial crisis of 2007–2008, as with other ABS classes, the student loan segment experienced a drastic decline in issuance. In 2008, Sallie Mae issued only $28 billion of new securities, a steep decline of 53 percent from the previous year. Since then, the SLABS segment has never recovered to its pre-crisis levels, although it still represents an important portion of the outstanding amount (SIFMA 2018). At the end of the third quarter of 2017, SLABS accounted for 13 percent of the total, which grows to 25 percent when excluding CDOs. Despite representing the second largest segment in terms of outstanding amount after auto loan ABSs and ignoring CDOs, SLABSs represented only 5 percent of the new issuances and 8 percent when excluding CDOs (SIMFA 2018).

The student loan industry is peculiar as it was born from the cooperation of federal/state agencies, not-for-profit, and for-profit corporations. For instance, in 1965 the Higher Education Act initiated the Federal Family Education Loan Program (FFELP) that was funded through a public/private partnership administrated at the state and local level. The private sector financed and serviced loans under the FFELP but benefited from a 98 percent (or 100 percent in case of defaults due to the death, disability, or bankruptcy of the borrower) insurance against default, provided by the U.S. Department of Education (DOE). These loans consisted of three types: (1) subsidized Stafford loans, where the DOE pays the interest while the student is attending school to students with proven financial need, (2) unsubsidized Stafford loans, to students who were ineligible for Stafford loans, and (3) PLUS loans, to parents of dependent students. Upon leaving school, students could refinance all their existing FFELP loans through a single *consolidation loan*. FFELP loans had to be originated by eligible lenders, such as commercial banks, credit unions, thrift institutions, insurance companies, state agencies, and nonprofit student loan companies. Although President Obama terminated the FFELP in 2010, outstanding loans issued under FFELP continue to represent a substantial portion of the total outstanding student loans and therefore their discussion remains of interest as of the time of this writing.

The Student Loan Securitization Process and Its Major Features

Owner trust structures usually issue the student loan ABSs. These structures guarantee more flexibility in allocating the principal and interest received to different classes of securitized notes. In fact, in contrast with other structures such as the grantor trust, both principal and interest due to subordinated securities can be used to pay senior securities, if needed. The owner trust typically issues one or more classes of sequential-pay, triple-A-rated notes and a single class of single-A rated securities. The securitization process through owner trust structures typically consists of a two-stage transfer of assets. In the first step, the lender sells the loans to a fully owned SPV, which in its turn transfers the assets to a trust. As the owner trust is an ineligible lender under the federal program, it nominates an eligible trustee to comply with FFELP regulations. The servicer transfers collections of principal and interest to the trust. The eligible trustee receives payments from third parties such as guarantors and the DOE in the form of special allowances and interest subsidy payments. The eligible trustee must also deposit the collected payments in the trust within a short period, usually within two days from collection. Special allowances depend on the fact that FFELP loans generally impose interest rate caps. The DOE makes these payments to the trustee if the accrued interest on a loan at the uncapped loan yield exceeds the accrued interest at the capped borrowing rate. Interest subsidy payments are the accrued interest on loans to borrowers who are eligible for federal interest subsidies while they are attending school.

Student loan-backed notes are typically indexed either to one-month LIBOR or to 91-day Treasury bill yields. The difference between interest due and available funds is carried over to be paid from future excess spread. Principal collections are distributed either quarterly or monthly to investors. The difference between the amount of loans purchased and written off in the period also influences the payment. Like other ABS structures, credit enhancement can be provided in several ways including subordination, reserve funds, and excess spread. Moreover, many structures use prefunding accounts or have short revolving periods and include a mandatory clean-up call from excess spread.

The timing of the reimbursement of the ABS notes depends on the collateral mix. Relevant factors include loan type, loan status, and school type. For example, the Federal Student Aid office indicates usual grace period of six months in which the borrower is given time to become financially settled after leaving school before starting principal and interest repayments. ABSs collateralized by pools with a high percentage of loans in their grace period can be expected to experience higher principal payments in the near future.

Residential (Home Equity Loan) ABS

Traditionally, some modest portions of pools of securitized mortgage securities as opposed to agency and private-label MBSs have been classified as a residential ABS. Residential ABSs are distinguished from the rest of the mortgage market by the purpose of the loans or the credit profile of the obligor base of the pool. Loans are not only used to buy a house, but may also involve a cash-out refinancing, paying for home renovations and family expenses, and consolidating consumer debt or diminishing monthly outflows. Residential ABSs are mostly composed of nonconforming first-lien mortgages, mainly to subprime borrowers, by riskier second-lien mortgages to prime borrowers, and by subprime borrowers and home equity lines of credit (HELOCs).

An important difference between nonconforming mortgages that tend to appear as the underlying asset of this class of ABSs versus standard MBSs is their prepayment risk. The higher convexity versus interest rate changes characterizing the former represents a risk diversification opportunity for investors. This situation arises because residential ABS prepayment rates tend to be more stable and less responsive to rates changes, even though they are typically higher, when compared to agency MBSs. The lower sensitivity to rates is due to two factors: (1) a smaller average loan balance and (2) fewer refinancing options due to lower credit quality. The main reason borrowers tend to prepay faster nonconforming residential loans is that they start from a low credit quality, often because of past delinquencies and excessive debt-to-income ratio. With time they recover and obtain access to better mortgage conditions, the so-called *credit curing effect*.

The same general concepts concerning structuring and relative value analysis introduced early on, apply to this ABS class. However, this segment has been unpopular with investors in the aftermath of the financial crisis of 2007–2008, when multiple issuers in these markets experienced severe problems. In fact, today residential ABSs only represent less than 5 percent of the amount of ABSs outstanding in the United States and a small proportion of the U.S. mortgage market.

Summary and Conclusions

This chapter has discussed ABSs, a term used to indicate structured finance products collateralized by cash flows from a pool of securitized non-mortgage or subprime mortgage assets. The ABS market originated in the United States in 1985 resulting from the issuance of the first security backed by a pool of automobile loans. After becoming extremely popular pre-2008, ABSs as an asset class have suffered massively from the financial crisis of 2007–2008. Since then, the sector has slowly regained popularity, but still not meeting pre-crisis levels of issuance. The popularity of ABSs derives from the fact that they allow the originator to obtain low-cost financing. The segregation of the assets in a bankruptcy remote special purpose entity separates the credit risk of the asset pool from that of the originator. Various internal and external credit enhancement mechanisms help to achieve a better rating for the most senior classes of the ABS and to lower the cost of credit to final borrowers.

The most popular collateral types for ABSs are automobile loans and leases, credit card receivables, student loans, and to a lesser extent home equity loans. Although the principles of securitization, such as bankruptcy remoteness, are similar for all types of ABSs, the specific characteristics of the different notes, such as the cash flow structure, depend on the collateral that is used.

Discussion Questions

1. Define an SPV and explain its economic benefits involving an ABS.
2. Discuss how SPVs differ from master trusts used in the case of credit card ABSs.
3. Define tranching and explain how it can be used as a mechanism of internal credit enhancement.
4. Explain how and why prepayment of the underlying obligations may represent a risk to many types of ABS investors.
5. Discuss which ABS category faces the highest prepayment risk.
6. Explain how the naturally revolving nature of credit card debt is reflected by the typical securitization structures applied when originating credit card ABSs.

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Collateralized Debt Obligations, Collateralized Bond Obligations, and Collateralized Loan Obligations

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Introduction

Collateralized debt obligations (CDOs), collateralized bond obligations (CBOs), and collateralized loan obligations (CLOs) are all structured financial products. CBOs typically hold high yield bonds whereas CLOs generally hold bank loans. Technically, both are varieties of CDOs. The terms are used to specify the type of underlying holdings. This chapter uses the term CDO in the discussion of the structure, uses, and market/economic impact of these securities. The latter part of the chapter discusses both CBOs and CLOs at a more granular level of analysis.

A CDO is created when an issuer, typically a large bulge bracket bank, creates a special purpose vehicle (SPV) to hold debt assets. The *bulge bracket* is a slang term used to describe the largest and most profitable multi-national investment banks whose banking clients are normally large institutions, corporations, and governments. A *special purpose vehicle* (SPV) is a subsidiary company with a separate and distinct asset and liability structure. The SPV, in turn, issues both equity and debt to fund the assets conveyed to the issuer. Both the SPV and the securities it issues are called CDOs. This dual nature of the term gives rise to the somewhat confusing phrase, "The CDO issues CDOs." Accordingly, the terminology and context are used to best negate this confusion by making clear whether that the reference is to the entity or the securities it issues. An

SPV issues several separate and distinct types of debt each varying in its degree of credit quality. These different notes are referred to as a *tranche*, which describes a security that can be divided into smaller pieces and subsequently sold to investors. The highest quality tranche known as Class A offers the lowest risk and subsequently lowest return. The other tranches in descending order of credit quality are Class B, C, and D. The equity issued by the CDO carries both the highest degree of risk and potential reward.

Drexel Burnham & Lambert introduced CDOs in 1987, which at that time represented the latest development in securitized financial products. *Securitization* is the process of aggregating different securities thereby diversifying risk and allowing the resulting products' credit quality to be higher than that of the underlying assets. Some scholars contend that the securitization concept dates back hundreds of years. Over time, it has provided issuers, consumers, and the society with many benefits. The first CDOs used plain vanilla high yield bonds as collateral. Given the AAA credit rating of the top-tier tranches, institutions and asset managers with a mandate to hold only investment grade debt could now access junk-rated debt, an asset class previously considered as too risky. The creation of the CDO serves as an example of traditional securitization: pooling risky debt and issuing claims with varied risk-return profiles to investors.

Beyond classifying a CDO into a CLO or CBO based on the underlying holdings, the securities can be broken down more fundamentally by their stated purpose. CDOs can be further classified as balance sheet, arbitrage, and synthetic CDOs. Banks and other financial institutions use balance sheet CDOs to remove riskier assets from their balance sheets, which in turn reduce portfolio risk, diversify funding sources, and improve regulatory capital relief. In this role, balance sheet CDOs are a credit risk transfer tool. An arbitrage CDO uses a portfolio manager to trade the underlying holdings in order to generate excess returns for investors. Finally, a synthetic CDO uses credit default swaps (CDSs) or other noncash assets to obtain exposure to a portfolio of fixed income securities.

Today, CDOs are associated with the financial crisis of 2007–2008 because they contributed to the turmoil that swept through capital markets and brought the world's financial system to the brink of collapse. The criticism is not entirely unjust. The chapter explores their increased popularity before the financial crisis and their decreasing role afterward.

Financial innovation has allowed great wealth to be created and arguably has improved the standard of living for the economy. Unfortunately, innovation inherently involves creating products and services triggering a process of rapid evolution that is difficult to fully comprehend at inception. The CDOs, CLOs, and CBOs are similar to other product developments but when coupled with a downturn in markets and investor faith, combined with an overreliance on statistical models, allowed leverage and risk to negatively affect financial markets. Therefore, a CDO can be viewed as a process for pooling (typically illiquid) assets and redistributing as new (more liquid) securities. This process is not inherently a risk-increasing activity. Hence, when used responsibly, it has a place in today's financial system. The role of these financial instruments in the financial crisis should not serve as a reason to label them as inherently dangerous.

This chapter begins by discussing the structure of CDOs and then examines their background and identifies the associated parities. The role of CDOs during the financial crisis of 2007–2008 is then discussed. The chapter concludes by examining CDOs in today's market.

The Structure of CDOS

CDOs, CBOs, and CLOs are three examples of products that fall under the "securitized" umbrella. Each securitized product is defined by its own unique features, but one aspect common to these structured products is that they are housed inside a legal entity called an SPV or *special purpose entity (SPE)*. Given that both terms are synonyms, only SPV is used going forward.

In the aftermath of the financial crisis of 2007–2008, the U.S. government created the Financial Crises Inquiry Commission (FCIC), which issued a lengthy report on SPVs defining them as "an off balance sheet vehicle (OBSV) comprised of a legal entity created by the sponsor or originator, typically a major investment bank or insurance company, to fulfil a temporary objective of the sponsoring firm" (PricewaterhouseCoopers 2011, p. 5). Since the assets encapsulated in an SPV are no longer on the sponsoring firm's balance sheet, using an SPV provides a means of disaggregating the risks of the underlying pool and reallocating those risks to investors who are willing to bear them. This process provides investors with access to investment opportunities they would not ordinarily have, potentially reduces the risks taken by the sponsor, and offers a new source of revenue for the sponsoring firm.

The SPV is typically created with the intention of shifting assets off the originator's balance sheet and simultaneously removing the associated liability. This process allows the originator to essentially create financial assets by issuing debt and shifting those assets and risks to a third party, namely the SPV. Once the assets are moved into the SPV, the SPV can sell those assets to outside investors in the form of securitized products (Telpner 2003).

Market participants have heavily scrutinized the use of SPVs for the lack of transparency. Not only were SPVs essential in creating toxic CDOs that led to the financial crisis of 2007–2008, but also years earlier, Enron executives used these entities during the accounting scandal that brought down the firm. Despite this negative press, a report by PricewaterhouseCoopers describes these entities as mostly beneficial:

> SPVs have a number of key utilitarian features and benefits that allow investors access to investment opportunities which would otherwise not exist. These include facilitating and supporting securitization, financing, risk sharing and raising capital to name a few. In the absence of SPVs, these objectives would not be possible without putting the entire corporation at risk. It also provides significant benefits to the parent firms by allowing ease of asset transfer, reducing "red tape," providing tax benefits and legal protection
>
> (PricewaterhouseCoopers 2011, p. 2).

As previously discussed, many securitized products require the creation of SPVs. These products are defined by their unique features, characteristics, and the underlying assets (i.e., collateral). Two products that fall under this umbrella are CBOs and CLOs. Simply stated, *CBOs* are securities backed or collateralized by a diversified pool of corporate bonds; *CLOs* are securities backed or collateralized by a diversified pool of corporate loans. The bonds used inside of a CBO portfolio are often riskier unsecured junior debt issued by various corporate or sovereign obligors. Conversely, a CLO is backed by a portfolio of secured or unsecured loans made to different corporate, commercial, and industrial loan customers from one or more lending banks. For example, the underlying holdings in a CBO might be comprised of debt issued by a large private business or municipality, while the assets contained in a CLO might represent credit card receivables or automobile receivables (Standard & Poor's 1999).

Regardless of the differences in their underlying holdings, both CLOs and CBOs offer the same advantage in that they pool almost exclusively risky or speculative rated assets to create AAA rated asset-backed securities (ABSs). This process occurs by creating a tranche system that has the effect of enhancing the overall credit profile of the structured product. The invention of tranches allowed investors to take on varying risk/return profiles, while investing in the same pool of assets. The AAA-rated tranche offers investors a return slightly higher than AAA Treasury securities, while theoretically taking on the same amount of risk. The fundamental idea behind the tranche system is the priority of claims in the event of underlying assets defaulting. Conversely, the lower rated tranches are the first to absorb losses, and thus offer higher potential returns. The order of priority of claims follows a convention similar to that used by credit rating agencies such as AAA, AA, A, and BBB. The Financial Crisis Inquiry Commission (FCIC) report summarizes this point by stating the fundamental idea behind the CDO made sense: "Pooling many bonds reduced investors' exposure to the failure of any one bond and putting the securities into tranches enabled investors to pick their preferred level of risk and return" (FCIC 2011, p. 129).

A typical CDO transaction involves nine parties: (1) asset originators, (2) issuers, (3) underwriters, (4) servicers, (5) administrators, (6) credit rating agencies, (7) credit enhancement providers, (8) liquidity facility providers, and (9) trustees. All play a unique role in the originating, structuring, and ultimately bringing a CDO to market. In most cases, the *asset originator* attempts to remove the risk of certain assets from its balance sheet and to transfer them and their associated risks to the SPV. The SPV, in turn, acts as the *issuer* and *servicer* of the CDO. Once the assets are pooled and transferred to the SPV, the CDO is subdivided into multiple tranches with varying risk and return characteristics. A credit rating agency (CRA) reviews each tranche and assigns a letter rating. This rating structure, which sequentially distinguishes among investment grade, junk, and an equity tranche, allows CDOs to attract investors with varying risk appetites.

A key trait for successful marketing purposes is the coveted AAA rating. If the CDO's underlying asset pool cannot garner an AAA rating on its own merits, even for the most senior tranche, credit enhancement providers and liquidity facility providers are employed. These two parties act as a form of insurance for the CDO. Through credit enhancement and liquidity guarantees, the senior tranche ultimately earns the AAA rating and appeals to a much larger pool of investors. Another party heavily involved in the structuring of a CDO is the *underwriter*, whose role is to help develop the product and to price and market the CDO. Finally, the *administrator* is responsible for managing and trading the underlying pool of assets, while the *trustee's* role is to monitor those underlying assets for potential default (Telpner 2003).

CDOs have historically been sold to and traded among sophisticated investors with a substantial amount of capital. These parties are known as *qualified institutional buyers (QIBs)*. By targeting this group of investors, the CDO can avoid the typical oversight given to public offerings that are available to retail investors. A report issued by the FCIC (2011) following the financial crisis emphasized the general lack of oversight in the CDO market. The report compares the SEC registration process for CDOs to that for mortgage-backed securities (MBSs) and asserts that issuers of CDOs used a different regulatory framework from the one that applied to most MBSs. Due to this difference, CDOs were not subject to even the minimal shelf registration rules. Underwriters were thereby able to issue CDOs under the SEC's Rule 144A, allowing the unregistered resale of certain securities to so-called QIBs. These investors included insurance companies such as MetLife, pension funds including the California State Teachers' Retirement System (CalPERS), and investment banks such as Goldman Sachs (FCIC 2011).

By allowing CDOs to fall under SEC Rule 144A, virtually no oversight occurred because they were held to a loose federal regulatory standard. The lack of oversight led to a highly active secondary CDO trading market. Although secondary market liquidity is often a positive feature for securitized products, the U.S. government's report stresses that in the absence of registration requirements, a new debt market developed quickly under Rule 144A. This market was fairly liquid because qualified investors could freely trade Rule 144A debt securities amongst themselves. However, the intent of Rule 144A was for corporate bonds, which differ substantially from the CDOs that dominated the private placement market more than a decade later (FCIC 2011).

History and Background

Although the securitization of financial assets dates as far back as 1790, the creation of the first rated CDO did not appear until two centuries later (Coval, Jurek, and Stafford 2008). Michael Milken, notorious for his role in junk bond trading, and his firm Drexel Burnham Lambert, one of the leading investment banks in the country at the time, introduced the first rated CDO in 1987. Market participants considered both Milken and his firm as experts in trading junk bonds. From their perspective, the CDO structure would act as the perfect vehicle to make those junk bonds appear more attractive. The innovation of tranches, defined by a precise risk profile, through the creation of the rated CDO cast a wider net with respect to potential investors.

Drexel Burnham Lambert created the first rated CDO by pooling a single asset class—junk bonds. Over time, the CDO structure became more attractive and lucrative, and incentivized firms such as Prudential Securities to become more creative in its structuring. By 1998, Prudential Securities had evolved from simply packaging a single type of asset into a CDO and started to pool assets from a diverse array of sectors to create the underlying CDO asset base. According to a report by the FCIC (2011, p. 130) after the financial crisis, "These 'multisector' or 'ABS' securities were backed by mortgages, mobile home loans, aircraft leases, mutual fund fees, and other asset classes with predictable income streams." The diversity was supposed to provide yet another layer of safety for investors. The additional layer of "safety" from the multi-sector diversification, coupled with the fact that these securities offered a better return than investments with comparable ratings, made them attractive opportunities for many investors.

By 2002, the multi-sector CDOs that had been hailed as highly diversified and thus theoretically safer faced unexpected problems. A high number of mobile home loans defaulted, air craft leases underperformed post-9/11 (i.e., the time after the September 11, 2001, terrorist attacks, characterized by heightened suspicion of non-Americans in the United States, increased government efforts to address terrorism, and a more aggressive American foreign policy), and mutual fund fee projections deteriorated after the dot-com bubble burst. According to the FCIC report,

> The accepted wisdom among many investment banks, investors, and rating agencies was that the wide range of assets had actually contributed to the problem; according to this view, the asset managers who selected the portfolios could not be experts in sectors as diverse as aircraft leases and mutual funds. (FCIC 2011, p.130).

Given the general consensus that the professionals creating and managing these products needed to return to assets they truly understood, "the CDO industry turned to nonprime mortgage-backed securities, [. . .] which seemed to have a record of good performance, and which paid relatively high returns for what was considered a safe investment" (FCIC 2011, p.130). This shift toward mortgage-based assets dominating the CDO market appeased all parties simply by offering something familiar, which gave the illusion of an outright investment in MBSs that the market had favored almost 20 years earlier.

Large institutions mandated to invest in highly rated assets, such as pension funds and in some cases insurance companies, acquired the high investment grade classes, while many of the underwriters of these CDOs became the largest purchasers of the super senior AAA tranches, with the equity tranche typically held by the underwriter. Although the top-rated tranches, along with the equity tranche, were in high demand, the mezzanine tranches that rated low investment grade were not as popular. This situation would inevitably lead to CDOs becoming the most frequent buyers of these mezzanine tranches. As the report by the FCIC states (2011, p.132), "It was common for CDOs to be structured with 5 percent or 15 percent of their cash invested in other CDOs; CDOs with as much as 80 percent to 100 percent of their cash invested in other CDOs were typically known as "CDOs squared." Ultimately, the entire structure imploded when the toxic mortgages that were pooled, packaged, and repackaged multiple times began to fail. The history of CDOs does not end here, despite their major contribution to the near destruction of global financial markets. CDOs in their various forms remain actively traded and continue as an important market in both size and activity.

Rating Agencies

Credit rating agencies (CRAs) received much attention for the role they played during the financial crisis of 2007–2008. Although various parties contributed to this crisis, CRAs, including the most respected firms including Moody's, Standard & Poor's, and Fitch, deserve a large share of the blame. At best, they looked the other way and at worst were derelict in their duties by awarding AAA ratings to these complex and risky securities. Much of the blame can be attributed to a combination of compensation incentives and mis-specified models. As independent, for-profit entities, CRAs earn fees paid by CDO issuers to rate the securities they underwrite. This situation creates a conflict of interest that motivates CRAs to issue unwarranted investment grade ratings in the interest of retaining the business of the large Wall Street firms that make up their client base. CRAs also relied on standardized mathematical models to develop a rating score. The combination of conflict of interest and faulty models facilitated the creation and distribution of toxic structured financial products.

These points are echoed in a piece published in the National Bureau of Economic Research (NBER) detailing the failures of the CRAs (White, Snowden, and Fishback 2014). The authors of this report describe a compounding effect spurred by the assignment of overly optimistic ratings, due in part to faulty mathematical models that relied on unlikely assumptions and the desire on the part of CRAs to win and retain business. From the issuer's perspective, obtaining a AAA rating on the most senior tranche was imperative to be able to attract business from institutional investors who had to invest in the safest assets. These investors include institutions such as insurance companies, money market funds, and pension funds. This situation led to "rating shopping" on the issuer's part, which ultimately led to the CRA simply appeasing the issuer for fear of losing out on the lucrative revenue stream these deals produce. The FCIC's report in the aftermath of the financial crisis summarizes this point:

> The role of the rating agencies was to provide basic guidelines on the collateral and the structure of the CDOs—that is, the sizes and returns of the various tranches—in close consultation with the underwriters. For many investors, the triple-A rating made those products are appropriate investments. Rating agency fees were typically between $250,000 and $500,000 for CDOs (FCIC 2011, p. 131).

As the issuance of CDOs ballooned from $20 billion in 2004 to more than $180 billion in 2007, CRAs were generating record profits and aggressively trying to secure as much of this business as possible. To keep up with an approximately 800 percent increase in CDO issuance and to reap the financial rewards associated with rating these deals, CRAs became increasingly reliant on scalable mathematical models. Barnett-Hart (2009) reinforces the CRAs' thirst for increased profits and overreliance on faulty models by affirming the decreased quality of CDO ratings developed when facing a time constraint. With the rapid pace of issuance, and the concomitant need to be rated, agencies could not keep up from an intellectual and capacity standpoint. The automation of rating a CDO using models with little to no human intervention and with little incentive to check the accuracy of the rating relative to the underlying collateral was instrumental in the problems that followed.

Most of the mathematical models used by CRAs to rate CDOs relied on two key assumptions: (1) the probability of default of the underlying securities and (2) the correlation between defaults. Unfortunately, these assumptions were extremely aggressive and, in many cases, simply incorrect. These models assumed a very low, and often nonexistent, correlation between the probabilities of default of underlying holdings. The FCIC's report articulates the dangers of this assumption through the analogy of flipping a coin to see how many times it comes up heads. Each flip is unrelated to the others (i.e., the flips are uncorrelated). As an analogy, consider a loaf of sliced bread. If the loaf has one moldy slice, it is likely to have other moldy slices. The freshness of each slice is highly correlated with that of the other slices and cannot reasonably be viewed as independent. As investors now understand, MBSs in CDOs were less like coins and more like slices of bread (FCIC 2011).

As previously discussed, the fundamental issue with these rating models cannot be solely attributed to correlation assumptions, but also to poor assumptions about the probability of default. Furthermore, the use of a qualitative framework for analyzing these structures on a mass scale was largely absent or at best underutilized. In estimating the probability of default, Moody's relied almost exclusively on its own ratings of MBSs bought by the CDOs. At no time did the agencies "look-through" the securities to the underlying subprime mortgages (FCIC 2011).

As CDO issuance grew, so did CRA profits. Unfortunately, the support staff tasked with rating each structured product apparently did not grow. As issuance grew, and staff size remained stagnant, CRAs relied more heavily than ever on unproven mathematical models. A sufficient number of qualified employees was unavailable to provide accurate assessments. According to Gary Witt, a former Director at Moody's, virtually no availability existed to do meaningful research and when personnel worked to create a new methodology, it was in their spare time (FCIC 2011). Witt asserts that even when fundamental issues arose about with their models and ratings, the CRAs were unable to create meaningful improvements.

Synthetic CDOs

Before the financial crisis of 2007–2008, CDOs were steadily becoming one of the most sought-after products by investors. The high returns that were being earned paired with the apparent low level of risk contributed to this situation. The dramatic increase in supply was only limited by a shortage of the underlying assets. CLOs and CBOs were supported, in most cases, by high quality loans and mortgages, which gave some credence to the AAA tranches for which these securities had become known. The supply of quality assets to underlie the CDOs simply fell short, even after concerted efforts by the Republican controlled Federal Housing Administration (FHA) to decrease lending standards, and effectually increase outstanding mortgages and loans. The answer to this problem, from the perspective of CDO sponsors such as Goldman Sachs, was to create synthetic versions of the collateralized obligations that had become so popular. The report by the FCIC summarized this point as follows:

> Firms like Goldman found synthetic CDOs cheaper and easier to create than traditional CDOs at the same time as the supply of mortgages was beginning to dry up. Because there were no mortgage assets to collect and finance, creating synthetic CDOs took a fraction of the time. They also were easier to customize, because CDO managers and underwriters could reference any mortgage-backed security—they were not limited to the universe of securities available for them to buy (FCIC 2011, pp.142–143).

Ultimately, the demand for an AAA-rated investment with a return higher than that of AAA-rated US Treasury motivated the push to continually generate more CDO supply. This situation led directly to creating synthetic CDOs, which are composed of bets such as credit default swaps (CDSs), on other mortgage products, rather than mortgage securities backed by tangible assets such as CDOs. In other words, the synthetic CDO sponsor no longer had the burden of purchasing, packaging, and collateralizing viable loans. Instead, the sponsor now builds baskets of CDSs that would reference existing CDOs, other securitized products, and even other synthetic securities. Standard and Poor's defines and explains the purpose of these products as follows:

> Credit-linked structures often referred to as "synthetic CLOs," have collateral in the form of a credit derivative, such as a credit swap, a credit-linked note, or a combination thereof. A synthetic CLO using, for example, a CLN allows the issuer to achieve the same transfer of risk as a CBO or a CLO without the need to legally transfer the assets that created the credit exposure. The term "synthetic CLO" is somewhat limiting, in that these synthetic structures can "bundle" corporate credit exposures, not only "traditional" corporate loans (Standard & Poor's 1999, p. 95).

Investors in a synthetic CDO would typically fit into one of three categories: (1) short investor, (2) unfunded long investor, or (3) funded long investor. Investors taking a short position in the synthetic CDO would essentially take a long position in the CDS that the CDO was referencing; making periodic premium payments while the referenced asset performs and profiting if the referenced asset defaulted. Conversely, investors taking an unfunded long position in the CDO would take a short position in the referenced CDS, receiving periodic premium payments while the asset performed, but being liable for making the short investor whole in the event that the value of the referenced asset decreased past a certain point. Neither the short position nor the unfunded long position requires an upfront cash investment, whereas the funded long position is analogous to a long bond position. The funded long position initially invests cash in the CDO and in return receives periodic payments of principal and interest assuming the referenced securities perform. Therefore, if the referenced securities do not perform, investors taking a funded long position have the potential of losing their full investment (Gibson 2004).

Not surprisingly, synthetically engineered products such as synthetic CDOs, which are void of any tangible underlying asset, carry substantial risk for investors, but potentially greater contagion risk for global financial markets and *systemically important financial institutions*, which are banks, insurance companies, or other financial institutions whose failure might trigger a financial crisis. They are colloquially termed "too big to fail." In fact, George Soros discusses the asymmetric risk/return profile of CDSs, the overwhelming downward pressure they place on the underlying asset of the CDS and recommends prohibiting these products. Soros also highlights the endemic nature of CDS by asserting that, ". . . the potential damage that CDS could do [is] not limited to financial firms" (Wheatley and Lewis 2009, p. 1). He cites the bankruptcy of North America's largest newsprint maker, AbitbiBowater Inc., and the bankruptcy of General Motors to showcase the contagion caused by CDSs and adds that, "In both cases, some bond holders owned CDS and they stood to gain more by bankruptcy than by reorganization. It's like buying life insurance on someone else's life and owning a license to kill" (Wheatley and Lewis 2009, p. 1). The FCIC report gives strong support to the notion that the interrelated nature of many synthetic CDOs led to cascading by pointing out that,

> . . . synthetic CDOs created by Goldman referenced 2408 mortgage securities, some of them multiple times. For example, 610 securities were referenced twice. Indeed, one single mortgage-backed security was referenced by nine different synthetic CDOs created by Goldman Sachs. Because of such deals, when the housing bubble burst, billions of dollars changed hands (FCIC 2011, p. xxv).

The Great Financial Crisis

Following the recession of 2000-2001 and the associated stock market correction, the U.S. economy enjoyed six years of prosperity. Between 2002 and 2007 the economy experienced an uninterrupted period of expansion, unemployment fell, and interest rates rose moderately. This period of growth unleashed a wave of optimism that contributed directly to a dramatic increase in growth in housing sector. As housing prices increased at historic rates, lenders granted individuals credit that previously was denied because they did not qualify. This cumulative speculative behavior fueled further price increases and unbridled enthusiasm. This situation had a positive, if not illusionary, impact on the mentality of home buyers who suddenly believed that real estate was a high return, low risk endeavor.

Purchasing houses became the new benchmark of success in the United States. The rate of U.S. home ownership grew from just over 64 percent in 1995 to a peak of nearly 70 percent in 2004. The Bush Administration's 2003 American Dream Down Payment Act, which made home ownership more affordable and obtaining a mortgage far easier, partly promoted this growth. Although the logic was sound and the intent of these policies was to help citizens, this effort was one factor that ultimately prompted excess risk-taking on behalf of home buyers and mortgage lenders. This increased demand for mortgages incentivized banks and mortgage brokers to issue home loans to buyers with substandard credit. In some cases, the home buyers received NINJA loans, which is slang for "no income, no job, no assets," without needing proof of income or assets.

The massive increase in the demand for homes made the securitization of mortgages essential to reduce risk and increase liquidity. Fannie Mae, Freddie Mac, and Ginnie Mae packaged most of these mortgages into MBSs. Fannie Mae and Freddie Mac are government sponsored enterprises (GSEs), which are publicly traded companies created by Congress without the "explicit" backing but presumed implicit backing of the U.S. government to make home ownership more affordable. Ginnie Mae functions in a similar capacity but focuses on loans issued by Federal Housing Authority (FHA), which helps first time home purchasers, the Veterans Administrations (VA), and the Rural Housing Administration. Once a mortgage is securitized and packaged into an MBS by one of these agencies, it sits on their balance sheet until it is sold to other investors, such as mutual funds, pension funds, or banks (Ross 2015).

The MBS is a central character in the story of the CDO because it served as a catalyst for further speculation. In other words, the creation of more MBSs further enhanced both in terms of credit quality and liquidity by being securitized again into a CDO. The resulting CDO offered the potential for investors to capture an attractive spread over the 10-year U.S. Treasury security in a seemingly low risk, liquid security (Coval et al. 2008). This instrument was attractive for both asset owners, such as pension funds, and managers looking to enhance returns, diversify, and keep risk low. As described in the previous section, it was also attractive for financial institutions with exposure to MBSs, looking to move them off of their balance sheet to meet regulatory capital restrictions.

CDOs increasingly used MBSs as collateral leading up to 2007. Once securitized, the statistical models showed that the risk associated with a single MBS was diversified away and appeared to vanish. CDOs could offer the yield associated with junk credit in an investment grade wrapper. Clearly, a relatively high yielding investment vehicle with low risk was in high demand by asset managers and asset owners alike. The increased demand for CDOs caused the demand for mortgages to increase. Similarly to how the demand for steel causes the demand for iron to rise, the demand for CDOs increased the demand for mortgages.

CDOs are perhaps the most controversial financial product since the innovation of securitization. During the financial crisis of 2007–2008, the CDO was the proverbial bubble that burst, unleashing a liquidity crunch that contaminated the entire global financial system. Not only did the parties directly involved in a CDO transaction behave irresponsibly, but also the product's objective to diversify away the risk of subprime mortgages, combined with an over-leveraged financial system, led to devastating effects.

As CDOs received more attention from investors, the investment banks that continuously underwrote these securities began to demand more mortgages to quench their thirst for these structured products and the associated fees generated from building them. Some speculation exists within the investment community about the influence investment bankers' demand for mortgages had on their parent banks' lending standards. The more lenient the lending standards, the more mortgages could be issued, which led to more CDOs being created.

In 2007, cracks began to form in the bedrock of the U.S. economy. Unemployment started to increase, personal incomes dropped, and previously affordable mortgage payments vanished. With CDO pricing models built upon the assumption that housing prices would continuously rise, banks found themselves overexposed. Although details of the resulting financial crises go beyond the scope of this chapter, clearly these products exposed a system overleveraged with more than a few guilty participants.

Summary and Conclusions

The reputation of CDOs, CBOs, and CLOs is likely to be marred for the foreseeable future based on their involvement in the financial crisis of 2007–2008. Falling under the umbrella of structured financial instruments, the initial intent of CDOs was to diversify away the risk of high yield or junk rated debt thereby creating more demand for that debt and allowing less worthy borrowers to pursue the American dream of homeownership. Advancements in computing technology, financial modeling, and unbridled ambition led to excess risk-taking that permeated throughout the investment banking community, traders, and borrowers. The confluence of an overly complicated product structure, outdated regulatory oversight, and economic factors combined to devastate major financial institutions and nearly the entire financial system.

Despite the scar left by CDOs, these products are starting to mount a comeback. With credit yields depressed following the ultra-accommodative monetary policy put in place in 2009 to help aid the recovery of the U.S. economy, investors are yearning for a vehicle that provides an attractive yield, which could lead to the return of the CDO (Wharton 2013). The structure of the CDO is comparable to other structured financial products in many ways. The building blocks of the CDO and the overly complicated synthetic CDO are the defining factors that make the CDO different. If used responsibly, CDOs can be a valuable tool for gaining exposure to credit risk as a diversified vehicle. The following statement speaks to the environment for these products, "Not only are lenders far more cautious, regulators seem to be waking up, capital requirements are tightening, and investors are chastened" (Wharton 2013, p. 1).

Time will inevitably reveal whether involved parties learned the necessary lessons about the abuses of CDOs. Whether the majority of the blame ultimately rests with bankers, mortgage brokers, predatory borrowers, CRAs, or regulators, all played a role, and all paid a severe yet perhaps uneven price. If history is any predictor, investor memory is likely to fade and leverage is likely to once again build up in the financial system. Hopefully, those charged with responding to future crises have the necessary tools at their disposal to prevent the wide spread panic that ensues when sophisticated products evolve beyond regulatory oversight and greed takes over.

Discussion Questions

1. Describe how CDOs, CBOs, and CLOs differ.
2. Describe the primary parties to a CDO.
3. Discuss the process and importance of tranching.
4. Explain the attraction of the CDO structure to investors.
5. Explain why banks use SPVs.

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PART VI

BOND VALUATION AND ANALYSIS

24

Factors Affecting Bond Pricing and Valuation

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Introduction

The bond market is one of the most important financial markets in the United States. It plays a central role in funding economic activities in both public and nonpublic sectors, which is critical for the development of the entire economy. For instance, U.S. corporations raised $820 billion to finance their daily operations from the bond market in 2001. That amount grew dramatically to $1.6 trillion in 2016. By contrast, according to the Securities Industry and Financial Markets Association (SIFMA) (2018a, 2018b), the amount of newly issued equity fluctuated around $200 billion each year during the same period. On average, the primary bond market is six times larger than the primary equity market. Figure 24.1 provides more detailed information on the issuance of corporate bond and equity between 2001 and 2016. The sheer size of the bond market attracts much attention from both investors and regulators.

When an entity decides to issue a new bond, it contacts one or several investment banks to form an underwriting syndicate. A main function of investment bank underwriters is to price the bond in an accurate and efficient way. Accurate bond valuation is important to the issuer because this process directly affects its net proceeds, which could affect its financing, payout, and investment policies. Bond valuation is also important to investors in the sense that it provides the economic foundation to their investment strategies. Government policymakers are also concerned with bond valuation because it could influence the efficiency of the entire financial market. The economic significance of the bond market makes understanding the pricing and valuation mechanism behind it important. Although this chapter focuses on the valuation of corporate

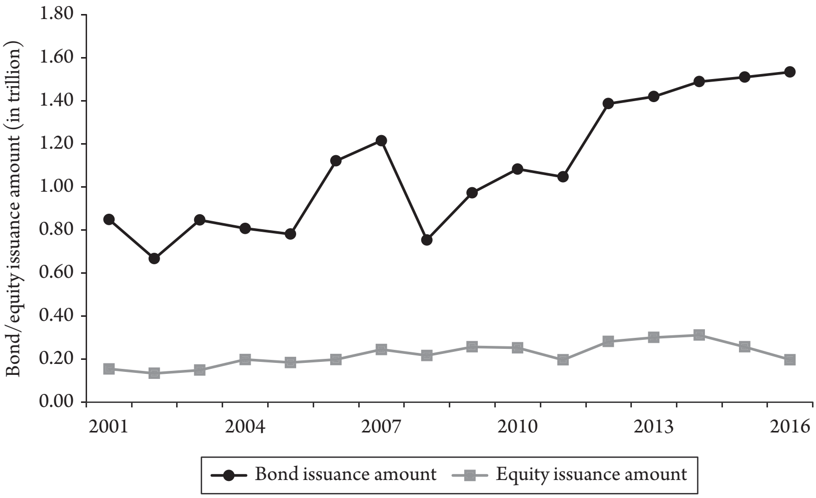

Figure 24.1 New Bond and Equity Issuance
This figure plots the annual issuance amount (in $ trillion) in the U.S. corporate bond and equity market between 2001 and 2016.
Source: SIFMA (2018a, 2018b).

bonds, the economic rationale behind most of the pricing factors discussed also apply to the valuation of other types of fixed-income securities.

Equation 24.1 shows the standard bond valuation formula:

$$P = \sum_{t=1}^{T} \frac{E(CF_t)}{(1+r)^t} \tag{24.1}$$

where $E(CF_t)$ represents expected future cash flows, and r represents (constant) yield-to-maturity. The intuition behind this formula is that the price of a risky bond equals the sum of present values of all future expected cash flows. Although this formula appears straightforward, its real-life implementation can be complicated because investors must accurately estimate expected future cash flows and the discount rate. Expected future cash flows are determined by various financial variables such as the bond's coupon rate, default probability, and recovery rate in the event of default. To accurately estimate the expected future cash flows, investors need to make assumptions with respect to all these variables. However, predicting these various factors in an unbiased manner can be challenging because almost all macro-, firm-, and bond-level characteristics can influence the prediction.

Estimating the discount rate can also be challenging. For a risky corporate bond, investors usually decompose the bond's yield-to-maturity (YTM) into two parts for valuation purposes: a risk-free rate and a yield spread. Empirically, investors typically could use the U.S. Treasury rate of the closest maturity as a proxy for the risk-free rate, and the yield spread represents the portion by which the YTM might exceed the Treasury rate. The yield spread can be interpreted as the compensation rewarded to investors for bearing potential default risk, liquidity risk, and loss given default associated with their investment. Similar to the expected future cash flows, a wide range of financial variables also influence the yield spread. Hence, considering all possibilities to find a perfect estimation poses many difficulties.

The study of corporate bond pricing proceeds along two different paths (Boardman and McEnally 1981). The first approach examines the macroeconomic determinants of bond yield or yield spread. The second approach focuses on the firm-level determinants of bond price. This chapter incorporates both approaches and aims to presents an overview of the bond pricing literature. However, discussing all pricing factors is impractical. Therefore, this chapter focuses on several basic but important pricing factors in bond valuation.

The remainder of the chapter is organized as follows. The next section discusses the bond pricing factors, including the Treasury yield, liquidity premium, credit rating, equity volatility, corporate governance, accounting quality, product market competition, creditor rights, and financial innovation. The final section provides a summary and conclusions.

Factors Affecting Bond Pricing

Factors affecting bond pricing and valuation include traditional fixed-income variables, such as the risk-free rate, credit risk, and liquidity risk, as well as elements that are commonly analyzed in corporate finance, such as corporate governance, accounting quality, product market competition, and financial innovation.

Treasury Yield

Bond investors provide businesses with funds to meet their financial needs. In exchange, bond issuers promise investors a series of future cash payments in the form of interest and principal. Investors can invest directly in the Treasury bond market. This "risk-free" income from Treasuries reflects the time value of money, which is the most fundamental portion that influences a bond's value. Therefore, any economic variables that could influence the Treasury yield also have implications for valuing corporate bonds.

The Treasury rate could influence a bond price through both the coupon rate and discounting factor in each period. When the Treasury rate is high, investors naturally demand a high coupon rate to compensate for the opportunity cost of their investment. Conversely, the yield curve of the Treasury rate influences bond price through each period's discount rate, which is more likely an ex-post influence.

The yield curve graphically represents the Treasury yields at different maturities. Figure 24.2 shows four different shapes of the yield curve. Panel A shows a normal or positively sloped yield curve, which is the most common yield curve and it implies that the yield increases monotonically with the maturity of the Treasury. Panel B shows a flat yield curve, which implies that the Treasury yield is insensitive to the Treasury maturity. Panel C shows a negatively sloped yield curve, which indicates a decrease in the Treasury yield as the maturity increases. Finally, Panel D shows a humped yield curve in

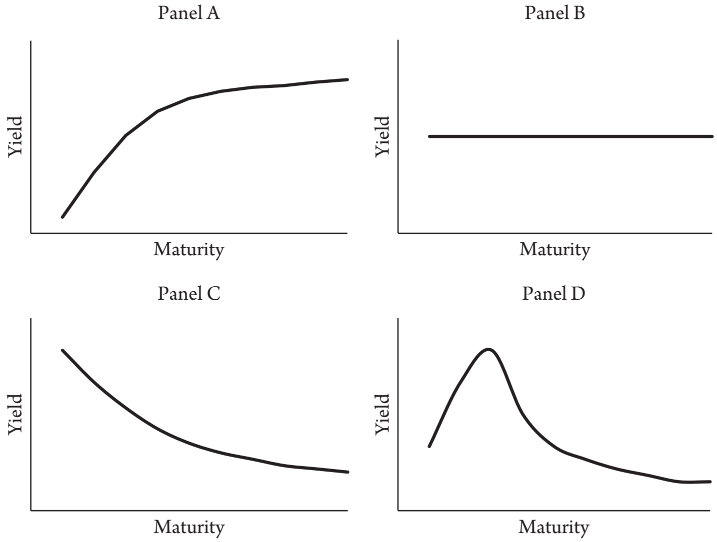

Figure 24.2 Yield Curve Shapes
This graph shows four common shapes of the yield term. Panel A shows a positively sloped yield curve, indicating that the Treasury yield increase with the Treasury maturity. Panel B presents a flat yield curve, implying that the Treasury yield remains constant across different maturity. Panel C shows a negatively sloped yield, inferring that the Treasury yield decreases with the Treasury maturity. Panel D illustrates a hump-shaped yield curve in which the Treasury yield increases with the Treasury maturity at the short-maturity spectrum, and then decreases with the maturity at the long-maturity spectrum.

which the Treasury yield increases as the maturity at the beginning, and then decreases. Generally, the relation between yields and maturities is known as the term structure of interest rates or simply the *term structure*. Given the influence of the Treasury yield on bond valuation, understanding the economic reasons behind each type of the term structure is important.

Pure expectations theory, liquidity preference theory, and preferred habitat theory are the three most popular theories used to explain the different types of the yield curve.

- *Pure expectation theory* maintains that the only factor that affects forward Treasury rate is the expected future spot Treasury rate. According to this theory, a rising term structure reflects that investors expect the future spot Treasury rate will be higher than the current Treasury rate.
- *Liquidity preference theory* contends that investors need to be compensated for holding a longer maturity Treasury because it tends to be less liquid than a comparable shorter maturity Treasury. This theory implies that the shape of the yield curve is determined by both the expected future spot Treasury rate and the liquidity premium. According to this theory, a rising term structure does not necessarily reflect that investors expect in the spot Treasury rate to rise in the future, as it could be just the results of the high liquidity premium.

- *Preferred habitat theory* assumes that investors have a preference for different Treasury maturities, and investors demand a risk premium to shift from their preferred maturity habitat. Unlike the liquidity theory, this theory does not assume that the risk premium increases monotonically with the Treasury maturity.

Overall, the Treasury yield is the most important and fundamental factor influencing a bond's value. Hence, understanding the term structure is at the center of bond valuation. The following sections focus on factors that could influence the *yield spread*, which is the difference between the bond's YTM and the Treasury yield.

Credit Risk

Credit risk is the risk that bond issuers fail to make required payments, which is the most fundamental factor that could influence the yield spread. Because directly measuring a bond's credit risk is challenging, the existing finance literature typically uses a bond's credit rating as a proxy of credit risk (Bai, Bali, and Wen 2017). The *bond credit rating* is a letter rating that provides information about the issuer's ability to make coupon payments and repay the principal at maturity. When a firm issues a bond, it usually obtains a letter credit rating from a credit rating agency (CRA). The credit rating industry is dominated by the three largest CRAs: Moody's, Standard & Poor's (S&P), and Fitch Ratings. The credit ratings provided by each CRA represent its own opinion for the firm's credit risk. Once a credit rating is awarded to a bond, the rating becomes public information and investors can access the rating without costs. In general, a high credit rating indicates an issuer's strong ability to meet its payment obligations. The bond issuer is allowed to provide rating agencies with private information to produce a more accurate credit rating, so the credit rating is also an important avenue to reduce the information asymmetry between issuers and investors. Investors rely on credit ratings to make investment decisions and manage their portfolio risk. Therefore, the informativeness of credit ratings plays an important role in the bond pricing discovery process.

Bond issuers can obtain credit ratings for the same bond from several different CRAs simultaneously. The credit ratings provided by different CRAs could be the same, but could also differ. This situation arises because CRAs might assess a bond's credit risk based on various information sources, and their rating model also could be proprietary (Bongaerts, Cremers, and Goetzmann 2012). Usually, such rating divergence among various raters disappears over time.

The best rating a bond could receive is AAA (S&P, Fitch) or Aaa (Moody's), which implies the issuer has extremely strong ability to meet the payment obligations. However, CRAs award an AAA-level credit rating to very few bond issues. The worst credit rating a bond could receive is D, indicating the issuer is in default. Rating grades are further differentiated by modifiers, for example "+" or "–" for S&P ratings. AAA, AA, A, and BBB are commonly known as investment-level grades (i.e., bonds with credit rating of BBB– or above). On average, an investment grade bond has relatively lower credit risk compare to the speculative grade bond (i.e., bonds with credit rating of BB+ or below). Speculative grade indicates a weak capacity of the issuer to repay debt obligations. Also, default risk is supposed to increase monotonically as the credit rating moves along the credit rating spectrum from AAA to D.

Ideally, a bond credit rating should accurately reflect the issue's credit risk. Therefore, investors should respond to the new credit information released by credit ratings. Katz (1974), Grier and Katz (1976), and Hand and Holthausen (1992) examine daily excess bond returns associated with the announcement of credit rating changes, and observe price effects associated with such changes. On average, a rating upgrade (downgrade) is followed by a price increase (decrease). Furthermore, Kliger and Sarig (2000) use Moody's refinement of its rating system as an exogenous event in which firms' fundamentals do not have any chance to see whether bond ratings contain pricing-relevant information. They find that bond value increases when Moody's announces a better-than-expected rating.

Credit ratings also could influence bond pricing through the demand channel since the major investors in the bond market are subject to credit rating related investment constraints. For instance, insurance companies, pension funds, and banks face a higher secured capital requirement if they want to invest in low-rated bonds (Massa and Zhang 2011; Massa, Yasuda, and Zhang 2013; Becker and Ivashina 2015). This credit-rating-related investment friction would post negative effects on the demand, which could lower a bond's price.

Overall, credit ratings can influence a bond's price by either conveying new credit information to the market or influencing investor's behavior through the regulation friction channel. Typically, a downgrade (upgrade) in a credit rating has a negative (positive) effect on a bond's price. At a broader level, the financial literature documents that the influence of credit rating changes is not confined only to the bond market. For instance, Pinches and Singleton (1978), Goh and Ederington (1993), and Avramov, Chordia, Jostova, and Philipov (2007) find that credit rating changes also have implications for the stock market. However, a more detailed discussion on this topic is beyond the scope of this chapter.

Liquidity Risk

The idea that investors demand a liquidity premium for illiquid securities can be traced to Amihud and Mendelson (1986). Several other papers provide further evidence for this argument (Bhide 1993; Amihud 2002; Longstaff 2004; Acharya and Pedersen 2005). Illiquid securities are associated with higher transaction costs on the secondary market compared to more liquid securities. Such high transaction costs could set barriers on investors' hedge activities and expose them to firm-specific credit risks. Also, illiquid securities may force investors to accept a lower selling price in a fire sale, which could reduce their expected future cash flows. These costs associated with the liquidity risk would negatively affect the price of illiquid securities.

The U.S. corporate bond market is a thinly traded market (Chordia, Sarkar, and Subrahmanyam 2004; Friewald, Jankowitsch, and Subrahmanyam 2012). On average, a corporate bond only trades 52 days a year (Bessembinder, Kahle, Maxwell, and Xu 2008). Therefore, the influence of illiquidity on security price should be more pronounced in the bond market than in the stock market. The composition of investors in the bond market is the main reason leading to illiquidity. In contrast to the stock market, the major investors in the U.S. corporate bond market are passive investors, such as insurance companies, pension funds, and banks (Butler, Gao, and Uzmanoglu 2017a). These investors adopt a passive buy-and-hold investment strategy, causing illiquidity in the bond market.

Although the influence of liquidity risk on bond pricing is intuitive, the empirical evidence on this rationale is relatively scarce when compared with what exists in the stock market. One potential reason is that credible trading information on bond markets was not widely available until the introduction of the Trade Reporting and Compliance Engine (TRACE) database in 2001, which comprehensively covers the U.S. corporate bonds daily trading information. The scarcity of bond trading information prevents researchers from implementing empirical tests on the influence of bond illiquidity on the yield spread.

In recent years, the availability of the TRACE database largely stimulates the growth of this stream of literature. Several papers point out that credit risk accounts for only a small portion of the spread between the corporate bond yield and the Treasury yield (Elton, Gruber, Agrawal, and Mann 2001; Chen, Lesmond, and Wei 2007; Bao, Pan, and Wang 2011; Huang and Huang 2012). Longstaff, Mithal, and Neis (2005), Ericsson and Renault (2006), and Chen et al. (2007) suggest that the liquidity premium might be the missing factor that could explain the remaining part of the yield spread. They comprehensively examine the relationship between corporate bond liquidity and bond yield spread in both theoretical and empirical research settings and find that liquidity is priced in the yield spread. More illiquid bonds are associated with a higher yield spread, and an improvement in liquidity causes a significant reduction in yield spread. These results hold in several rigorous robustness research settings. Chen et al. find that the liquidity premium alone can explain about 7 percent of the cross-sectional variation in bond yields for investment grade bonds and about 22 percent of the cross-sectional variation in bond yields for speculative grade bonds.

In summary, existing empirical evidence suggests that the liquidity premium accounts for a large portion of the corporate bond yield spread. All else equal, liquidity is inversely correlated with a bond's required return and its price.

Corporate Governance

Corporate governance can have a profound influence on a firm's debt value. Good corporate governance can improve firm operation efficiency, maximize the firm's productivity, and enable it to undertake good investment opportunities, which could increase the value of pledged assets in the firm and reduce its bankruptcy risk. As a result, good corporate governance could positively affect a bond's price. Yet, good corporate governance can also result in a decrease in bond value. When managers' interests are well aligned with those of shareholders, firm managers might implement policies that benefit shareholders at the expense of bond holders. Such policies could include financing, investment, and payout policies. For instance, managers might forgo valuable investment opportunities that could only benefit debt holders when the firm is in deep distress. This well-known underinvestment phenomenon is called the *debt overhang problem* (Jensen and Meckling 1976; Myers 1977). Therefore, high quality corporate governance could perhaps surprisingly negatively affect a bond's price. Compared to good corporate governance, the influence of poor corporate governance on a bond's value is more intuitive. Poor corporate governance could reduce the firm's profit margin, waste valuable resources, and destroy the value of in-place pledged assets, all of which reduce a firm's bond value.

A stream of research explores the relation between corporate governance and bond value. Bhojraj and Sengupta (2003) find that high corporate governance quality could reduce a firm's default risk by mitigating agency costs and monitoring managerial performance by reducing information asymmetry between firms and lenders. They also find that improved corporate governance mechanisms could lead to better bond ratings and higher bond prices. Klock, Mansi, and Maxwell (2005), who examine the relation between the cost of debt and shareholder protection provisions, find that antitakeover governance provisions lower the cost of debt financing. Anderson, Mansi, and Reeb (2004) find that board independence and bond size could help firms reduce the cost of debt. They also find that fully independent audit committees can help firms lower their borrowing costs. Furthermore, larger audit committee size and higher meeting frequency also could reduce a firm's borrowing costs. Cremers, Nair, and Wei (2007) find that shareholder control is associated with higher borrowing costs if firms are exposed to takeover risks. They also find that bond covenants could reduce the credit risk when led by strong shareholder governance.

Overall, the influence of corporate governance on bond value is not as clear as with other variables and empirical tests could be relatively complicated. More research is needed in this area to disentangle the competing factors.

Accounting Quality

Borrowing market frictions could arise from the information asymmetry between firm insiders and debt holders and play an important role in bond pricing. Usually, high information asymmetry discourages investors from bond investments, due to their concerns about the uncertainty associated with the firm's future performance. Hence, information asymmetry could force bond issuers to accept a higher borrowing cost, which is likely to have negative effects on bond value. A firm's voluntary or compulsory accounting information disclosure could be an important avenue through which bond issuers could mitigate such a negative influence from information asymmetry. Therefore, high accounting quality should be important for a firm to reduce its borrowing yield.

Research provides evidence to support this prediction. According to Sengupta (1998), the disclosure quality ratings provided by financial analysts could have real effects on a firm's borrowing costs. Specifically, a higher disclosure quality rating would lower a firm's borrowing costs. Pittman and Fortin (2004) investigate the impact of auditor choice on a firm's yield spread. They find that hiring reputable auditors could help firms reduce their borrowing costs by improving the credibility of their financial statements. Kim, Simunic, Stein, and Yi (2011) test the influence of a voluntary audit on firm's cost of debt by examining Korean privately held firms. They find that private companies with voluntary audits enjoy lower borrowing cost compared to their peers without voluntary audits. Bharath, Sunder, and Sunder (2008) study the influence of the quality of accounting information from financial statements on debt contracting. They find that firms with poor accounting quality prefer private debt, and the accounting information has a stronger influence on the yield spread on corporate bonds than bank loans. Lambert, Leuz, and Verrecchia (2007) theoretically model the influence of accounting information quality on a firm's cost of debt, and such influence could be both direct and indirect. Graham, Liu, and Qiu (2008) find that financial restatements have a negative influence on debt contracting. More specifically, yield spread increases after financial restatement, which highlights the influence of mispresenting accounting information on a firm's borrowing costs. In summary, high accounting quality could have positive effects on a bond's price.

Product Market Competition

Product market competition potentially influences a firm's cost of debt because it could affect a firm's default probability and loss given default (Valta 2012). High product market competition could restrict a firm's pricing power and profits, which could reduce its cash inflows and increase a firm's probability of failing to meet its debt obligation payments. Hou and Robinson (2006) and Frésard and Valta (2016) maintain that the competition among industry competitors could discourage firms from innovation investments, which could increase the cost of debt by forgoing valuable investment opportunities.

In contrast, the product market competition could also influence asset liquidation value in default. The underlying rationale is that a highly competitive product market has many comparable producers that occupy similar production equipment. Once a competitive product market firm faces financial distress, the potential buyers of its liquidated assets have alternative choices to acquire similar assets from its competitors, which reduce a firm's bargaining power on asset sales. This situation influences the recovery rate of bond investors. This lower recovery rate could also be priced into a bond. Hence, product market competition could influence bond prices through the asset recovery risk.

As Valta (2012) shows, intense product market competition could reduce the value of bank loans. Following the same rationale, the argument can be generalized to the public bond market. However, further research on this topic is required to provide empirical evidence.

Creditor Rights

Different countries' financial markets provide dissimilar levels of protection to investors based on the completeness of the country's legislative environment. Compared to emerging financial markets such as China, India, and Turkey, well-developed financial markets including the United States, United Kingdom, and Japan tend to provide bond investors with stronger protection in the event of issuer default. If investors are well protected by financial market regulations, they face less credit risk exposure in the event of a debtor's bankruptcy (Qian and Strahan 2007). Hence, the development of the protection on creditors in financial markets should have important effects on firm borrowing costs and bond prices.

Several papers investigate this prediction by comparing financial markets across different countries. Qian and Strahan (2007) find that legal and institutional environments influence debt contracts. They also provide empirical evidence that under strong creditor protection, a firm's debt has a lower yield spread. Bae and Goyal (2009) examine whether legal protection affects debt borrowing cost across 48 countries. They find that the yield spread is higher in poor creditor protecting countries compared to countries where creditors are well protected.

Equity Volatility

Equity volatility is also an important factor that could influence bond price and valuation. Merton (1974) proposes a structural model to value risky corporate bonds within an option framework. He contends that holding a corporate bond can be viewed as having a long position in a risk-free bond and simultaneously shorting a put option on the firm's asset. Because the volatility of a firm's equity influences the value of the put option, equity volatility could play a role in bond valuation.

Campbell and Taksler (2003) empirically explore the economic rationale that equity volatility could influence corporate bond yield spreads. They examine panel data during the late 1990s and show that idiosyncratic firm-level volatility can explain as much cross-sectional variation in yields as credit ratings. Using credit default swap (CDS) premiums—the percentage of the face value of a credit default swap contract regularly paid by buyers to sellers to maintain the contract—as a direct measure of a firm's credit risk, Zhang, Zhou, and Zhu (2009) find that the equity volatility risk could predict a large portion of a firm's credit spread.

Financial Innovation

CDSs are one of the most important financial innovations during the last several decades. Figure 24.3 plots the time series of the notional amount of outstanding CDS contracts from 2001 to 2016. The outstanding notional amount of CDSs increases dramatically from $1 trillion in 2001 to $65 trillion in 2007 and starts to decline after the financial crisis of 2007–2008. In 2016, the total outstanding notional amount of CDS contracts was $15 trillion, which still accounts for one of the largest financial derivative markets (Oehmke and Zawadowski 2016). CDS trading provides investors with important hedging opportunities and new information regarding bond issuer's credit risks.

The U.S. corporate bond market underwent major transformations after the advent of CDSs (Hu and Black 2007; Bolton and Oehmke 2011; Parlour and Winton 2013; Saretto and Tookes 2013; Subrahmanyam, Tang, and Wang 2014; Butler, Gao, and Uzmanoglu 2017b). Blanco, Brennan, and Marsh (2005) find that the CDS market leads the bond market in determining the price of credit risk. Acharya and Johnson (2007) find significant incremental information revelation in the CDS market. Forte and Pena (2009) explore the relation among stock market implied credit spreads, CDS spreads, and bond spreads. They find that stocks lead CDSs and bonds more frequently than the reverse,

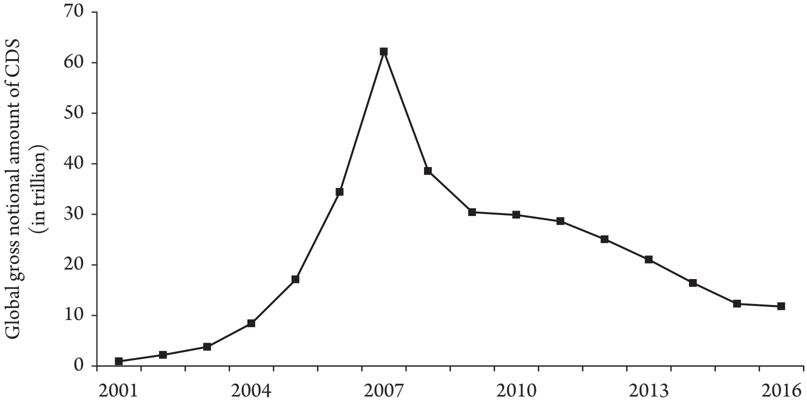

Figure 24.3 CDS Notional Amount
This figure plots the global notional amount (in $ trillions) of outstanding CDS between 2001 and 2016.
Source: Bank for International Settlements (2017) and International Swaps and Derivatives Association (2018).

and the CDS market leads the bond market. Oehmke and Zawadowski (2016) maintain that CDS markets emerge as "alternative trading venues" serving a standardization and liquidity role. They find that net notional CDS positions are larger and CDS trading volumes are higher when the underlying bonds are associated with higher trading costs (i.e., higher underlying bond fragmentation and contractual heterogeneity). In contrast, several papers find negative effects of CDS trading on the underlying bond market. Das, Kalimipalli, and Nayak (2014) suggest that the advent of CDSs was largely detrimental as bond markets became less efficient, evidenced no meaningful reduction in pricing errors, and experienced no improvement in liquidity. Danis (2016) provides evidence that bond holders who are hedged with CDS are less likely to participate in a debt restructuring, but instead favor bankruptcy to trigger payouts on their CDS contracts.

Given the hedging benefits and information benefits, CDS trading is likely to have positive effects on the cost of corporate debt, which could influence corporate bond valuation. Specifically, CDS trading provides more hedging opportunities and improves the accuracy of the estimation of issuer's credit risk, which could stimulate the demand of the CDS underlying bonds and reduce the yield spread. However, Saretto and Tookes (2013) find that firms with traded CDS contracts on their debt can maintain higher leverage ratios and longer debt maturities. The heightened leverage might increase a firm's bankruptcy risk, resulting in a widening yield spread. Subrahmanyam et al. (2014) find that the probability of both a credit rating downgrade and bankruptcy increase after the inception of CDS trading, which also can negatively influence bond prices. Therefore, the influence of CDS trading on bond value is an open question. Ashcraft and Santos (2009) empirically investigate this question. They find that the onset of CDS trading does not lower the cost of capital for the average firm but leads to a small reduction in bond and loan spreads for firms that are safer and more transparent. Overall, this stream of literature provides evidence that financial market innovation is an important factor that could influence bond valuation through both hedging and information channels.

Other Factors

Besides the range of factors previously discussed, several other important factors need to be mentioned. For instance, option-type bond characteristics are also relevant components of bond price. The value of a callable bond is equivalent to that of an option-free risky bond minus the value of the embedded callable option. Also, the value of a puttable bond is equivalent to that of an option-free risky bond plus the value of the embedded puttable option. Hence, all factors such as interest volatility that could influence the value of the embedded options can also influence a bond's price. Additionally, bond covenants could place additional constraints on a firm's daily operations. For instance, some bond covenants prevent firms from issuing dividends, which leaves more cash in the firm and increases the recovery rate in the event of default. Hence, such protective covenants are likely to have a positive effect on a bond's price.

Moreover, almost all firm-level financial variables could influence bond price. For example, the finance literature finds that the price of bonds is positively correlated with stock market performance and negatively correlated with a firm's leverage. Also, firm-level decisions could have real effects on bond value. For instance, if a firm reduces its cash dividend, which increases its cash holding, the increase in pledged cash raises the value of bonds. Another example considers how a firm's investment policy influences its borrowing costs. If a firm actively participates in innovation investments, it may enjoy lucrative opportunities which could have a positive effect on prices. Yet, if a firm aggressively pursues unsuitable innovation investment opportunities, it might destroy firm value by accepting negative NPV projects. Therefore, firm-level factors can also play a critical role in bond valuation.

Finally, macroeconomic variables can also be important factors in bond valuation. For instance, the increase in the unemployment rate induces cash outflows from insurance companies through the unemployment insurance payment channel. As previously mentioned, insurance companies are major investors in the corporate bond market. Therefore, the unexpected reduction in cash could negatively affect the demand for bonds, which is likely to reduce bond prices.

Summary and Conclusions

The corporate bond market plays a vital role in providing funds for a firm's daily and long-term operations. The sheer size of the corporate bond market underscores the importance of understanding the valuation mechanism behind it. This chapter examines critical factors that could influence corporate bond prices and have important implications for bond issuers, investors, and financial market policymakers.

This chapter starts with the Treasury yield, which is the fundamental component of a bond's value and presents three theories to help explain the term structure of the Treasury yield. Next, the chapter discusses the factors that could influence a bond's yield spread. Credit risk and liquidity risk are the two most relevant factors that affect bond prices. Several empirical papers show that these factors jointly explain a large part of the cross-sectional variations in the yield spread. The chapter also shows that equity volatility, accounting quality, product market competition, creditor rights, and financial innovations can affect bond prices. Examples are provided about how other bond-level, firm-level, and macroeconomic variables affect bond prices. For instance, embedded bond features, issuer's financial health, and the broader macroeconomic environment also play roles in bond valuation.

Overall, the bond pricing factors discussed in this chapter influence bond value through four different channels: default probability, recovery rate in default, credit risk hedging, and revelation of new information. A factor that could reduce an issuer's default probability, increase the recovery rate, provide additional credit risk hedging opportunities, and supply more credit risk information is likely to positively influence bond prices. Although this chapter explores several of the most important bond pricing factors, many others exist.

Discussion Questions

1. List the main factors that could influence bond valuation.
2. Discuss why the corporate bond market is illiquid.
3. Discuss why accounting disclosure can influence bond value.
4. Discuss how the advent of CDSs could reduce borrowing costs.

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25

Valuing and Analyzing Bonds with Embedded Options

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Introduction

Many corporate bonds have additional provisions related to their retirement. These provisions are unlike covenants that specify the general rights of bond holders and/or obligations of the issuer, as the focus is on the retirement of a bond. Table 25.1 describes the most common bond provisions:

Other than the *sinking fund provision*, which specifies the exact schedule of bond retirements, all the other provisions give either the issuer or the bond holders additional options (a right but not obligation) to retire the bond before the stated maturity. These options, known as embedded options, are similar to other financial options such as calls and puts traded in the derivatives market, but they cannot be traded separately from the bond. This chapter discusses the analysis and valuation of three main types of bonds with embedded options: callable, puttable, and convertible. The next two sections introduce the basics of callable and puttable bonds, discuss their unique risk characteristics, and then elaborate on widely used valuation models such as the binomial model. The following section discusses the analysis measures and the risks pertaining to the convertible bonds. A convertible bond differs from callable and puttable bonds due to its unique link to the corporation's equity value. The final section offers a summary and conclusions.

Callable Bond and Puttable Bond

A *callable bond* allows the issuer to redeem the bond at a specified price. This right is equivalent to exercising a call option on the bond: buying the underlying bond at the specified price, hence the name. Callable provisions often specify a lock-down (protection) period when the issuer cannot call, or a first available call date (*first call date*) before which the issuer cannot call the bond. Sometimes the bond indenture specifies a series of call dates. Figure 25.1 displays the Bloomberg description page of a callable and convertible zero-coupon bond issued by ALZA Corporation. Although issued on

Table 25.1 **Summary of Bond Provisions**

Bond Provision	*Explanation*
Call provision	Allows the issuer to repurchase the bond at a pre-specified price at certain time before maturity.
Make whole call provision	Allows the issuer to repurchase the bond at the bond's market value at call time before maturity.
Sinking fund provision	Requires the issuer to the repurchase part of the bond issue periodically.
Put provision	Allows the bondholder to sell the bond back to issuer at prespecified price before maturity.
Convertible provision	Allows the bondholder to convert the bond issue into prespecified shares of the issuer.
Exchangeable provision	Allows the bondholder to exchange the bond for a prespecified number of shares of another stock, but not the issuer's stock.
Contingent convertible provision (COCO bond)	Allows the bondholder to convert the bond only if the stock price exceeds a threshold level for a specific number of trading days.

This table summarizes all bond provisions that specify how a bond issue can be retired.

November 2, 2000, with a maturity on July 28, 2020, its first call date is December 7, 2017, less than three years from the maturity date.

According to data from the Securities Industry and Financial Markets Association (SIFMA 2017), 62 percent in terms of principal amount of fixed rate U.S. corporate bonds issued between 1996 and 2015 were callable, while about 68.7 percent of all nonconvertible corporate bonds issued in 2016 contained call provisions. As shown in Figure 25.2, callable-nonconvertible bonds are becoming more common while the popularity of convertible bond dwindles.

Among the most frequent embedded option features, the callable bond provision is the only one that grants the option to the issuer instead of the bondholder. Therefore, the callable option could potentially be exercised to the disadvantage of investors. The value of the callable bond to investors should be the comparable straight bond value minus the call option value as illustrated in Equation 25.1.

$$\text{Callable bond value} = \text{straight bond value} - \text{call option value} \tag{25.1}$$

Risks of Callable Bonds

Investing in a callable bond is equivalent to holding a bond and selling the embedded call option to the bond issuer. This combination of a short call and the underlying bond

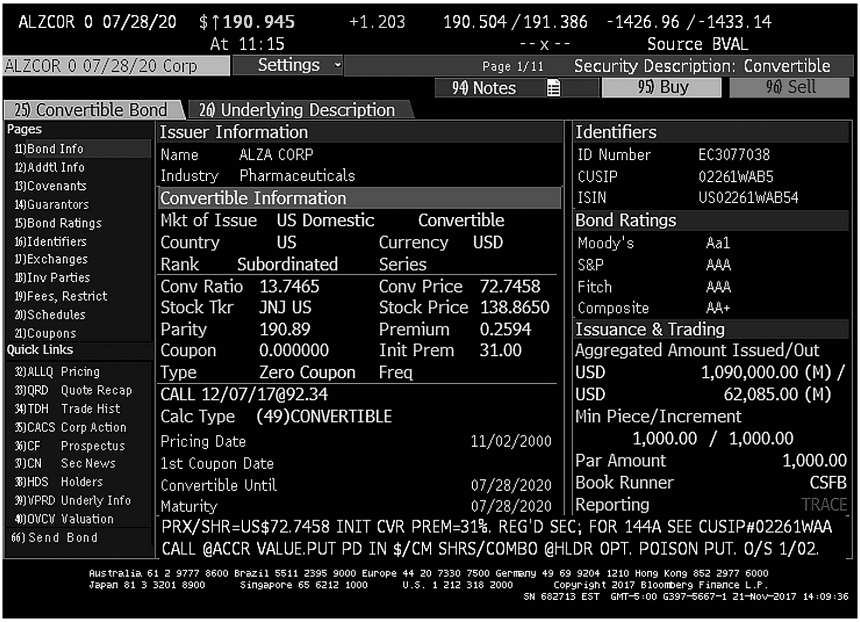


Figure 25.1 Callable Convertible Bond Issued by ALZA Corp.
A sample callable and convertible bond issued by ALZA Corp matures on July 28, 2020. The bond is callable starting on December 7, 2017, at call price $92.34. The bond is also convertible at a conversion ratio of 13.7465. The screenshot was taken on November 22, 2017.
Source: Bloomberg.

is equivalent to a "covered call" position in the derivatives market. However, because interest rate risk dominates the bond risk profile, callable bonds pose unique risks to the disadvantage of their holders.

Price Compression

When interest rates increase, the callable bond value decreases in the same manner as other bonds. But when interest rates drop, and other non-callable bonds are enjoying price appreciation, the upside of the callable bond's price is limited because the issue is more likely to be called as rates drop below the issue (or coupon) rate. This feature gives the callable bond a backward bending price-yield relation at sufficiently low interest rates. The callable bond's backward bending shape in its price-yield relation, called *negative convexity*, is its unique feature.

As shown in Figure 25.3, when the market yield is high and the bond price is lower than the call price, callable bonds exhibit the same convex price-yield relation as other bonds. However, when the market yield is low and an equivalent straight bond price rises above the call price, the callable bond price can rise above the call price but exhibits *negative convexity*. Even if no call has been announced, the potential of being called at the call price makes investors reluctant to pay a price much higher than the call price.

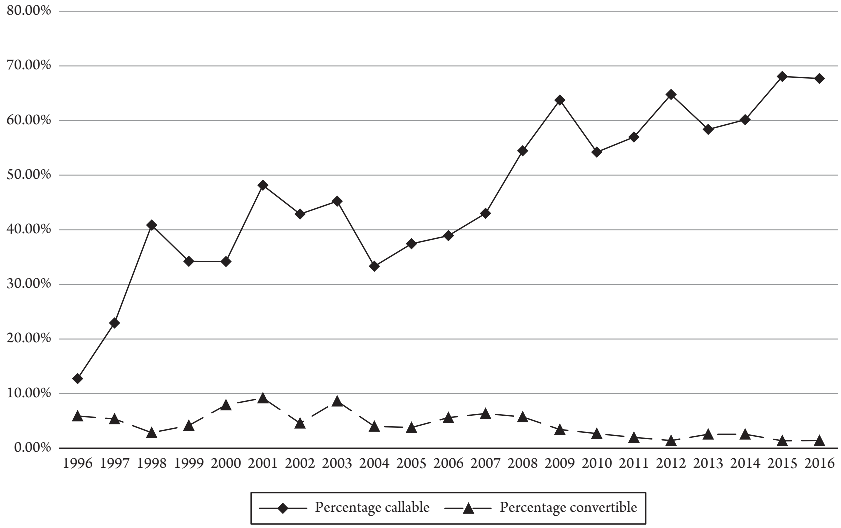


Figure 25.2 Annual Issuance of Callable and Convertible Bonds between 1996 and 2016
This figure shows the annual issuance of callable and convertible bonds between 1996 and 2016 as a percentage of all U.S. corporate bond issues. Data are taken from The SIFMA November 2017 report. *Source*: www.sifma.org.

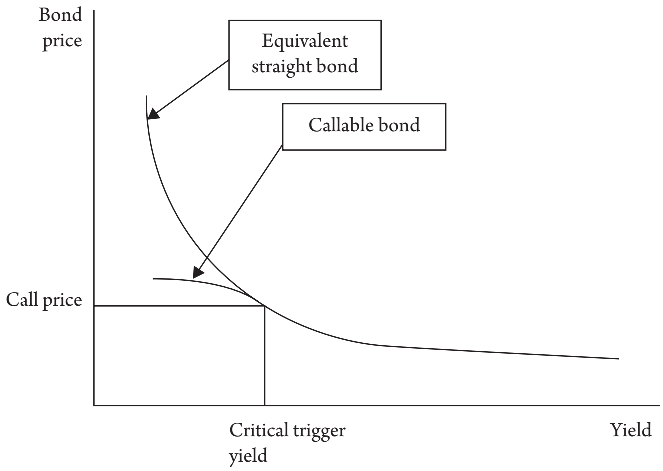


Figure 25.3 Price Compression in a Callable Bond
This figure illustrates price compression. The price of a callable bond does not rise as fast as an otherwise equivalent straight bond when the yield drops below a critical trigger and the bond price rise beyond the call price. The curve of callable bond demonstrates negative convexity.

This relation is easier to understand when referring to the callable bond price as the equivalent straight bond price minus the embedded call option value: when the interest rate is relatively high, the bond price is low; the call option is out-of-the-money possessing little value. In this case, the callable bond value behaves just like a straight bond. However, when interest rates decrease and the straight bond's value rises, the call option value increases because the value of its underlying, the straight bond, rises. As a result, the callable bond value, which is the increasing straight bond value net of a rising option value, increases much more slowly.

Reinvestment Risk

When the issuer calls the bond for cash, which happens mostly in a high-price, low-interest rate environment, investors face the conundrum of whether to reinvest the large amount of cash in a low interest-rate environment or wait for interest rates to rise in the future and forgo time value. This disadvantageous synchronization between bond call and adverse market conditions (i.e., low interest rates) is called *reinvestment risk*. This situation is analogous to when a mortgage lender has the loan balance refinanced or prepaid.

Yield to Call

While yield-to-maturity (YTM) gives straight-bondholders a yield measure of the coupon payment and principal payment if the bond is held until maturity, *yield-to-call* (YTC) modifies the yield measure to reflect the possibility of a call before maturity. YTC is computed by replacing the bond's remaining maturity with time until the first available call time; replacing the principal with the call price and then computing the yield (I/Y on most financial calculators) just like other yield calculations.

For example, a 20-year 6 percent coupon bond can be first called at the end of eight years at call price \$1,100. Its current market price is \$1,021. Assuming semiannual coupon payments, each coupon payment is \$30. The YTC can be calculated using the time-value function of a financial calculator as follows: Setting P/Y = 1; N = 8 × 2 = 16, the number of payments; PV = −1,021; PMT = 30; and FV = 1,100, the call price. Then press button CPT, followed by button I/Y. The result of I/Y = 3.313 percent is the semiannual YTC. The annualized YTC is then 2 × 3.313 percent = 6.626 percent. In practice, if a callable bond can be called at par, it is called a *par call*.

Puttable Bonds

Unlike a callable provision, a puttable provision gives the bondholder, not the issuer, the option to sell (put) the bond back to the issuer. Therefore, a puttable bond is equivalent to a long put option in addition to the underlying bond. Such a combination establishes a floor at the put price for the puttable bond, hedging the interest rate risk for bond holders. Note, however, that the puttable bond still has the same credit risk as a comparable straight bond, since the put option is also sold by the bond issuer.

Puttable bonds have become less popular in developed markets. However, according to Tendulkar and Hancock (2014), issuance of puttable bonds in emerging markets has soared after the financial crisis of 2007–2008. In 2013 alone, emerging markets issued $47 billion in puttable bonds, representing 5 percent of all emerging markets bond issuance.

Yield to Put

Analogous to the YTC for callable bonds, a simple yield analysis that incorporates the put option is the yield-to-put (YTP), which assumes that the holder of an embedded put option exercises the option at the first available opportunity. Namely, in the yield calculation, the maturity is set to the put date and the principal set to the put price. This yields a static YTP measure that can serve as a rough estimate of the puttable bond yield.

Continuing with the previous example with a slight modification: consider a 20-year, 6 percent coupon bond that can be put at the end of five years at par $1,000. Its current market price is $1,021. Assuming semiannual coupon payments, each coupon payment is $30. The YTP can be calculated using the time-value function of a financial calculator as follows: Set P/Y = 1, N = 5 × 2 = 10, which is the number of payments; PV = –1,021, PMT = 30, and FV = 1,000, which is the put price. Then press button CPT, followed by button I/Y. The result of I/Y = 2.757 percent is the semiannual YTP. The annualized YTP is then 2 × 2.757 percent = 5.513 percent.

Valuation of Callable and Puttable Bonds

Valuation of the embedded call (put) option associated with callable (puttable) bonds is not straightforward. First, an option is worthless if there is no uncertainty in interest rate behavior. Since the embedded options of callable bonds and puttable bonds shift the interest rate risk between issuer and bondholder, the exercise of these options is primarily influenced by the market interest rate. Therefore, the options are properly valued only if the model incorporates the uncertainty of future interest rates. In other words, a proper valuation model of callable bonds demands a dynamic (i.e., change over time) and uncertain interest rate component. In contrast, traditional interest rate models are static (i.e., do not change over time) even if the entire term structure is considered. Chapter 12 introduced the conversion of the traditional coupon-yield-curve into a spot rate curve, which provides an accurate static interest rate term structure. The next sections review the process and then introduce a simplistic dynamic interest rate model.

Spot Rate Curve

To accurately capture the market interest rate movement, the corporate bond yield must be decomposed into a clean benchmark rate and a yield spread overlay that corresponds to the bond-specific risk such as credit risk liquidity risk as illustrated in Equation 25.2.

$$\begin{aligned}&\text{corporate bond yield}\\&\qquad = \text{benchmark yield} + \text{yield spread of the corporate bond}\end{aligned} \tag{25.2}$$

The most common benchmark rates are Treasury rates of various maturities. These securities are free from credit risk and have the lowest liquidity risk because Treasury securities represent the largest and most actively traded fixed income market in the world. Because of the large amount of principal involved, any additional accuracy in valuation can result in price correction of millions, if not billions, of dollars. The Treasury yield curve, however, does not provide such high accuracy. It mixes the yields for short-term zero-coupon bonds that have no reinvestment risk with medium- or long-term coupon bearing bonds that introduce reinvestment risk.

Conversely, because each cash flow of a bond arrives at a different time and therefore incurring different term-risk, credit risk, liquidity risk, and reinvestment risk, each should be discounted at a different rate that reflects its own term risk and other associated risks. This process can be achieved by treating each cash flow as a separate zero-coupon bond with its principal equal to the cash flow, discounting each cash flow using the yield of the zero-coupon bond of the same term and at comparable credit risk level. Then, the bond price is computed as the sum of the present values of all these cash flows. Valuation using this method is much more accurate than using a single, static YTM for valuation.

The zero-coupon bond yields for all terms are called the *spot rates* or *zero rates*. A plot of current spot rates at all terms is called the *spot rate curve*. Unfortunately, spot rates are unobservable for any maturity greater than one year and must be inferred, using a procedure called *bootstrapping*.

Since Treasury zero-coupon bonds are available only in very short-term Treasury bills, Treasury agencies have been issuing zero-coupon bonds at other maturities using the cash flows of the Treasury notes and bonds, called Separate Trading of Registered Interest and Principal of Securities (STRIPS). But even STRIPS are not traded for all terms in a regular coupon payment schedule (e.g., 0.5 year, 1 year, 1.5 years, 2 years, and 2.5 years). That means the spot rate curve must be a hypothetical yield curve constructed from a market available coupon yield curve with yields at 0.5, 1, 2, 5, and 10 years, and so forth. First, from on-the-run (i.e., the most recently issued) Treasury issues, extrapolation is necessary to determine the coupon bond yields for terms between the trading coupon-bond terms (described in Chapter 12). Second, analysts use the bootstrapping methodology to infer the spot rate from each coupon bond yield.

Notice here that analysts use only the yields of on-the-run issues. First, even if off-the-run (i.e., issued before on-the-run issues) issues are available in the remaining maturities, gaps in the spot rates still occur. Second, off-the-run issues are almost always less liquid. The *liquidity risk premium* (i.e., the additional yield required for investors to take on this additional liquidity risk) is higher than the comparable on-the-run issues, defeating the purpose of building a clean benchmark for the market interest rate.

Static Spread (Z-spread)

Similar to the traditional yield spread mentioned in the previous section, a yield spread can be added to the spot rate curve to force the bond value equal to the bond market price. In contrast to the traditional yield spread, which is added to one benchmark rate to determine the bond's YTM, the yield spread is added across the entire spot rate curve for all terms. Geometrically, the yield spread creates a curve parallel to the bootstrapped yield curve. This yield spread is called the *static spread* or *Z-spread*. The Z-spread is a clean measure of all bond-specific risks including credit risk and liquidity risk. Figure 25.4 illustrates a Z-spread as a spread over a hypothetical spot rate curve. This resulting yield curve reflects all risks of the bond, therefore can be used to provide an accurate bond price.

Binomial Interest Rate Model

Even if the spot rate curve and the corresponding Z-spread vastly improve the accuracy of bond valuation, they are static and therefore insufficient to value bonds with embedded options because options have no value without uncertainty. The simplest dynamic discrete-time model that can incorporate interest rate uncertainty is a *binomial interest rate tree*, which is a visual representation of the possible values of interest rates (forward rates) based on an interest rate model and an assumption about interest rate volatility. The binomial model specifies that, at each time step, there can be multiple possible interest rates as shown in Figure 25.5. Each node can evolve into two possible nodes—one node has a higher interest rate than the other. Figure 25.5 displays a one-step binomial tree, in which Equations 25.3 and 25.4 hold:

$$r^H = r \times e^{\sigma} \quad (25.3)$$

$$r^L = r \times e^{-\sigma} \quad (25.4)$$

Therefore, the upper node interest rate r^H is the lower node interest rate r^L times the exponential of twice the interest rate volatility as shown in Equation 25.5.

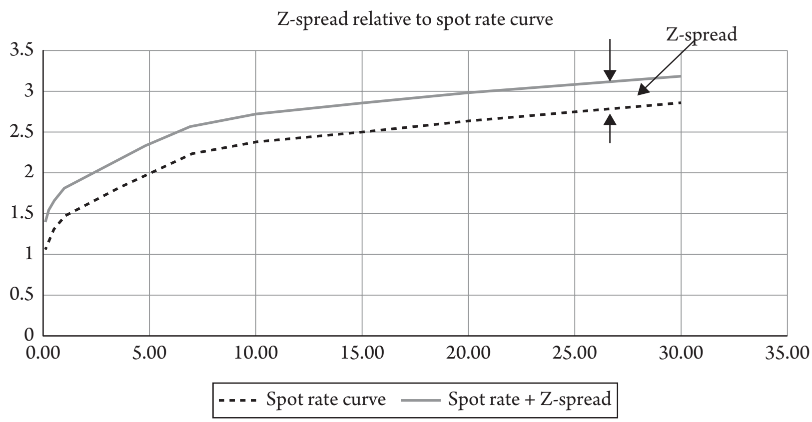


Figure 25.4 Hypothetical Z-Spread Illustration

The dotted line represents the hypothetical spot rate curve calculated from all Treasury yields. The full line represents the final parallel yield curve (spot rate curve + Z-spread) that makes the bond value equal to the bond's market price. The Z-spread added to achieve this yield curve represents the bond-specific risks, including but not limited to default risk, liquidity risk, and risks from bond-structures such as embedded options.

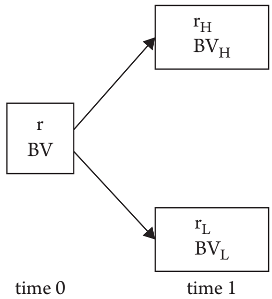


Figure 25.5 One-Step Binomial Tree
This figure displays a single unit binomial tree: a one-step tree. The tree consists of one starting node and two ending nodes, indicating the starting interest rate at time 0 can go up to the upper node at time 1 or go down to the lower node value at time 1. BV denotes the bond value at each node.

$$r^H = r^L \times e^{2\sigma} \tag{25.5}$$

The one-step tree described in Figure 25.5 forms a single tree unit, with one starting node and two ending nodes. A tree is formed when multiple tree units are combined by setting the end nodes of one tree unit as the starting nodes of the two tree units in the following time step, as shown in Figure 25.6.

In this tree, all nodes in one vertically aligned column reflect all possible interest rate situations in the same time point. Each time step is usually set to be six months to price semiannual coupon payments. Unlike the binomial tree used to value financial options, interest rates in each time-step of the tree are interdependent. Because the factor e^{σ} is fixed throughout the tree, all the interest rates in each time step are related to each other by a factor of $e^{2\sigma}$. As shown in Equations 25.6 and 25.7, at the second time step, the highest interest rate in the column r_{HH} is equal to the middle interest rate r_{HL} times a factor of $e^{2\sigma}$, while the middle interest rate r_{HL} is in turn equal to the lowest interest rate r_{LL} times a factor of $e^{2\sigma}$.

$$r_{HH} = r_{HL} \times e^{2\sigma} \tag{25.6}$$

$$r_{HL} = r_{LL} \times e^{2\sigma} \tag{25.7}$$

Historically, interest rates have (almost) always been positive, reflecting opportunity costs and other risks of lending. Therefore, the binomial interest rate model assumes positive interest rates in all nodes. Here the exponential form of this up-and-down-factor $e^{2\hat{}}$ prevents the interest rate from becoming negative.

Calculating the Bond Value at Each Node

The bond values on a binomial tree are calculated using backward induction. The process of backward induction starts from the end step of the tree—the maturity time

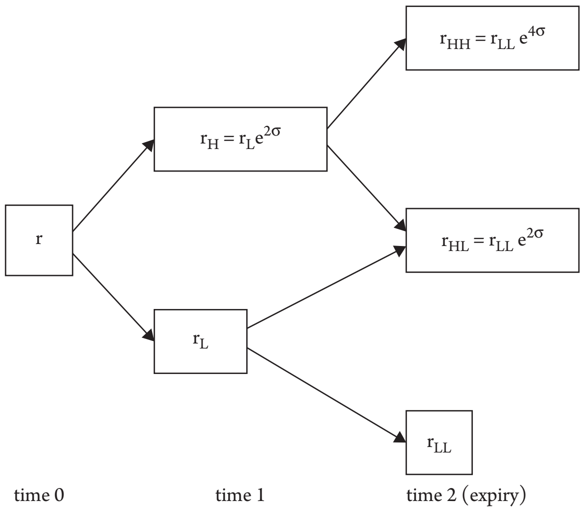


Figure 25.6 Binomial Tree Setup
All interest rates in the tree are 6-month short-term interest rates at the time step. The starting node of the tree displays the current six-month interest rate. The first step contains two nodes, both present the possible interest rate six months later. The second step contains three nodes that present three possible interest rates one year later. At each vertical time grid, the interest rates are linked by a fixed factor: the interest rate in each node above is $e^{2\sigma}$ times the rate in the node below (e.g., $r_H = r_L \times e^{2\sigma}$). Each node can lead to two nodes only.

when the final coupon and principal are paid. The bond values at all terminal nodes are equal to the principal. Then within each tree unit (the node triangle), the bond value of the starting node is the average of two ending nodes value, plus the coupon payment, discounted by the rate at the starting node, which is the current spot rate, as illustrated in Equation 25.8.

$$BV_t = \frac{1}{2} e_t^{-r \times \Delta t} \left(BV_{t+1}^{H} + BV_{t+1}^{L} \right) \tag{25.8}$$

where Δt in a semiannual tree is a half-year.

Binomial Tree Calibration

Before being applied in bond evaluation, a binomial tree must be calibrated using the interest rates and forward rates in the market. The calibration process is to find the interest rates in all nodes so that, when the tree is applied, the resulting value of bond of all terms equals their market value. As a common practice, the entire binomial tree is calibrated using on-the-run Treasury issues and their extrapolated rates, step by step. Although multiple interest rates exist at each time-step, only one unknown rate must be calibrated because all interest rates in the same time-step are related to each other by a factor of $e^{2\sigma}$. For instance, the model can choose to calibrate the interest rate at the lowest node of each time-step.

For example, a 1.5-year, semiannual tree can be constructed to evaluate a two-year bond using the following market yield information. The interest rate volatility is set to be $e^{2\sigma}$. From the on-the-run issues, the missing 1.5-year maturity yield can be extrapolated as the average of one-year yield and two-year yield as shown in Equation 25.9:

$$Y_{1.5} = \frac{(Y_1 + Y_2)}{2} = \frac{1.46 + 1.61}{2} = 1.535\% \tag{25.9}$$

Table 25.2 displays, for evaluating a two-year bond, the yield of on-the-run issues and the resulting extrapolated par-yields, spot rates, and forward rates.

Because the six-month and one-year T-bills are zero-coupon bonds, their yields can be used as spot rates for six months and one year. The six-month and one-year spot rates are then 1.30 percent and 1.46 percent, respectively. The 1.5-year spot rate can be bootstrapped by setting the coupon rate equal to the yield 1.535 percent, resulting in a coupon payment of $1.535\% \times 100/2 = 0.7675$, as shown in Equation 25.10:

$$100 = \frac{0.7675}{\left(1 + \frac{0.0130}{2}\right)} + \frac{0.7675}{\left(1 + \frac{0.0146}{2}\right)^2} + \frac{100.7675}{\left(1 + \frac{z_{1.5}}{2}\right)^3}$$

$$z_{1.5} = 1.5364\% \tag{25.10}$$

Once all spot rates are calculated, interest rates at all nodes are calibrated using yields of on-the-run Treasury issues. To calibrate the first time-step interest rates (namely the 6-month interest rates six months later) on the tree, the YTM of an on-the-run one-year (that lasts for two time-steps) Treasury bill is used. Equation 25.11 shows the results of setting the coupon rate to equal to the one-year Treasury issue's yield:

Table 25.2 **Illustration of the Yields in the Example**

Term	*On-the-Run Issue Yield-to-Maturity (%)*	*Extrapolated Par Yield Curve (%)*	*Spot Rate (%)*	*Forward Rate (%)*
6-month	1.300	1.300	1.300	1.300
1-year	1.460	1.460	1.460	1.620
1.5-year	—	1.535	1.536	1.689
2-year	1.610	1.610	—	—

The first column shows the yields of all the on-the-run issues used to calibrate the interest rate tree in this example. In the second column, the missing yield is inserted at 1.5-year with a hypothetical Treasury yield extrapolated from the 1-year T-bill and the 2-year T-note. In the third column, the spot rates (hypothetical zero-coupon bond rates) are calculated from the extrapolated par-yield curve. In the fourth column, the 6-month forward rates are calculated from the spot rates. The forward rate serves as a starting point of calibrating each node of a binomial tree.

$$c = 1.46\%, \text{ coupon} = \frac{1}{2} \times 1.46\% \times 100 = 0.73 \qquad (25.11)$$

Figure 25.7 illustrates the binomial tree setting when calibrating for its six-month rates, r_L and r_H. Since $r_H = r_L \times e^{2\sigma}$, only r_L needs to be calibrated. Therefore, $e^{2\sigma}$ is the x value to be solved.

Since the coupon rate is intentionally set to equal the par-yield, such a hypothetical bond should be traded at par. For convenience, the par value is set to be 100. As illustrated in Equation 25.12, x is determined to make the bond price equal to 100:

$$BV_L = \frac{1}{1+\frac{x}{2}}\left[\frac{1}{2}(100+100)+0.73\right]$$

$$BV_H = \frac{1}{1+\frac{x e^{2\times 0.1}}{2}}\left[\frac{1}{2}(100+100)+0.73\right]$$

$$100 = BV = \frac{1}{1+\frac{0.013}{2}}\left[\frac{1}{2}(BV_{HH}+BV_{HL})+0.73\right] \qquad (25.12)$$

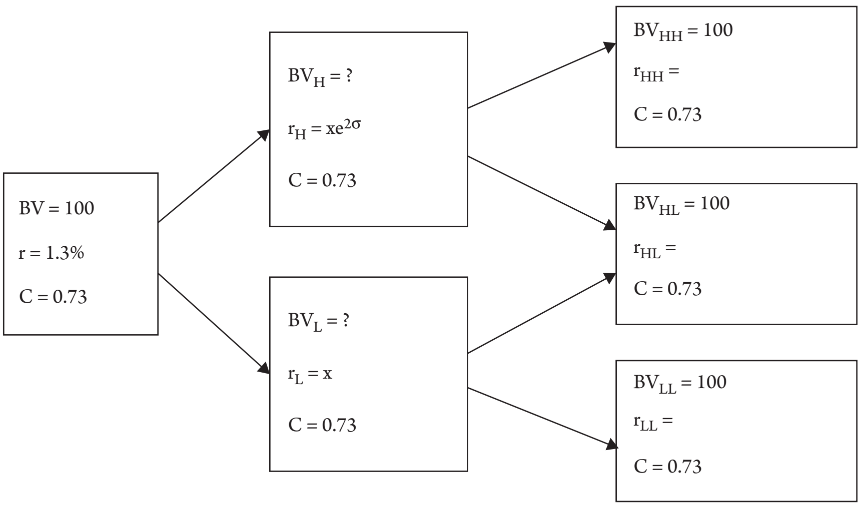


Figure 25.7 Binomial Tree Calibration at Six Months: Setup

This figure demonstrates the setup for calibrating the first step (interest rates in six months) of a binomial interest rate tree using the YTM of an on-the-run one-year Treasury bill. The yield is 1.46 percent. Coupon rate of 1.46 percent is set to equal to the yield so that the bond price equals par value for calibration purpose. Coupon payment 0.73 is calculated from the coupon rate of 1.46 percent and a par of $100. All interest rates in the tree are six-month short-term interest rates at the time step.

Because the current price of this hypothetical bond should be equal to 100: BV = 100, solving this set of equations where x is the only unknown yields: x = 0.01456, or 1.456 percent. Therefore, r_L =1.456% and r_H =1.778%. Figure 25.8 illustrates this set of calibration results for six-month forward rates. The correct bond values at six months are also displayed in the correct node. Notice that the rates at bond maturity, nodes at one year, are missing because they are not applicable. All forward rates displayed in trees are applicable to the tree unit starting with that node. No tree unit exists starting at the maturity because the final cash flow is when par is returned.

Now that the first step is calibrated, further calibration takes places in the second step. To calibrate the second step interest rates on the tree, the hypothetical 1.5-year Treasury yield, 1.535 percent, is used. Setting the coupon rate equal to the 1.5-year yield, gives a coupon payment of $1.535\% \times \frac{100}{2} = 0.7675$. Again, the lowest interest rate in the second step r_{LL} is set as the unknown x. Then $r_{HH} = xe^{4\sigma} = 1.4918\,x$ and $r_{HL} = xe^{2\sigma} = 1.2214\,x$. Figure 25.9 shows the setup for calibrating rates at the one-year time step. Here, the last time-step of the tree (i.e., the step at maturity) is omitted since it contains no useful information for the forward rates.

Equations in system 25.13 expresses the bond value at each node as an expression of x,

$$BV_{LL} = \frac{1}{1+\frac{x}{2}}\left[\frac{1}{2}(100+100)+0.7675\right]$$

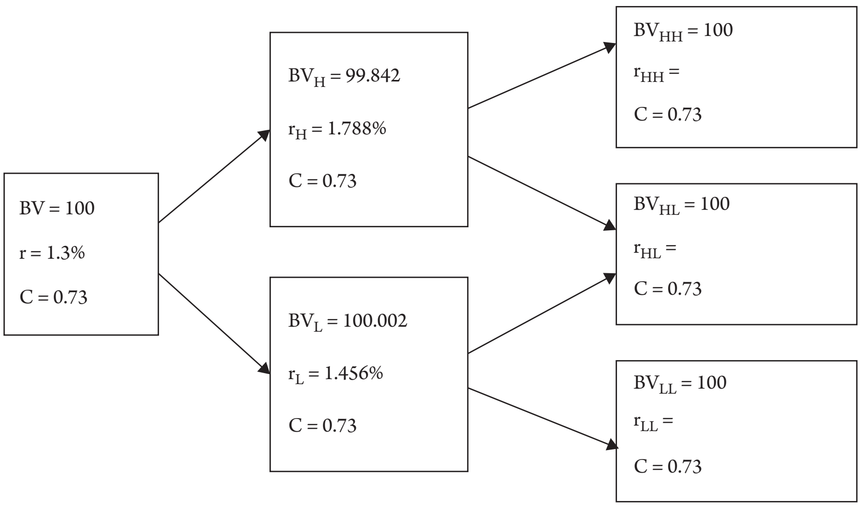


Figure 25.8 Binomial Tree Calibration at Six Months: Results

This figure demonstrates the results of calibrating the first step (interest rates in six months) of the binomial interest rate tree using the YTM of an on-the-run one-year Treasury bill. The yield is 1.46 percent. Coupon rate of 1.46 percent is set to equal to the yield so that the bond price equals par value for calibration purposes. Coupon payment 0.73 is calculated from the coupon rate of 1.46 percent and a par of $100. All interest rates in the tree are 6-month short-term interest rates at the time step.

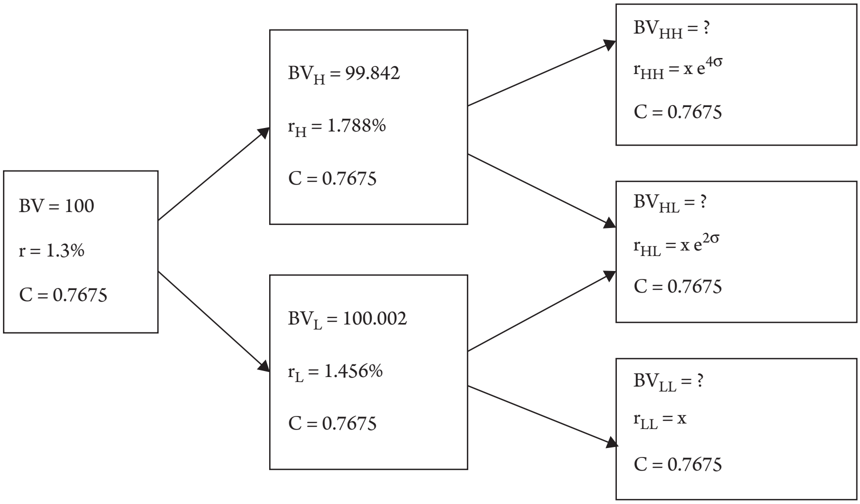


Figure 25.9 Binomial Tree Calibration at One Year: Setup
This graph displays the setup of calibrating the second step (at one year) of a 1.5 year (three-step) binomial tree with on-the-run Treasury issues. In the second step, the interest rates are calibrated at one year using the YTM of a hypothetical 1.5-year Treasury issue that is extrapolated from an on-the-run one-year Treasury bill and an on-the-run two-year Treasury note. The yield is 1.535 percent. The coupon rate of 1.535 percent is set to equal the yield so that the bond price equals the par value for calibration purposes. The coupon payment of 0.7675 is calculated from the coupon rate of a 1.535 percent and a par of $100. All interest rates in the tree are six-month short-term interest rates at the time step. The starting node of the tree is at the current time. The first step contains two nodes, both 6-months later. The first step interest rates are calibrated from an on-the-run one-year Treasury issue. The second step contains three nodes at one year. The four tree nodes are omitted at 1.5 year because they all contain the same redundant information: par = 100 and coupon = 0.7675, which is presented throughout the tree.

$$BV_{HL} = \frac{1}{1+\frac{xe^{2\times 0.1}}{2}}\left[\frac{1}{2}(100+100)+0.7675\right]$$

$$BV_{HH} = \frac{1}{1+\frac{xe^{4\times 0.1}}{2}}\left[\frac{1}{2}(100+100)+0.7675\right]$$

$$BV_{L} = \frac{1}{1+\frac{0.01456}{2}}\left[\frac{1}{2}(BV_{HL}+BV_{LL})+0.7675\right]$$

$$BV_{H} = \frac{1}{1+\frac{0.01778}{2}}\left[\frac{1}{2}(BV_{HH}+BV_{HL})+0.7675\right]$$

$$100 = BV = \frac{1}{1+\frac{0.013}{2}}\left[\frac{1}{2}(BV_{HH} + BV_{HL}) + 0.7675\right] \quad (25.13)$$

Solving this system of equations for the only unknown x by iterative trial and error gives $r_{LL} = x = 1.3713$ percent. The tree is then updated to the final version in Figure 25.10, in which the result interest rates at all nodes are displayed.

Although only one unknown exists with this process, this calibration is not as simple as it seems. For the n^{th} step calibration, solving an n-order polynomial equation of x is required which gives n roots. At a second and third step, judging and picking the correct root (e.g., the only positive root for the interest rate) are relatively easy. As the number of steps increases for evaluating longer term bonds with options, the number of roots increases and makes the root selection complicated. In that case, numerically searching for the root starting from the six-month forward rate at that time, as indicated by the

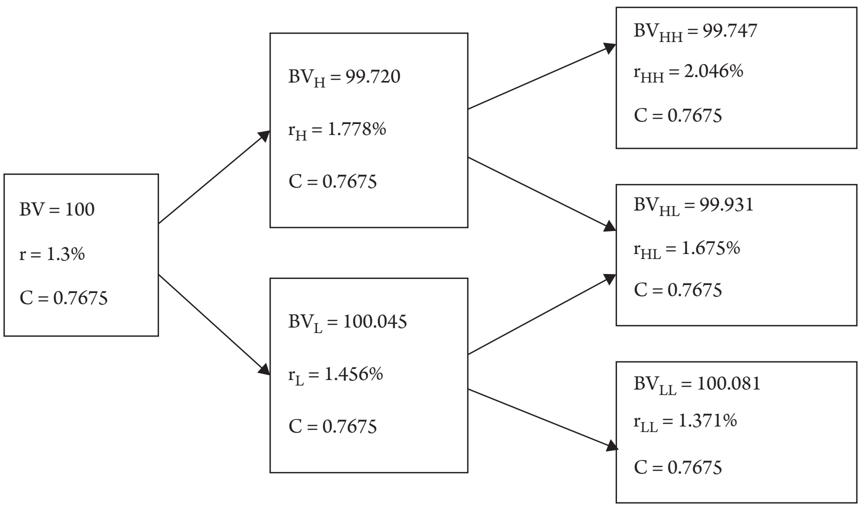


Figure 25.10 Binomial Tree Calibration at One Year: Results

This figure displays the results of calibrating the second step (at one year) of a 1.5-year (three-step) binomial tree with on-the-run Treasures issues. In the second step, the interest rates are calculated at one year using the yield-to-maturity of a hypothetical 1.5-year Treasury issue that is extrapolated from an on-the-run one-year Treasury bill and an on-the-run two-year Treasury note. The yield is 1.535 percent. The coupon rate of 1.535 percent is set to equal the yield so that the bond price equals the par value for calibration purposes. The coupon payment of 0.7675 is calculated from the coupon rate of 1.535 percent and a par of $100. All interest rates in the tree are six-month short-term interest rates at the time step. The starting node of the tree is at the current time. The first step contains two nodes, both six months later. The first step interest rates are calibrated from an on-the-run one-year Treasury issue. The second step contains three nodes at one year. The four tree nodes are omitted at 1.5 year because they all contain the same redundant information: par = 100 and coupon = 0.7675, which is presented throughout the tree.

spot rate curve, is helpful. This process not only expedites the root searching process, but also enhances the accuracy of the result.

Puttable Bond Valuation Using a Binomial Interest Rate Tree

After the tree is calibrated, its most important application is to value bonds with embedded options, such as callable or puttable bonds. The call or put options embedded allow different actions for the issuer and the bondholder for each interest rate scenario. Since each interest rate scenario is represented by a node in the binomial tree, this scenario-specific action can be reflected by revising the value in the corresponding tree node.

For example, if a callable bond with a 5 percent coupon is first available to be called after one year at the call price of $100 (also known as callable at par), then starting from one year, all nodes' bond values can be revised into bond's call price, if the bond value is greater than the call price. Using the previously calibrated interest rate tree, the resulting bond value at each node is shown in Figure 25.11.

The omitted tree steps at the 1.5-year time step contain trivial information: par = 100, coupon = $0.05 \times \frac{100}{2} = \$2.5$, which is assumed throughout the tree. If non-callable, the

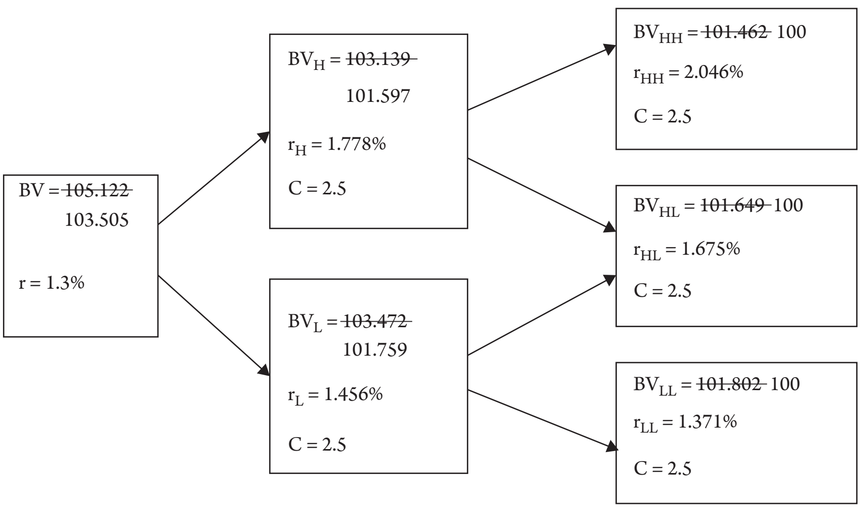


Figure 25.11 Binomial Tree Application: Callable Bond Valuation

A 1.5-year (three-step) binomial tree calibrated with on-the-run Treasury issues used to calculate a 1.5 year remaining maturity callable bond with the call price at 100 percent of par, callable after one year. The starting node of the tree is at the current time. The first step contains two nodes, both at six months later. The second step contains three nodes at one year later. At the third step at 1.5-year, the four tree nodes are omitted because they all contain the same trivial information: par = 100 and coupon = 2.5, which are presented throughout the tree. Valuing this callable bond involves replacing all bond values at one year that are greater than the call price by the call price. Then the bond values at six months (bottom node) and the current bond value that are changed after the revision at one year are calculated.

comparable straight bond would trade above par at $105.122, and the bond value at all nodes before maturity will be greater than par value given that its coupon is higher than the interest rate. But now, all bond values that are greater than call price at one year are replaced by the call price. This leads to a revision of six month bond values into 101.597 and 101.760 and the current bond value at 103.505. For this bond, the bond price premium is compressed even if the interest rate drops below the coupon rate.

A similar process is used to value a puttable bond, any tree nodes with a bond value lower than the put price into the put price would be revised, starting from the end of tree. Figure 25.11 shows an example of a puttable bond with coupon 1.7 percent that is puttable at par after six months. Starting from one year, bond values less than par are revised upward to the put price, par = 100. The top node at one year is then revised to 100. This process leads to a revaluation of bond value at the top node in the six-month grid, from 99.882 into 99.968. However, because this bond is puttable starting in six months, this bond value 99.968 is again revised into 100 since it is less than 100. After these two revisions, the current bond value increases to 100.302 as illustrated in Figure 25.12.

Option-Adjusted-Spread (OAS)

The process in the previous section develops a revised binomial interest rate tree with all rates calibrated from on-the-run Treasury bonds. Therefore, all interest rates in the tree

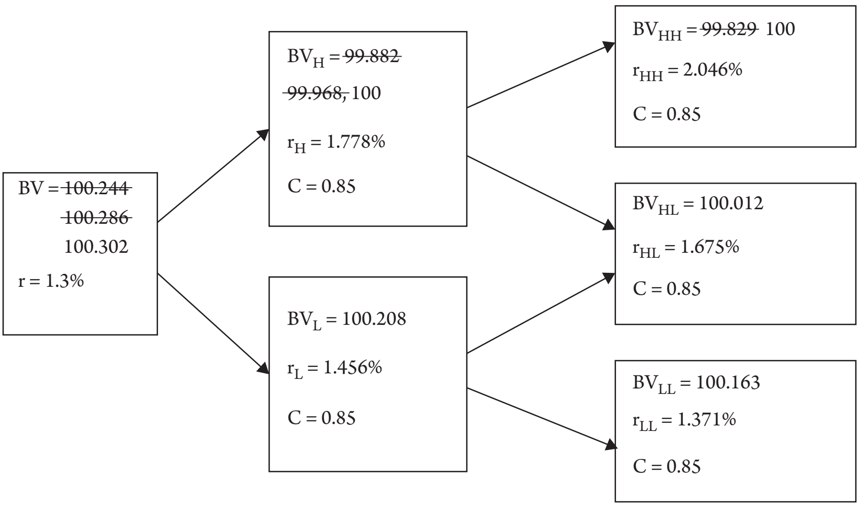


Figure 25.12 Binomial Tree Application: Puttable Bond Valuation

A 1.5-year remaining maturity puttable bond with put price at par, puttable after six months. The starting node of the tree is at the current time. The first step contains two nodes, both at six months later. The second step contains three nodes at one year later. The third step, which is at 1.5-year, contains four tree nodes that are omitted in the graph because they all contain the same trivial information: par = 100, coupon = 0.85, which is presented throughout the tree. To evaluate this puttable bond, replace all bond values after six months that are less than put price by the put price and then update bond values at six months and the current bond value accordingly.

are free of credit risk and liquidity risk premiums. Given that callable and puttable bonds are mostly corporate bonds that have credit risk and liquidity risk, a yield spread still needs to be added on the interest rate of each tree node to match the credit risk and liquidity risk profile of the corporate bond. This yield spread on top of an option-adjusted binomial tree is called the *option-adjusted spread (OAS)*. Analogous to the computation of the Z-spread, the OAS is the result of a trial-and-error search that arrives at a bond value (i.e., the model price), that is the same as the observable market bond price. The only difference here is that, in each trial, after adding the trial spread, the bond values on the tree are revised according to the callable and/or puttable features.

Since the binomial tree displays multiple interest rate scenarios at the same time step, the effects of embedded call or put options can be addressed by revising the bond value at a specific node to call price or put price, as illustrated in the previous section. As a result, the OAS is a yield spread excluding the risk effect of the option. Compared to the zero spread (Z-spread) that captures all bond-specific risk, including option effects, the OAS is a cleaner measure of credit risk and liquidity risk. The difference between the Z-spread and OAS then reflects the risks introduced by the embedded option, a yield-based representation of the option value. For callable bonds, options bring additional value to the issuer and increase the yield spread: Z-spread > OAS, leading to a positive differential. For puttable bonds, the put option brings additional value to the bondholder, leading to a tighter yield spread and negative difference between the Z-spread and OAS as illustrated in Equation 25.14.

$$\text{Option cost} = \text{Z-spread} - \text{OAS} \tag{25.14}$$

Callable and Puttable Bond

If a bond has multiple embedded options, then traditionally, the *yield-to-worst*, which is the minimum of all the YTC, YTP, and YTM, is used to gauge the downside risk from these options. However, because YTC and YTP often assume that call- and put-exercise occur at the first available dates or some arbitrarily selected dates, the resulting yield-to-worst measure fails to recognize the fact that the call option provides flexibility for the issuer while put or convertible options are options for bond holders.

With the previously mentioned binomial mode, both the call and put exercise timing is assumed to depend on the underlying straight bond price, achieving the valuation by revising the bond values at specific nodes that satisfy the call- or put- conditions. The binomial tree gives a much more precise and convenient way to value bonds with multiple options.

Binomial Model and Motivation for Callable Bond

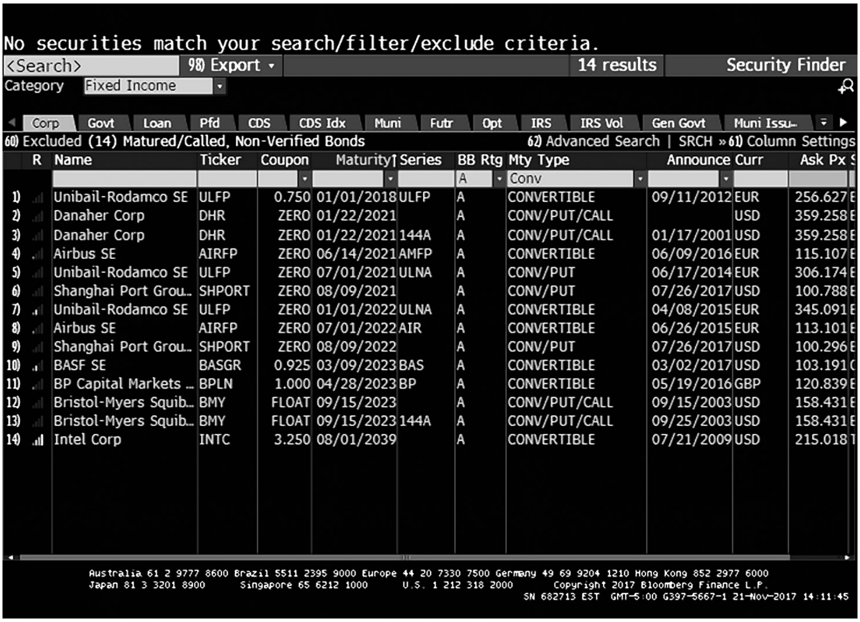
Theoretically, the binomial model assumes that the issuer will call the bond as soon as the bond price exceeds the call price, to hedge the interest rate risk (Green 1984; Brennan and Kraus 1987; Mayers 1998). If firms are issuing callable bonds to keep open the option to "refinance," then the bond should be immediately called when the interest rate drops below the critical yield. Such optimal call policy is well established by Ingersoll (1977) and Brennan and Schwartz (1980). Empirical studies, however, show that exercise of the option occurs well after the price exceeds the call price. What is also not explained by interest-hedging theory is that most firms do not refund their bonds (i.e., retire a bond using the fund from another bond issuance) when they call the bond. For example, King and Mauer (2014) show that 77 percent of bonds called in their sample are not refunded.

Another stream of research proposes a signaling theory: firms issue and call callable bonds to send a positive signal to the market when asymmetric information exists, namely when the managers have insider information about the firm's current and future investment opportunities (Robbins and Schartzberg 1986). Jameson, King, and Prevost (2016) study *make-whole callable bonds* (i.e., callable bonds that are called at their market value instead of a fixed call price, as defined in Table 25.1) and provide empirical evidence that supports signaling theory: callable bonds are issued to signal a good financial status to the market. On the other hand, if firms issue callable bonds to send a positive signal to the market, then the market should treat the call provision favorably. Yet the post-issuance bond rating changes are often negative (Crabbe and Helwege 1994; Ederington and Stock 2002), contradicting signaling theory. Overall, the call policy adopted by firms is often theoretically suboptimal, leading to additional difficulties in bond valuation.

Convertible Bonds

A *convertible bond provision* gives the bondholder the choice to convert the bond into some pre-specified shares of the issuer's stock. Recall from Figure 25.2 that new issuance of convertible bonds has been steadily decreasing, and the outstanding convertible bonds are mostly high-yield bonds. Because convertible bonds are mostly lower-rated bonds, their prices are highly sensitive to the issuer's stock price. This section introduces several analytical measures regularly used to analyze convertibles. First, the *conversion ratio* is the number of shares of common stock into which the bond can be converted. Convertible bonds can have physical settlements or cash settlements. In physical settlements, the bondholder typically receives the issuer's stock shares upon conversion. In cash settlements, the bondholder receives the cash value of the issuer's stock instead.

Interestingly, many convertible bonds are also callable or puttable. Figure 25.13 shows the Bloomberg listing of outstanding U.S. A-rating convertible bonds on November 21, 2017. For callable and convertible bonds, the call option can be unprotected or protected. An *unprotected call* is a regular callable provision that can still have a lock-down period during which the bond cannot be called. In contrast, a *protected callable bond* can only be called if the issuer's stock trades higher than a specified trigger price. This call protection saves bond holders from the worst scenario: when the issuer calls the bond, at least bond holders can choose to convert the bond into shares of stock with an attractive price. For puttable and convertible bonds, conversely, such additional protection is unnecessary because the put option and convertible option are both bond holders' options.


No securities match your search/filter/exclude criteria.
<Search> 98) Export 14 results Security Finder
Category Fixed Income
Corp Govt Loan Pfd CDS CDS Idx Muni Futr Opt IRS IRS Vol Gen Govt Muni Issu...
60) Excluded (14) Matured/Called, Non-Verified Bonds 62) Advanced Search | SRCH » 61) Column Settings

	Name	Ticker	Coupon	Maturity	Series	BB Rtg	Mty Type	Announce	Curr	Ask Px
						A	Conv			
1)	Unibail-Rodamco SE	ULFP	0.750	01/01/2018	ULFP	A	CONVERTIBLE	09/11/2012	EUR	256.627
2)	Danaher Corp	DHR	ZERO	01/22/2021		A	CONV/PUT/CALL		USD	359.258
3)	Danaher Corp	DHR	ZERO	01/22/2021	144A	A	CONV/PUT/CALL	01/17/2001	USD	359.258
4)	Airbus SE	AIRFP	ZERO	06/14/2021	AMFP	A	CONVERTIBLE	06/09/2016	EUR	115.107
5)	Unibail-Rodamco SE	ULFP	ZERO	07/01/2021	ULNA	A	CONV/PUT	06/17/2014	EUR	306.174
6)	Shanghai Port Grou...	SHPORT	ZERO	08/09/2021		A	CONV/PUT	07/26/2017	USD	100.788
7)	Unibail-Rodamco SE	ULFP	ZERO	01/01/2022	ULNA	A	CONVERTIBLE	04/08/2015	EUR	345.091
8)	Airbus SE	AIRFP	ZERO	07/01/2022	AIR	A	CONVERTIBLE	06/26/2015	EUR	113.101
9)	Shanghai Port Grou...	SHPORT	ZERO	08/09/2022		A	CONV/PUT	07/26/2017	USD	100.296
10)	BASF SE	BASGR	0.925	03/09/2023	BAS	A	CONVERTIBLE	03/02/2017	USD	103.191
11)	BP Capital Markets ...	BPLN	1.000	04/28/2023	BP	A	CONVERTIBLE	05/19/2016	GBP	120.839
12)	Bristol-Myers Squib...	BMY	FLOAT	09/15/2023		A	CONV/PUT/CALL	09/15/2003	USD	158.431
13)	Bristol-Myers Squib...	BMY	FLOAT	09/15/2023	144A	A	CONV/PUT/CALL	09/25/2003	USD	158.431
14)	Intel Corp	INTC	3.250	08/01/2039		A	CONVERTIBLE	07/21/2009	USD	215.018

Australia 61 2 9777 8600 Brazil 5511 2395 9000 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2017 Bloomberg Finance L.P.
SN 682713 EST GMT-5:00 G397-5667-1 21-Nov-2017 14:11:45

Figure 25.13 Convertible Bonds of A-Rating Issuers
This image is the list of call convertible bonds from Bloomberg with an issuer of A-level in the Bloomberg credit rating. This short list of sample convertible bonds demonstrates the popular coexistence of convertible, callable, and puttable provisions.

Market Conversion Price and Conversion Price

Because the payoff of the option embedded is based on the issuer's stock or stock value, the valuation of a convertible bond is thus closely linked to the issuer's stock price as illustrated in Equation 25.15.

$$\text{conversion value} = \text{market price of common stock} \times \text{conversion ratio} \tag{25.15}$$

Given that the bondholder has the option to convert, the value of the convertible bond should be the larger of the conversion value or the comparable straight bond price.

From the stock market's perspective, convertible bonds provide an alternative method to obtain the issuer's stock. For the convertible bondholder, converting the bond into stock means an exchange of the principal (to be received at maturity) for the issuer's stock share. Equation 25.16 shows that the value of each share measured by the principal surrendered is called the *conversion price*:

$$\text{conversion price} = \text{principal}/\text{conversion ratio} \tag{25.16}$$

Conversely, for a potential convertible bond buyer who considers buying a convertible bond to indirectly obtain the issuer's stock share, then the price of each share becomes the *market conversion price* in Equation 25.17:

$$\text{Market conversion price} \\ = \text{Market price of convertible bond/conversion ratio} \quad (25.17)$$

Even if a bondholder eventually wants the shares, the investor has the additional flexibility of keeping the straight bond or timing the conversion if purchasing a convertible bond first. This flexibility is the conversion option value. For this additional option value, the market conversion price is most likely higher than the market stock price. This difference is called the *market conversion premium*, which is shown in Equation 25.18.

$$\text{Market conversion premium per share} \\ = \text{Market conversion price} - \text{market stock price} \quad (25.18)$$

To gauge the size of this market conversion premium, a regular practice is to express the premium as a percentage of the stock price as shown in Equation 25.19:

$$\text{Market conversion premium ratio} \\ = \text{conversion premium per share/stock price} \quad (25.19)$$

Market conversion premium represents the value of the conversion option. This conversion option can be viewed as a "call" option with the strike (i.e., the trading price specified in the option contract) set to the bond market price. This strike is changing and makes the conversion option harder to evaluate.

From the bond market's perspective, the convertible bond is a straight bond plus the conversion option. Because the option value should never turn negative as it is not an obligation, the convertible bond value should never drop below the equivalent straight bond value. The straight bond price can be viewed as the floor of the convertible bond price, and the difference between convertible and straight bond prices as the downside risk of the convertible bond. Equation 25.20 presents the premium of convertible bond price over the straight bond price as a ratio.

$$\text{Premium over straight value} = \frac{\text{Convertible bond price}}{\text{Straight bond price}} - 1 \quad (25.20)$$

A higher premium over the straight value results in higher downside risk, and a less attractive convertible bond.

Convertible Bond: Option-Based Valuation

Convertible bonds can be theoretically decomposed into a straight bond and a call option on the issuer's stock with strike price equal to the bond price at conversion. The conversion can then be deemed as a combination of (1) selling the bond at market price and (2) exercising the call option to buy the issuer's stock at the strike that equals to the bond price. This decomposition seems to present an easy solution to value a convertible bond because valuation of financial options is relatively well understood.

However, some difficulties arise. First, the call option is embedded in the bond itself and cannot be traded separately. Such a limitation leads to illiquidity that impedes the full realization of option value, even if the option were precisely valuated. Second, the underlying stock price is assumed to be independent from the interest rate. The previous valuation method using interest rate model is then infeasible unless a second state variable (or dimension) is introduced in the binomial tree. Third, although an ordinary financial call option has a fixed strike price, here the "call" option has a strike value equal to the bond price, which itself is a dynamic process. The payoff of this "call option" is then the maximum of two competing stochastic processes. In the options valuation literature, this is called an "exchange option." Its valuation involves the continuous stochastic models assuming risk-neutrality (Fischer 1978; Margrabe 1978). Additionally, a favorable income differential usually exists because the convertible bondholder receives coupons that are generally larger than the dividends based on conversion.

Callable and Convertible Bond

In practice, most convertible bonds are callable. Callable and convertible bonds allow the issuer to call and force the bond holders to convert. According to Stein (1992), a growing firm may find convertible debt financing cheaper than either an equity issue or a straight debt issue when it faces high information asymmetry costs and has high leverage. He contends that calling to force conversion to equity reduces leverage while allowing the firm to increase the equity in its capital structure through the "back door." Moreover, Mayers (1998) adds that convertible debt financing may help the firm to finance a sequence of current and future investments. King and Mauer (2014) find strong empirical evidence that supports both theories.

In a perfect capital market, an optimal policy is to call a convertible bond as soon as its conversion value exceeds the call price. However, researchers document that firms deviate from this policy by waiting until the conversion value exceeds the effective call price by a wide margin. Emery and Finnerty (1989) and Jaffee and Shleifer (1990) explain this puzzle by including transaction costs associated with a call notice period. Harris and Raviv (1985) propose a signaling explanation similar to the motivation of a callable bond. Finally, Asquith and Mullins (1991) contend that the delay of the call might be from the fear of failure to force-convert. If the bond holders do not choose to convert the bond into stocks, then the firm must redeem these bonds in cash, a burden on firm cash flow.

Summary and Conclusions

Bonds with embedded options present additional challenges in analysis and valuation. For callable and puttable bonds, a rough measure of yield is the YTC or YTP. A more accurate analysis of option effects calls for a dynamic interest rate model that allows for interest rate uncertainty. Achieving these results requires separation of each cash flow in the bond with each discounted using the spot rate corresponding to the term from the spot rate curve. To allow for interest rate uncertainty, the chapter introduces a discrete time binomial tree that allows interest rate uncertainty in each time step. Calibrated using on-the-run Treasury issues, the tree is then used to evaluate callable or puttable bonds by revising specific bond values according to the call or put structure. Adding a constant yield-spread on top of the binomial tree to make the bond's value equal to its market price generates the OAS, a yield spread that effectively removes the embedded option effect.

Although valuing callable and puttable bonds is achieved using a binomial tree, convertible bond valuation is closely linked to the issuer's stock price, adding an additional dimension of uncertainty. This chapter discusses the most popular measures used by market participants to gauge the risk and premium of convertible bonds and reviews financial option models to value the embedded conversion option.

Discussion Questions

1. Discuss how the binomial interest rate tree incorporates interest rate uncertainty.
2. Explain the application of the binomial interest rate model to value callable and/or puttable bonds.
3. Discuss why the Z-spread for a callable bond is higher than its OAS.
4. Discuss the difference between the Z-spread and the OAS.
5. Describe an approach for valuing convertible bonds.

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26

Valuing and Analyzing Mortgage-Backed and Asset-Backed Securities

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Introduction

Financial valuation is predicated upon the idea that the value of an investment today is the sum of the investment's discounted future cash flows. That premise does not change for fixed income securities. A bond's intrinsic value is the sum of all future interest and principal payments discounted at the relevant rate(s) of interest. For example, a five-year, option-free, semi-annual, fixed-income instrument would require the discounting of 11 total cash flows (10 coupon payments and one principal payment). If the bond is option-free, the dates of payment of principal and interest throughout the life of the bond are known with certainty unless a default or other unanticipated interruption occurs. Hence, the analyst only needs to determine the appropriate interest rates and then discount the cash flows at those rates.

When bond issues contain embedded options, they often appear in the form of stated call or put options. These options may include a *lock-out period*, a period in which the option cannot be exercised. However, upon expiration of the lock-out period, the bond is eligible to be called by or put to the issuer. For obvious reasons, valuation of these types of securities cannot simply rely on the discounted cash flow method as previously mentioned, due to the presence of an option that can, and often does, distort the timing and amount of future cash flows. Instead, analysts frequently use the binomial/lattice model. The model, which uses a binomial tree of interest rates derived from the forward interest rate curve, seeks to value securities whose cash flows can be altered by call or put options, the exercise of which largely depend on the then-current interest rate environment. In conjunction with the forward interest rate curve, this model allows the analyst to forecast future cash flows, which incorporate the embedded put or call, and then discount those cash flows at the appropriate rate(s) of interest.

Asset-backed securities (ABSs) and mortgage-backed securities (MBSs) are two heterogeneous categories of securities, within the broader fixed income markets, which contain embedded options. Heterogeneity is largely dictated by the underlying collateral constituting each ABS or MBS. The collateral underlying an ABS includes such sources as credit card receivables, aircraft lease receivables, student loans, home equity loan receivables, and almost any contract of future cash flows that can be pooled with other similar, but not necessarily identical, contracts that are then securitized and sold off to meet the various needs of investors. The collateral underlying an MBS is a portfolio of individual loans (mortgages) that have been underwritten, pooled, tranched (if the security is a collateralized mortgage obligation or non-agency security) and sold off to investors. *Tranching* typically involves creating securities offerings that prioritize the distribution of cash flows within an asset pool. Similar to callable and puttable bonds, an MBS contains embedded options. The mortgagor/obligor (i.e., the borrower) that utilizes a mortgage to buy a house has the option to prepay some, or all, of the outstanding mortgage, thus creating the "option" present in an MBS. However, MBSs exhibit less predictability than the bonds with stated embedded call or put options. This difference is primarily due to the presence of *prepayment risk*, the risk of unscheduled principal repayments into the mortgage pool, which is passed through to the investors.

The uncertainty in unscheduled principal repayments leads to a host of other risks for the MBS or ABS investor, such as call risk, extension risk, and reinvestment risk. This chapter mainly focuses on the U.S. agency MBS market, primarily due to its relative ease of understanding and broad application of pricing fundamentals to the wider niche markets of non-agency residential mortgage-backed securities (RMBSs), collateralized mortgage obligations (CMOs), commercial mortgage backed securities (CMBSs), and ABSs. Additionally, the U.S. Agency MBS market represents an overwhelmingly large percentage of outstanding volume relative to the broader securitized asset market. Security Industry and Financial Market Association's 2016 "Year in Review" report (SIFMA 2017) states that the total outstanding volume of all U.S. securitized assets, as of year-end 2016, was \$10.25 trillion, with \$6.53 trillion agency RMBS (63.71 percent) of outstanding volume, not including CMOs.

The goal of this chapter is to develop a foundational understanding of MBS valuation, which can then be applied to the various niches within the broader ABS segment of the fixed income market. First, the chapter begins by identifying the major differences between traditional, option-free, fixed income instruments, such as corporate debt, and MBSs, including a brief discussion on various cash-flow issues, agency versus non-agency deal structuring, and other interest rate-related topics. Next, the chapter examines major inputs/determinants of an MBS's valuation, such as prepayments, defaults, seasonality, seasoning, premium burnout, and other borrower inefficiencies. Lastly, these elements are combined into a basic valuation framework, which includes a brief discussion on various spread measures, both static and dynamic, and the use of the Monte Carlo simulation (MCS) for MBSs.

MBS Versus Traditional Fixed Income Securities

As previously mentioned, a fixed income security's intrinsic value, both for MBSs and traditional fixed-income securities, is the present value of future cash flows. Throughout this chapter, the term *traditional fixed income security* refers to an option-free, fixed coupon bond paying semi-annual coupon payments until the bond's stated maturity, at which point the investor receives the bond's stated face value. Accordingly, four main differences exist between these two types of investments: (1) coupon frequency, (2) coupon amount, (3) coupon composition, and (4) bond maturity date. A traditional bond pays a stated amount of interest at a pre-specified interval for a stated maturity, at which point the face value is returned to the investor. During the investment's life, assuming no issuer default, coupon payments are expected with certainty at pre-specified points in time. Valuation is simple: the future coupon and return of principal (face value) can be discounted at interest rates implied by the forward interest rate curve plus the applicable spread depending on the specific type of investment. The intrinsic value is the sum of these discounted cash flows.

For MBSs, a host of differences exist but only four are highlighted. First, due to the underlying collateral, an MBS pays a monthly coupon, not annual or semi-annual, as the underlying loans (mortgages) make monthly payments. Since an MBS is simply a pool of these loans, the coupons paid to the MBS investor are aligned with the inflow of funds from the mortgagor, net of any guarantee fees ("g-fees"), fees collected by FNMA or FHLMC on each securitization in order to protect against any future defaults within the respective mortgage pools, base servicing, or excess servicing held by the issuing agency or entity. For private label MBSs, no guaranteed fee exists; this is only applicable for agency RMBSs that contain *government loans* (i.e., loans explicitly guaranteed by the Federal Housing Administration [FHA] and Veterans Administration [VA] via the backing of the U.S. Treasury) and are largely securitized through the Government National Mortgage Association (GNMA) or qualifying *conventional loans*. Conventional loans are securitized through the Federal Home Loan Mortgage Corporation (FHLMC or "Freddie Mac") or the Federal National Mortgage Association (FNMA or "Fannie Mae"), which are government-sponsored entities (SPEs) that do not explicitly carry the guaranteed backing of the U.S. Treasury, but are often viewed as containing an implicit backing.

Next, the traditional bond's coupon payments consist entirely of interest until maturity when principal is paid with a bullet payment. In contrast, the monthly coupon on an MBS is comprised of both interest and principal reflecting the characteristics of the underlying collateral. When a borrower repays the loan each month, that payment is comprised of both principal and interest, the composition of which largely depends on the age of the mortgage and the mortgage's amortization schedule. Therefore, the funds that flow into the loan pool and subsequently are paid out to the MBS investor are also mixed. The specific type of security that this chapter examines is an agency RMBS pass-through security, in which each MBS investor owns and receives a monthly cash flow based on the holder's pro-rata ownership share of the specified MBS pool.

Aside from the timing of the cash flow and the composition of the coupon payment, another important differentiator is the coupon amount. For traditional securities, a specified percentage of the bond's face value is paid out to the bondholder at a pre-specified time. However, the amount of the coupon payment is not specified for MBS investors. This structure can be directly attributed to prepayments, which are the single most important determinant of and complicating factor for MBS valuation. As detailed in the next section, monthly principal and interest payments to the MBS investor contain three core elements: interest, scheduled principal, and unscheduled principal (prepayments). This last category can be further subdivided into voluntary prepayments and involuntary prepayments. The more prepayments that occur within a given month, the larger is the monthly MBS "coupon," which consists of both principal and interest. However, the lack in predictability of *mortgage prepayment speeds*, the rates at which mortgagors repay all or some of their outstanding loan balance (mortgages), causes obvious and sizeable valuation complications for these securities.

Lastly, MBSs and traditional bonds differ in their maturities. Traditional, option-free, bonds have a stated maturity, on which full repayment of principal (face value) is due. For bonds containing a single embedded call or put option, if the investment environment is such that the bond will likely be called by, or put back to, the issuer, then the maturity date will be the date of the effective option. Additionally, the pricing and/or yield of the bond will reflect the shorter investment period—for example the bond's yield-to-call (YTC) can and likely will differ from the initial yield-to-maturity (YTM). For MBSs, again depending on prepayment speeds, interest rates, and other economic variables such as borrower financial conditions, the maturity of the MBS can vary in length. Because the underlying assets in an MBS pool are numerous (i.e., different loans [mortgages] that have similar, yet varying, "maturities"), the weighted average maturity (WAM) of the MBS pool can be used as a proxy for the security's overall maturity. Simple agency MBSs are pass-through securities without tranching. Various structuring techniques, such as tranching, vary from deal to deal and allocate principal, interest, losses, and prepayments based upon pre-specified allocations stated in the bond's offering prospectus. A side calculation, which is essentially the counterpart of the WAM, is the weighted average loan age (WALA), which acts as a proxy for the pool's overall age. This measure can be used to analyze various factors including seasoning and burnout as determinants to the pool's potential future prepayment rates. These topics are discussed later in this chapter.

The intrinsic value of most fixed income securities is simply the discounted sum of future cash flows. However, valuation is challenging because of the unpredictable nature of an MBS's future cash flows. The next section shows that investors expend substantial effort to predict the future cash flows of these securities in order to find dislocations within the market, capture relative value, and earn profits.

Calculating MBS Cash Flows and Major Determinants to MBS Valuation

If a security's intrinsic valuation is simply the sum of the discounted future cash flows, then the importance of an economic variable to a security's value should be judged by its propensity to alter the investment's cash flows. As previously mentioned, an MBS investor is exposed to such risks as call risk, extension risk, and reinvestment risk. Call risk and reinvestment risk are often associated with periods of declining interest rates. As interest rates fall, bond prices increase. As bond prices rise, traditional (non-MBS) bonds with embedded call options begin to approach their *call price strike level*, the level at which the bond issuer of the bond can call the bond back from the investor. This situation poses a problem for the investor who must now reinvest newly acquired cash, which was acquired from the issuer in exchange for the bond that was called away, into a new fixed income investment at a lower interest rate.

For MBS investors, call/reinvestment risk is a familiar concept. The driving force behind this exposure, and the most important factor in MBS valuation, is the prepayment rate. As interest rates begin to drop, prepayments accelerate, returning principal to MBS investors at a faster rate than originally anticipated (contraction risk), leaving the MBS investor searching to redeploy capital at lower rates. In contrast, extension risk occurs as interest rates rise, prepayment rates drop, causing the monthly "coupon" payments to decline as less unscheduled principal (prepayment) is returned to the investor than originally estimated. The MBS investor is now unable to redeploy capital into higher yielding alternatives until the MBS is repaid in full.

The presence of prepayments is a key contributor to the unique sensitivity of MBS to interest rates because of negative convexity. This property can be illustrated with a brief example. Assume for simplicity the price-yield relation for a traditional, option-free bond has a linear relation (i.e., a rise (fall) in interest rates results in an equal drop (increase) in price for all levels of interest rates). Whereas a decline in interest rates causes a rise in prices for the traditional, option-free bond, the decline in interest rates causes a flurry of prepayments for the MBS holder, which increases the cash flow to the MBS investor but shortens the WAM of the MBS pool and shortens its duration. The decrease in duration of the MBS inhibits the upward movement of the price performance of an MBS, creating a divergence in performance relative to the option-free bond whose duration is unchanged.

Yet, if interest rates increase, the traditional option-free bond declines in price. The MBS investor experiences a decrease in unscheduled principal payments (prepayments), extension of MBS pool's WAM, and an increased duration. All else equal, bonds with longer durations experience larger price declines. Thus, an MBS underperforms the traditional bond once again. According to Fabozzi, Bhattacharya, and Berliner (2011), MBS investors are generally compensated for this phenomenon with higher base-case yields.

Clearly, prepayments have a wide and varying impact on MBS cash flows. After reviewing terminology and prepayment measurement, this section discusses key variables that drive prepayments for an MBS, differentiating between voluntary and involuntary prepayments, also known as *credit-related prepayments* (i.e., defaults). The section also examines some predominant types of prepayment models used in MBS valuation, such as the Salomon Smith Barney Model, Wharton Model, and Richard and Roll (Goldman Sachs) Model.

Mortgage Loan Mechanics

To analyze and ultimately value an MBS, forecasting monthly cash flows is crucial. If such forecasting is imprecise, the MBS pricing model is likely to suffer severe estimation and modeling risk and ultimately have poor predictive capabilities. Assuming a fixed-rate, fully amortizing mortgage pool, Equation 26.1 shows the monthly mortgage payment factor (MPF) equation (Fabozzi et al. 2011), which is used to calculate the inflow of monthly payments (i.e., principal and interest) into the MBS pool throughout the MBS pool's life:

$$MPF = \frac{r(1+r)^n}{(1+r)^n - 1} \tag{26.1}$$

where *MPF* is the monthly mortgage payment factor; r is the pool's monthly weighted average coupon (WAC); and *n* is the loan term (in months).

When multiplied by the outstanding balance of the mortgage pool, the MPF equation produces the total mortgage payments that flow into the pass-through structure. Assuming a fixed WAC for the pool, this portion of the monthly cash flows can be forecasted until the pool's original balance is completely paid down. However, the impact of prepayments must be explicitly incorporated.

The Calculation of Prepayments

The most frequently used approach to measuring prepayments is *the conditional prepayment rate* (CPR), also known as the *constant prepayment rate*. This measure is the annualized percentage of unscheduled principal payments within an MBS pool over a given period. This rate is *annualized*, but cash flows from an MBS pool are distributed on a monthly basis. Therefore, another measurement called the *single monthly mortality* (SMM) is used. The SMM considers the total monthly payment into the MBS pool and measures the monthly rate of prepayments, explicitly incorporating scheduled principal and interest payments. Equation 26.2 illustrates the SMM of a given pool (Fabozzi et al. 2011):

$$\text{Single Monthly Mortality rate (SMM)} = \frac{(\text{total payment} - \text{scheduled interest payment} - \text{scheduled principal payment})}{\text{Unpaid principal balance} - \text{scheduled principal payment}} \tag{26.2}$$

Accordingly, the CPR can be calculated as the annualized SMM, as shown in Equation 26.3 (Fabozzi et al. 2011):

$$\text{Conditional Prepayment Rate (CPR)} = 1 - (1 - \text{SMM})^{12} \tag{26.3}$$

The SMM can also be derived from the CPR using Equation 26.4 (Fabozzi et al. 2011):

$$\text{Single Monthly Mortality rate (SMM)} = 1 - (1 - \text{CPR})^{\frac{1}{12}} \tag{26.4}$$

The CPR can be used as a singular assumption, and thus plugged directly into an MBS valuation, or it can be used as an input into a more complex prepayment model. For example, for a particular MBS agency pass-through pool, one could directly assume that prepayments are 2 percent of the pool's beginning-of-period outstanding balance over the agency pool's entire life. Using the CPR in this light illustrates the CPR's advantages, simplicity and flexibility. Alternatively, analysts can disaggregate a pool's prepayments into various categories that are discussed shortly and forecast these various sources of prepayments throughout the life of the MBS pool.

Broadly speaking, the observed general tendencies such as seasoning and burnout, led the Public Securities Association (PSA) to create the PSA prepayment benchmark. This prepayment benchmark is a monthly series based on annual prepayment rates (CPRs) that can be applied to forecast future prepayments within an MBS pool depending on the age, as determined by the WALA of the pool. "100 percent PSA," or the PSA standard benchmark, follows the following series of annual prepayment rates:

- CPR of 0.2 percent (on an annualized basis) is used for the first month, thereafter increasing by 0.2 percent annually per month up to 30 months, at which point a 6 percent CPR is assumed for the remainder of the pool's life (Fabozzi et al. 2011).

The acceleration of conditional prepayment rates over the first 30 months is known as the pool's CPR "ramp." A prepayment rate of "0 percent PSA" means that no assumed prepayments occur. Graphically, the various PSA "speeds" can be compared in Figure 26.1, which shows the various CPR ramps for different PSA assumptions.

Two items must be kept in mind. First, since the MBS pool's "age" is measured by the WALA, then "a pool with a wide dispersion of loan ages will tend to distort the PSA calculation" (Fabozzi et al. 2011, p. 55). Second, the SMM for a given PSA speed is not simply the SMM at 100 PSA multiplied by the referenced PSA speed (i.e., 1.50 for 150 PSA). The proper calculation for adjusting the SMM for a change in the 150 PSA speed is as follows:

CPR @ 100 PSA for month 12: 12(0.2 percent)=2.4 percent

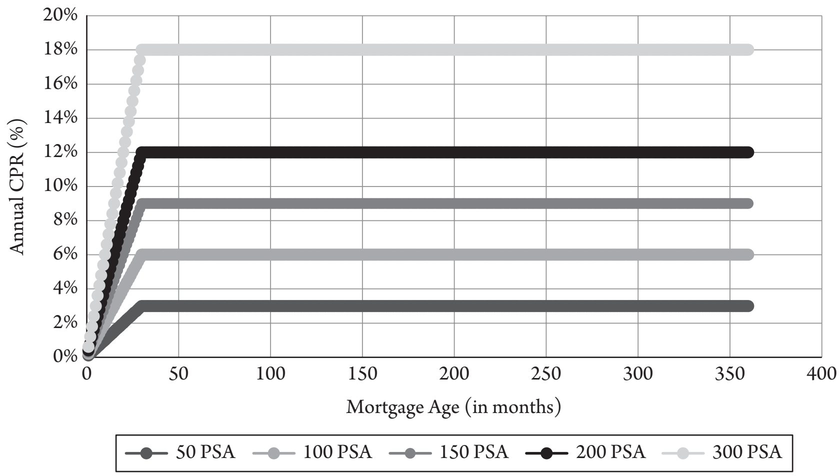

Figure 26.1. Varying CPR Ramps Associated with Different PSA "Speeds"
This figure illustrates the various CPR ramps and prepayment curves for a range of PSA Speed values, ranging from 50 PSA to 300 PSA.

$$\text{CPR @ 150 PSA: 2.4 percent}(1.50) = 3.6\text{ percent}$$

$$\text{SMM @ 150 PSA for month 12:} 1 - (1 - 0.036)^{\frac{1}{12}} = 0.31\text{ percent}$$

The analyst should first convert the pool's SMM to the annualized CPR using Equation 26.3, then multiply that CPR by the desired PSA speed. Once the "new CPR" has been calculated, this CPR is converted into an SMM as per Equation 26.4. For reference, Appendix A lists the first 40 months in an MBS cash flow forecast based on a hypothetical 30-year fixed-rate MBS pool. This example uses 100 PSA for a $600 million MBS pool, with base servicing of 35 basis points (bps) and a guarantee fee of 15bps, both of which are subtracted from the gross interest rate to reach the "pass-through" coupon rate at which interest is "passed along" to MBS investors.

Voluntary Prepayments

A *prepayment* is an unscheduled return of principal by the borrower of a mortgage loan that serves as collateral for an MBS pool. A partial prepayment, or a payment for less than the full outstanding balance on a mortgage loan, is called a *curtailment*. Broadly speaking, prepayments can take two forms: voluntary prepayments and involuntary prepayments. This section only considers the former. When forecasting voluntary prepayments, scheduled principal and interest should be explicitly considered. That is, the total cash flow that comes into an MBS pool consists of scheduled principal (per amortization schedule for each loan), interest, and unscheduled principal payments. This section only covers the unscheduled portion.

Although voluntary prepayments occur for many reasons, the most common are: (1) sale of property for mobility reasons, death of homeowner, or divorce; (2) destruction of property due to fires or other natural disasters; (3) partial prepayments (curtailments); and (4) refinancing. Items 1 and 2 can be grouped together in the "turnover" category. Overall, as Fabozzi et al. (2011, p. 78) state, "These rates are stable over time but are strongly influenced by the health of the housing market," which can be judged by both the levels of real estate appreciation and volume of existing home sales. Most loan contracts are now structured with *due-on-sale clauses*, which state that if a house is sold (transfer of ownership of the house), then the associated mortgage must be fully paid off. Therefore, in a healthy real estate market, a "natural" rate of turnover exists that leads to a quicker repayment of mortgages than if the mortgages were to be paid as per each loan's initial amortization schedule. One method of turnover analysis is the prepayment rate for mortgages in which the borrower's original mortgage rate is lower than the current Freddie Mac Primary Mortgage Market Survey (PMMS) Survey Rate such that the implied refinancing "option" is out-of-the-money and would not be exercised, leaving only a natural rate of prepayment attributable to turnover excluding any refinancing. According to Fabozzi et al., a more exact method is to examine turnovers to calculate the percent of existing sales for single-family houses. Moreover, while natural disasters can certainly lead to temporary spikes in damage to homes, attempting to model natural disasters is far too impractical and unreliable to build into a valuation model. Analysis of historical data may be one way of estimating housing turnover due to natural disasters.

Refinancing, the fourth item, receives the most attention and is also the most complex of the items listed. For mortgages, *refinancing* is the act of taking out a new loan at a different and presumably lower interest rate and simultaneously paying off the old loan. Two main forms of refinancing exist: rate-and-term refinancing and cash-out refinancing. For rate-and-term refinancings, the only two variables that change in the new mortgage loan are the interest rate and/or the term (maturity) of the mortgage loan. Usually, borrowers refinance their mortgages at lower interest rates and possibly extend the loan's term hoping to reduce both their monthly and overall payments. These types of refinancings "generally depend on the borrower's ability to obtain a new loan with either a lower rate of a smaller payment due. Therefore, this depends on the level of interest rates, shape of the yield curve, and the availability of alternative loan products" (Fabozzi et al. 2011, p. 89). Cash-out refinancings involve taking out a new mortgage loan with a larger principal balance, typically by at least 5 percent, where the difference of the two loans (new minus old) is paid out to the borrower. Sometimes this alternative form of refinancing can take the place of second liens on a house and can be used for various general purposes. Since the new loan is larger than the old loan, assuming the borrower initially maximized the amount to be borrowed (the old mortgage), this type of refinancing requires home price appreciation or previous principal paydown.

When attempting to model refinancing activity, rate-and-term refinancing activity can be viewed as a form of option exercise. If the borrower's mortgage loan rate at origination is greater than that of the prevailing market's mortgage rate, assuming no transaction costs, then the borrower is likely to opt to refinance. However, assuming no transaction fees exist, when in fact these fees can be substantial, would be naive. Therefore, a constraint on the refinancing incentive can be added such that the borrower will only refinance if the prevailing market's mortgage rate is low enough to compensate the investor for the additional costs that they will incur by refinancing to the lower rate. As Fabozzi et al. (2011) mention, this assumption implies that loan size strongly affects refinancing incentives: smaller loans typically require a greater refinancing incentive to trigger refinancing activity since transaction fees (as a percentage of outstanding principal balance) are costlier for smaller mortgages than larger mortgages. The refinancing incentive can be graphically illustrated by the following "S-Curve," shown in Figure 26.2, in which the X-axis is denoted as the "Refinancing Incentive" (MBS pool's WAC minus some benchmark rate using the Freddie Mac PMMS Rate)—and the Y-axis is the CPR.

A considerably higher level of prepayment speeds (CPR) exists when a positive difference occurs relative to a negative difference (i.e., a negative difference occurs when current market mortgage rates are greater than borrowers' original mortgage rates, as reflected by the pool's WAC).

Although interest rate movements are the predominant predictor of refinancing activity, several other factors also affect refinancing rates, and thus the prepayment speeds. The first set of factors, which can reduce or introduce a lag in refinancing rates, is borrower inefficiencies. As previously mentioned, certain transaction costs exist that may prohibit a borrower from refinancing, thus requiring a larger refinancing incentive before a refinancing is economically beneficial to the borrower. However, even if

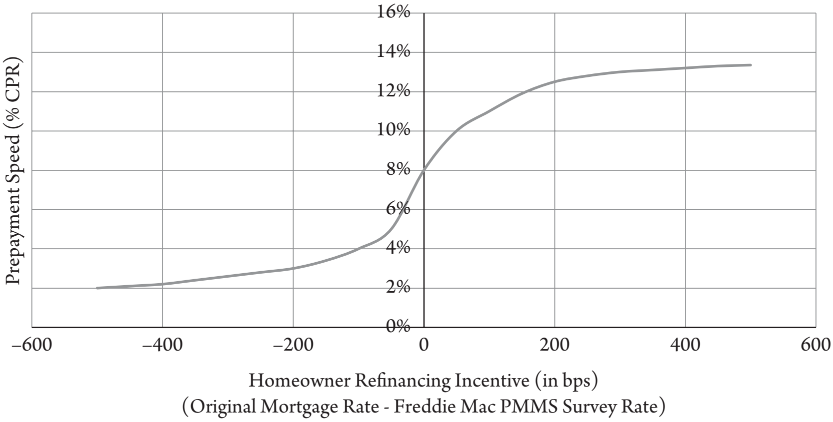

Figure 26.2 Hypothetical S-Curve Function Illustrating a Fixed-Rate MBS's Refinancing Incentive over Various Levels of Interest Rates

This figure illustrates a hypothetical mortgage pool's incentive to refinance existing loans and the corresponding effect on the pool's CPR. The refinancing incentive is measured by the homeowner's initial mortgage rate minus the Freddie Mac PMMS Survey Rate.

interest rates drop sufficiently far such that the refinancing incentive is large enough to compensate the investor for these incremental transaction costs, the borrower still may not refinance immediately or ever. This situation can be explained by noting that many borrowers are not particularly financially savvy and do not closely follow financial markets, particularly interest rates. Therefore, their decision to refinance is influenced through word of mouth, often from friends, family, or news media. In these situations, only precipitous drops in interest rates are likely to make headlines, which are known as the media effect. The outcome of the media effect is that refinancing lags behind the initial changes in interest rates and leads to waves of refinancing.

The next set of factors affecting mortgage refinancings involves borrower-specific financial conditions. To refinance a mortgage, a new loan must be underwritten. If the borrower's credit is insufficient to qualify for a new loan (to pay off the old loan in order to lower the monthly payments and/or extend the term of the loan), then the level of the refinancing incentive is unimportant: the borrower cannot refinance at any level of refinancing incentive. Therefore, even if the borrower could save money by financing, having sub-par credit prohibits taking advantage of the decline in rates. In contrast, if a borrower's credit improves, then the borrower does not necessarily need a decline in interest rates to refinance the mortgage. Often distressed borrowers are subjected to high interest rate mortgages or loans. By improving their credit, they increase the opportunity of refinancing some or all of those high-interest loans without even needing a decline in interest rates.

Although this chapter primarily concerns itself with fixed-rate mortgage loans, another factor that influences the refinancing activity in the mortgage market is the availability of other mortgage products such as adjustable-rate mortgages (ARMs). Depending on the shape and slope of the yield curve, incentives to refinance from fixed-rate to an ARM may exist. For example, in economic regimes with steep yield curves, ARM rates (3/1, 5/1 or 7/1, meaning that for the first three, five, or seven years the loan rate is fixed and then the rate will adjust annually, respectively) are generally lower than 30-year fixed-rate mortgages making products such as interest-only (IO) mortgages particularly attractive. Thus, during periods of a steepening yield curve more refinancing activity will involve ARMs. However, when short-term interest rates gradually rise, the incentive to refinance from fixed-rate mortgages to ARMs decreases due to the general flattening of the yield curve.

Finally, two of the more underappreciated factors affecting refinancing activity are burnout and seasonality. *Burnout* reflects the tendency for loan pools to reach a point of diminishing prepayment activity in which further declines in interest rates cause fewer, if any, borrowers to refinance. This relation largely involves borrower inefficiencies and the interest rate path dependency of MBS. Since interest rates strongly affect prepayments, both the current level of interest rates and interest rate path are important. If a large drop in interest rates occurs earlier in the life of the MBS pool, then future declines in interest rates may not have the same impact on refinancing rates. Moreover, if borrowers have deteriorating credit and cannot secure a new mortgage to refinance the old mortgage, then the level of interest rates is unlikely to affect the borrower's ability to refinance. In contrast, *seasonality* refers to the time of year in which refinancing activity occurs. Typically, refinancing activity tracks home sales, which increase in the spring through fall months with summer months being the most active. Therefore, the MBS investor should reflect this fact in any prepayment model.

Involuntary Prepayments

Various underlying economic factors lead to mortgage prepayments such as interest rates, real estate transaction activity (turnover), and the sensitivity of borrowers to changes in these fundamentals (borrower inefficiencies). However, these factors assume that the borrower has been making at least the minimum payments of principal and interest (scheduled interest) if not more (unscheduled principal payments—i.e., "voluntary prepayments"). This assumption is a bold claim. Not only do increases in interest rates slow down the rate of prepayments, but also raise the "cost" of a mortgage, ceteris paribus. For example, at the beginning of the financial crisis of 2007–2008, a large portion of the mortgage market consisted of ARMs, whose interest rates and thus monthly payments reset periodically (typically annually). During the crisis, when interest rates suddenly spiked, borrowers experienced monthly payment "shock" as the ARMs reset to dramatically higher interest rates. This payment "shock" resulted in many borrowers becoming unable to make the monthly payments on their mortgages, enter the delinquency phase, and then ultimately default on their mortgage. Although the implications of this topic are beyond the scope of this chapter, two main agencies monitor measures of delinquency, the Office of Thrift Supervision (OTS) and the Mortgage Bankers Association (MBA).

Eventually, during normal economic conditions, most delinquent mortgages escape delinquency and become "current" with their payments. However, some mortgages cannot escape delinquency and fall into default, ultimately leading to the foreclosure and liquidation process where the lender, often a bank, liquidates the asset(s) to recover the value in the property and limit loan losses (i.e., minimize loan write-offs). For guaranteed loans offered through the FHA and VA and securitized by Ginnie Mae, MBS investors are not concerned with defaults because the loans underwritten by those agencies, which make up the collateral pool of the MBS, are explicitly backed by the full faith and credit of the U.S. Treasury. Similarly, conventional loans that are severely delinquent and securitized by Fannie Mae and Freddie Mac are often not serious causes for concern because of the collection of the guarantee fee at the pool's inception. However, for investors in non-agency MBSs, defaults are critical. For these MBSs, the occurrence of defaults ultimately affects the timing and amount of cash flows, whereas for conventional loans (agency MBSs) only the timing is affected. This conclusion assumes that Ginnie Mae, Fannie Mae, and Freddie Mac are all operating as a going concern and will not go bankrupt.

Two primary factors—the delay in cash flows and the loss severity—must be considered in forecasting cash flows associated with involuntary prepayments. The *delay in cash flows* concerns the length of time that the lender or bank takes to advance through the foreclosure and liquidation process and receive cash for the property. *Loss severity* is a measure of the loss from the property as a percentage of the outstanding unpaid amount remaining on the mortgage. Although several credit-related risk metrics exist, the loan-to-value (LTV) of the loan/mortgage is a key indicator of the probability of default. A mortgage's *loan-to-value* is the percentage of the mortgage value relative to the value of the underlying property. Certainly not all loans with high LTVs, 90 percent or above, default but empirically these higher-LTV loans are more "at risk" for default. The underlying reason is that fluctuations in market/appraisal value of a property can quickly revalue the loan as *underwater*, in which the amount owed on a mortgage exceeds the net recoverable amount of the property that collateralizes the loan. That is, if the market value of the property collateralizing the loan falls, the LTV of the mortgage on that property rises. Therefore, less depreciation in market value of an underlying property is needed to raise the LTV above 100 percent than for lower LTV loans. Accepted credit theory suggests that loans with an LTV less than 100 percent should never see a borrower default. However, when LTVs exceed 100 percent delinquencies tend to increase with some eventually reaching default.

In agency pass-through MBS pools, defaults result in the MBS investor receiving full principal repayment upon declaration of excess delinquency. At this point, the delinquent loan is classified as "nonperforming," subsequently removed from the pool, and the unpaid balance of the loan is repaid to all investors on a pro-rata basis, along with accrued interest. Therefore, in times of economic stress leading to increased delinquencies and defaults, prepayment rates for agency pass-throughs may actually increase. This situation may be counterintuitive as most investors would assume that increased defaults would slow down prepayment speeds and reduce the amount of principal prepaid. Yet, the opposite is observed. For agency pass-through MBSs, limits on the amount of time a loan can be delinquent exist. Additionally, all loans are guaranteed either by explicit guarantees from the U.S. Treasury or implicitly by FNMA and FHLMC via their guarantee fee. Thus, involuntary prepayments due to defaults and delinquent loans bought out by the sponsoring entity can be combined with rates of voluntary prepayments to estimate an overall pool prepayment rate (CPR) and speed incorporating both types of prepayments, voluntary and involuntary.

For non-agency securities, voluntary prepayments and involuntary prepayments must be reported and calculated separately. Credit support for non-agency MBSs is achieved through various methods of structuring, such as tranching. In this structuring method, a pool of mortgages is securitized, and the resulting capital "stack" is structured such that credit support is internalized. Senior tranches, which can act similar to agency pass-throughs, are relatively protected from any increases/decreases in prepayment speeds as well as any losses. Other subordinated tranches can be structured such that some tranches receive a percentage of principal and interest only after the senior tranche has been paid in full and can experience losses if the losses are sufficiently high. Even further down the capital stack, the "equity" tranche can be, and often is, structured such as the first to suffer any losses resulting from defaults in the underlying pool. In return for accepting the first loss position, equity investors are compensated with substantially higher-than-average yields.

To calculate the prepayment rate associated with involuntary prepayments, the monthly rate of involuntary prepayments must first be calculated using Equation 26.5. This rate is called the *monthly default rate* (MDR) and is calculated in the following manner (Fabozzi et al. 2011, p. 69):

$$\text{Monthly Default Rate (MDR)} = \frac{\text{Default loan balance}}{\text{Beginning pool balance} - \text{scheduled principal payment}} \tag{26.5}$$

Similar to the SMM rate, annualizing the rate of defaults results in the conditional default rate (CDR). Just as SMMs can be converted to CPRs, MDRs can be converted into CDRs using Equation 26.6:

$$\text{Conditional Default Rate}(\text{CDR}) = 1 - (1 - \text{MDR})^{12} \tag{26.6}$$

This equation can be inverted and de-annualized in a similar manner as the CPR calculations, which for non-agency securities is called the *voluntary prepayment rate* (VPR). For non-agency securities, to calculate the pool's total prepayment rate, inclusive of voluntary and involuntary prepayment rates, the CDR cannot simply be added to the VPR. Instead, quoted VPRs and CDRs must first be de-annualized, summed, and then re-annualized. The analyst can then apply a PSA "speed" to this prepayment rate to forecast monthly cash flows. Although this explanation of forecasting prepayment rates is extremely simplified, keep in mind that the MDR and the CDR mentioned previously must also consider loss severity. When a loan enters default, the bank/lender repossesses the property and attempts to liquidate often through foreclosure auctions. Although full recovery is a possibility, recovering the entire outstanding loan amount through this process is unlikely, thereby leading to a loss or "haircut." The loss percentage, when measured relative to the outstanding amount of the defaulted loan inclusive of foreclosure costs, is the *loss severity rate*.

The amount of principal recovered, net of transaction costs, is called the *recovery rate*. The loss severity rate (LSR) can be calculated as shown in Equation 26.7:

$$\text{Loss Severity Rate (LSR)} = 1 - \text{Net Recovery Rate} \tag{26.7}$$

where the net recover rate is defined by Equation 26.8:

$$\text{Net Recovery Rate} = \frac{\text{Liquidation proceeds (net of ransaction costs)}}{\text{Outstanding balance on mortgage}} \tag{26.8}$$

In a similar manner using the PSA convention with CPR rates, a pre-specified assumption for default rates, which is known as the *standard default assumption* (SDA), can be used. The following specifications denote "100 percent SDA":

- A 0.02 percent initial CDR, rising 0.02 percent per month (on an annualized basis) until reaching 0.6 percent CDR in month 30.
- A constant 0.6 percent CDR from months 30 to 60.
- A linear decline of 0.0095 percent CDR between months 61 and 120, reaching 0.03 percent in month 120.
- A constant 0.03 percent CDR for the remaining term.
- Assumes a voluntary prepayment speed of 150 PSA.

Graphically, Figure 26.3 illustrates the 100 percent SDA excluding the effects of the voluntary prepayment assumption.

Given the turbulence experienced in the mortgage and MBS markets since 2007, discussing recent developments that may not align with credit theory as presumed via "the rational individual" is also important. The most interesting of these developments is the emergence of "strategic defaults." Before 2007, real estate markets experienced only limited and modest declines in value relative to the broader markets. Therefore, the corporate credit theory underlying the LTV premise discussed earlier (in which borrowers are expected to default on a loan as soon as the LTV exceeds 100 percent) was relatively untested. According to Fabozzi et al. (2011), before 2007 the mortgage sector had long operated under the assumption that obligors (borrowers) rarely walk away from their properties because of the importance of dwellings to families' well-being. Furthermore, Ong, Poh, and Spieler (2006, p. 211) note:

> Many previous studies identify loan, property, borrower, and environmental factors that impact the probability of foreclosure. Implicit in these studies is the assumption that the property was purchased at fair value. We question this assumption based on several empirical findings regarding property value uncertainty. In contrast to previous research, we explicitly quantify the price premium from a hedonic pricing model. Using a comprehensive database of real estate transactions from Singapore between 1989–2000, we document a price premium associated with properties that are subsequently foreclosed

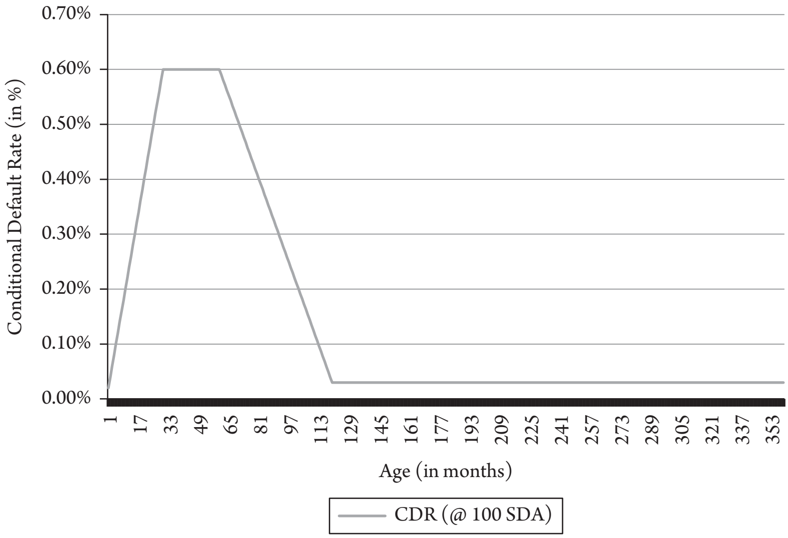

Figure 26.3 Graphical Depiction of a 100 Percent Standard Default Assumption
This figure illustrates the strategic default assumption at 100 percent. The figure involves the following assumptions: (1) a 0.02 percent initial CDR, rising 0.02 percent per year per month until reaching 0.6 percent CDR in month 30, (2) a constant 0.6 percent CDR from months 30 to 60, (3) a linear decline of 0.0095 percent CDR between months 61 and 120, reaching 0.03 percent in month 120, (4) a constant 0.03 percent CDR for the remaining term, and (5) a voluntary prepayment speed of 150 PSA.

> based on actual sales transactions. In addition, we find that the premium paid at purchase significantly increases the probability of foreclosure. These results are robust and continue to hold after controlling for other property-specific factors, time-varying macroeconomic conditions, alternative model specifications, and definitions of price premium.

This activity blurred the lines of traditional credit theory. However, the broad decline in property values beginning in 2007 caused a relatively new phenomenon to emerge: borrowers who could still afford to make their monthly payments, but despite the LTVs rising above 100 percent. The sudden and precipitous drop in property values increased LTVs such that the borrower was economically justified to walk away from the property, and sometimes leaving the keys behind.

Prepayment Models

Because the valuation of an ABS depends heavily on the rate of principal prepayment, the ability to correctly value an MBS hinges on an analyst's ability to forecast these prepayment rates to develop a comprehensive cash flow forecast. Since the development of MBSs, analysts have developed numerous prepayment models, each varying in their complexity and inputs, to capture the relation between underlying economic fundamental data and future prepayment rates. Some prominent models include the Salomon

Smith Barney Model, Wharton Model, and Goldman Sachs Model, also known as the Richard and Roll Prepayment Model. Although some publicly disclosed information about the major inputs is available, model-specific sensitivities such as factor loadings or other correlation data are considered proprietary information and are thus not generally available for study. Nonetheless, despite differences in model formulae and factor sensitivities, several common underlying independent variables are leveraged across these major models.

When analyzing the underlying economic factors, using pool level data is generally sufficient because most loans are reasonably homogenous within a given pool. However, analysis at the loan or mortgage level results in a more accurate valuation because each loan's characteristics may react differently to the underlying economic data. Nevertheless, one of the most important independent variables across the various models is the ratio of the mortgage pool's weighted average note rate (assuming pool-level data) relative to the market's prevailing mortgage rate, which is often referred to as some version of the *refinancing incentive*. Whereas some models calculate this variable in a separate sub-model, in which a prepayment "duration" is calculated, other models use this independent variable as the fundamental driver of prepayments with other factors acting as multipliers or factor loadings. In the context of prepayment models, *prepayment duration* is a measure of change in the prepayment rate with a change in a specific factor. Other notable independent variables are turnover, seasonality, burnout, and seasoning.

Valuation of an MBS and an ABS

Unlike valuing an MBS pool, when valuing traditional fixed-rate bonds with a single embedded option, either a put or a call, an analyst might use the binomial/lattice model introduced earlier in this chapter. The binomial model incorporates backward induction with a forward interest rate curve and an interest rate volatility assumption to value the security. This model is appropriate because the security's valuation is not dependent on the interest rate path. That is, the level of interest rates at one point in time has no effect on the bond's future cash flows at a different level of interest rates (i.e., the coupon is fixed). In other words, the bond's valuation is not interest-rate-path dependent, whereby current cash flow of an MBS is highly dependent on the history of interest rates during the life of the MBS pool. This section discusses both relative and absolute valuation, incorporating less favored relative valuation spreads, such as nominal spreads and "Z-spreads," as well as more popular methods such as MCS and option adjusted spread (OAS), which can be used for either relative spread analysis or absolute valuation.

The nominal spread represents a simpler and less accurate measure of relative valuation. At its most basic level, the nominal spread is simply the difference in yield between an MBS or ABS and the yield of the relevant, maturity matched benchmark security. In this chapter, the benchmark security is a U.S. Treasury bond. The nominal spread is computed based on the Treasury yield curve and the relevant benchmark is the interpolated Treasury bond that matches the average life of the MBS. However, two complications arise. First, cash flows from an MBS are monthly whereas coupons on a benchmark security are typically semi-annual or annual in some cases, so the yield comparison needs to take this difference into account. Second, an embedded prepayment risk in an MBS exists. Therefore, the spread between the two securities captures only a portion of this risk. Although the former issue can be managed, the latter is a serious shortcoming of the nominal spread measure in relation to an MBS.

To properly compare the yield on an MBS and the yield on a U.S. Treasury security, a common approach is to use the bond equivalent yield (BEY) method to calculate the nominal spread. Essentially, this involves calculating the BEY for the MBS, using the security's monthly cash flow yield and the BEY for a semi-annual pay coupon U.S. Treasury security, which is the benchmark security for this example. The BEY for a U.S. Treasury security can be calculated as shown in Equation 26.9:

$$\text{Bond Equivalent Yield}(\text{UST}) = 2^{*}\,\text{Effective Semiannual Yield} \tag{26.9}$$

For the MBS, the BEY calculation shown in Equation 26.10, is more challenging but still twice the semi-annual rate:

$$\text{Bond Equivalent Yield}\,(\text{MBS}) = 2\left[\left(1+\frac{i}{12}\right)^{6} - 1\right] \tag{26.10}$$

where *i* is the annual mortgage yield, which is "the interest rate that equates the present value of the projected monthly cash flow equal to the market price plus accrued interest of the MBS (Fabozzi et al. 2011). The BEY formula for MBS incorporates the monthly cash flows and the compounding frequency, whereas the traditional BEY formula, which also captures the nature of compounding, emphasizes the semiannual benchmark coupon payments. Thus, manipulating the BEY formulas allows for the relative comparison of two different securities. Equally important is the fact that an implicit assumption about prepayment rates is embedded within the mortgage yield. Specifically, calculating a monthly cash flow yield requires making a forecast about the prepayment rate so that a schedule of cash flows can be calculated. Therefore, a major assumption of the nominal spread is the realization of forecasted prepayment speeds. A *nominal spread* is a spread metric computed at a given point on the treasury curve, as opposed to a spread that can be applied over an entire curve. This drawback, among other reasons, reduces the usefulness of the nominal spread for relative MBS valuation.

A better alternative to the BEY approach is to measure the spread relative to each point on the benchmark curve (i.e., a parallel upward shift). Using the new curve to discount the cash flows (each at the applicable spot rate plus the "spread"), so that the model price equals the market price of the MBS, isolates the "true" spread of an MBS over a benchmark more precisely. This "spread" is referred to as the *zero-volatility spread* or, more simply, the *Z-spread*, which is the basis point spread that must be added to the discount rate from the Treasury spot curve, such that the sum of the forecasted cash flows equals the MBS's current market price. Although a superior measure to the nominal spread, the Z-spread is not directly observable and is an iterative process, thus limiting its applicability and practicality. Despite its numerous strengths, the Z-spread still embeds the same prepayment assumption that was present with the nominal spread, which presents a large, and thus destabilizing, risk.

Both the nominal spread and the Z-spread suffer from risks surrounding prepayment speeds. Despite the Z-spread's advantage (spread over an entire curve) compared to the nominal spread (spread over single point), the risk inherent in assuming a single prepayment function can be fatal for security valuation as prepayment fluctuations are nearly impossible to forecast with certainty. Although the Z-spread is not particularly useful when prepayment speeds fluctuate, it can be useful for types of an ABS that do not experience rapidly changing prepayment speeds. As Fabozzi and Kothari (2008) note, the Z-spread can be useful for certain types of automobile loan ABS. In these ABS pools, borrowers technically have the right to refinance (prepay) when rates decline below the original loan rate but rarely exercise this option. Previous discussions disqualified the binomial model as a means of valuation for an ABS and MBS due to the series of embedded options present in the monthly cash flows.

Another widely used valuation methodology is the MCS model. This model is a data-intensive technique that allows a user to choose from various inputs, along with measures of parameter volatility or dispersion, and generate a large number of random outcomes for a desired output. Based on realizations from these interest rate "paths," an accompanying probability distribution is created. The flexibility of the MCS model is crucial for an MBS because an analyst can assume probability distributions for a multitude of valuation variables, most importantly interest rates, and measure the effect that various random interest rate paths have on the valuation of an MBS. Therefore, MCS offers a possible solution to the problem of prepayment risk that has plagued traditional MBS valuation.

When creating an MCS, Fabozzi et al. (2011) identify four essential, integrated steps: (1) simulate short-term interest rate and refinancing rate paths; (2) project the cash flow on each interest rate path; (3) determine the present value of the cash flows on each interest rate path; and (4) compute the theoretical value of the MBS. An MCS allows the user to input a variable in addition to a volatility or dispersion estimate. Therefore, for the first step, the user can input a benchmark interest rate term structure and apply a one-factor (or multi-factor) interest rate model (where either on-the-run or off-the-run Treasuries can be used for calibration). As Fabozzi, Richard, and Ru (2012, p. 882) note, "Since 1998, structured products are using swaps instead of Treasuries for pricing and hedging purposes. The main reason is that spread to swaps is more stable than to Treasuries." In building the interest rate model, the user can input a constant volatility assumption. That is, for each point on the benchmark term structure, the volatility can be assumed constant. However, a more probable and realistic method is to assume a certain volatility metric for short-term interest rate volatility, and another rate for longer-term interest rate volatility. Classical interest rate models, such as the Cox-Ingersoll-Ross model or the Vasicek model, assume decreasing interest rate volatility with respect to time. A final option is to build a term structure of interest rate volatility, where each point on the term structure can potentially have a unique rate of volatility. These volatility assumptions determine the width or dispersion of the interest rate paths determined throughout the various trials within the simulation. Although both the short-term interest rate assumptions and the accompanying volatility estimates are important, the user must also dictate an assumed relation between short-term interest rates and refinancing rates given that a large portion of prepayment cash flows depend on refinancings.

Once the short-term interest rates and refinancing rates have been established and various interest rate paths have been created by an MCS, the next step is to project the cash flow, using a prepayment model for each interest rate path. As Fabozzi et al. (2011, p. 218) note, when using an MCS, "there is a prepayment rate for *each* month on a given interest rate path, and the rate for a given month across all interest rate paths is not necessarily the same." Thus, as interest rates evolve, so does the SMM and hence prepayments. This forecasting of cash flows considers scheduled principal payments, interest payments, and, most importantly, unscheduled principal payments (prepayments).

After creating the interest rate paths and projecting the cash flows for each path, the cash flows must be discounted back to the present. This process discounts each monthly cash flow for a given interest rate path at the applicable spot rate created by the interest rate term structure and interest rate volatility assumption established in first step, plus a spread. The sum of these discounted cash flows is the present value for this interest rate "path." Calculating the "theoretical" value of the ABS or MBS is simply taking the weighted average of the values of the paths that an MCS has created.

Given that the short-term interest rate term structure was derived from U.S. Treasury securities, if the cash flows that were calculated by the MCS were discounted at these U.S. Treasury-implied spot rates, the sum of the discounted values would be much higher than the current market price of the MBS, assuming the security in question is riskier than Treasury bonds, which are considered as risk-free. Therefore, a spread must be applied to every cash flow on every interest rate path such that, when added, the "theoretical" value as calculated above equals the current market price of the security. This spread is called the OAS. As with the Z-spread, the OAS is an iterative process across an entire spot rate curve, or each interest rate path across all trials, used to reconcile a model's valuation with the security's current price. It is superior to the Z-spread because it incorporates prepayment risk into the spread measurement. As a result, if finding a comparable security to the ABS or MBS in question is possible, then the analyst can possibly calculate an OAS from the comparable security and then apply that the OAS, along with the analyst's cash flow forecasts and prepayment model, to the security in question in an attempt to calculate the absolute value of an MBS and exploit any perceived price discrepancies.

Summary and Conclusions

Valuations methodologies used for traditional fixed income investments, namely discounted cash flow (DCF) models and nominal spread measures, often fall short in valuing an MBS and ABS. As such, noting that valuation is ultimately dictated by the characteristics of the underlying collateral is important. For an MBS, valuation is largely based on the pattern of prepayments and interest rate fluctuations along with several other pool-specific characteristics. However, given a different pool of underlying collateral, such as automobile loans or aircraft receivables, the valuation function can take on a completely different form with its own unique variables. Can borrowers prepay the loan? Do prepayment penalties exit? How do loan rates move with interest rates? Do frictions prevent borrowers from refinancing given a decline in interest rates? Is refinancing even possible? How often does the pool receive principal and interest payments? These are all questions that, depending on the underlying collateral, may have different answers, which in turn affect the projected cash flows. Besides the underlying collateral and deal-specific structuring, the allocation of principal and interest income throughout the capital stack must also be considered. Ultimately, the successful valuation of any ABS or MBS, regardless of the robustness of any model used, lies on the precision with which the underlying variables are analyzed and forecasted.

Discussion Questions

1. Discuss the primary differences between traditional (option-free) bonds and MBSs.
2. Discuss some of the strengths and weaknesses of the zero-volatility spread in valuing an MBS.
3. Identify the four core elements to an MBS valuation model.
4. Explain the concept of negative convexity and why an MBS exhibits this phenomenon.

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Appendix A

Sample 30-year Fixed Rate Agency Pass-Through MBS Cash Flow Analysis Adapted from Frank J Fabozzi (2011, p. 58)

Underlying pool type:	30-year fixed rate
Original princ bal:	600,000,000
WAC:	6.00%
Monthly Gross Int Rate:	0.50%
Guaranty Fee:	0.15%
Base Servicing:	0.35%
Pass-through rate:	5.50%
WAM (in mos):	360
PSA Assumption:	100%

Month	Beginning o/s Balance	^{CPR}100 PSA	CPR_A	SMM	MPF	Mortgage Payment	Net Interest	Sched. Principal	Prepayments	Total Principal
1	600,000,000.00	0.20%	0.20%	0.000167	0.00599551	3,597,303.15	2,750,000.00	847,303.15	99,950.44	947,253.59
2	599,052,746.41	0.40%	0.40%	0.000334	0.00600148	3,595,202.93	2,745,658.42	849,544.51	199,767.57	1,049,312.08
3	598,003,434.33	0.60%	0.60%	0.000501	0.00600750	3,592,503.32	2,740,849.07	851,654.25	299,400.14	1,151,054.39
4	596,852,379.94	0.80%	0.80%	0.000669	0.00601355	3,589,204.48	2,735,573.41	853,631.07	398,796.88	1,252,427.95
5	595,599,952.00	1.00%	1.00%	0.000837	0.00601966	3,585,306.84	2,729,833.11	855,473.73	497,906.61	1,353,380.34
6	594,246,571.66	1.20%	1.20%	0.001006	0.00602580	3,580,811.15	2,723,630.12	857,181.03	596,678.27	1,453,859.31
7	592,792,712.35	1.40%	1.40%	0.001174	0.00603199	3,575,718.46	2,716,966.60	858,751.86	695,060.95	1,553,812.81
8	591,238,899.54	1.60%	1.60%	0.001343	0.00603822	3,570,030.11	2,709,844.96	860,185.15	793,003.92	1,653,189.07
9	589,585,710.48	1.80%	1.80%	0.001513	0.00604449	3,563,747.74	2,702,267.84	861,479.90	890,456.71	1,751,936.61
10	587,833,773.87	2.00%	2.00%	0.001682	0.00605081	3,556,873.30	2,694,238.13	862,635.17	987,369.13	1,850,004.30
11	585,983,769.57	2.20%	2.20%	0.001852	0.00605718	3,549,409.04	2,685,758.94	863,650.10	1,083,691.33	1,947,341.43
12	584,036,428.14	2.40%	2.40%	0.002022	0.00606359	3,541,357.50	2,676,833.63	864,523.87	1,179,373.82	2,043,897.69
13	581,992,530.45	2.60%	2.60%	0.002193	0.00607005	3,532,721.51	2,667,465.76	865,255.74	1,274,367.54	2,139,623.28
14	579,852,907.16	2.80%	2.80%	0.002364	0.00607655	3,523,504.21	2,657,659.16	865,845.05	1,368,623.88	2,234,468.93
15	577,618,438.24	3.00%	3.00%	0.002535	0.00608310	3,513,709.03	2,647,417.84	866,291.18	1,462,094.73	2,328,385.91
16	575,290,052.32	3.20%	3.20%	0.002707	0.00608969	3,503,339.69	2,636,746.07	866,593.61	1,554,732.53	2,421,326.15
17	572,868,726.17	3.40%	3.40%	0.002878	0.00609634	3,492,400.20	2,625,648.33	866,751.87	1,646,490.32	2,513,242.18
18	570,355,483.99	3.60%	3.60%	0.003051	0.00610303	3,480,894.86	2,614,129.30	866,765.56	1,737,321.72	2,604,087.28
19	567,751,396.71	3.80%	3.80%	0.003223	0.00610977	3,468,828.25	2,602,193.90	866,634.35	1,827,181.08	2,693,815.43
20	565,057,581.28	4.00%	4.00%	0.003396	0.00611655	3,456,205.25	2,589,847.25	866,358.00	1,916,023.41	2,782,381.41
21	562,275,199.87	4.20%	4.20%	0.003569	0.00612339	3,443,030.99	2,577,094.67	865,936.33	2,003,804.48	2,869,740.81

22	559,405,459.06	4.40%	4.40%	0.003743	0.00613028	3,429,310.91	2,563,941.69	865,369.22	2,090,480.86	2,955,850.08
23	556,449,608.97	4.60%	4.60%	0.003917	0.00613721	3,415,050.68	2,550,394.04	864,656.64	2,176,009.93	3,040,666.57
24	553,408,942.41	4.80%	4.80%	0.004091	0.00614420	3,400,256.28	2,536,457.65	863,798.63	2,260,349.92	3,124,148.54
25	550,284,793.87	5.00%	5.00%	0.004265	0.00615124	3,384,933.93	2,522,138.64	862,795.29	2,343,459.97	3,206,255.26
26	547,078,538.61	5.20%	5.20%	0.00444	0.00615833	3,369,090.11	2,507,443.30	861,646.81	2,425,300.15	3,286,946.96
27	543,791,591.65	5.40%	5.40%	0.004615	0.00616547	3,352,731.58	2,492,378.13	860,353.45	2,505,831.50	3,366,184.95
28	540,425,406.70	5.60%	5.60%	0.004791	0.00617267	3,335,865.32	2,476,949.78	858,915.54	2,585,016.04	3,443,931.58
29	536,981,475.13	5.80%	5.80%	0.004967	0.00617991	3,318,498.57	2,461,165.09	857,333.47	2,662,816.85	3,520,150.32
30	533,461,324.81	6.00%	6.00%	0.005143	0.00618721	3,300,638.81	2,445,031.07	855,607.74	2,739,198.04	3,594,805.78
31	529,866,519.03	6.00%	6.00%	0.005143	0.00619457	3,282,293.76	2,428,554.88	853,738.89	2,720,719.52	3,574,458.40
32	526,292,060.63	6.00%	6.00%	0.005143	0.00620198	3,264,050.67	2,412,171.94	851,878.73	2,702,345.60	3,554,224.32
33	522,737,836.30	6.00%	6.00%	0.005143	0.00620944	3,245,908.96	2,395,881.75	850,027.21	2,684,075.70	3,534,102.91
34	519,203,733.39	6.00%	6.00%	0.005143	0.00621696	3,227,868.07	2,379,683.78	848,184.30	2,665,909.24	3,514,093.54
35	515,689,639.86	6.00%	6.00%	0.005143	0.00622453	3,209,927.45	2,363,577.52	846,349.93	2,647,845.65	3,494,195.58
36	512,195,444.28	6.00%	6.00%	0.005143	0.00623217	3,192,086.53	2,347,562.45	844,524.07	2,629,884.34	3,474,408.42
37	508,721,035.86	6.00%	6.00%	0.005143	0.00623985	3,174,344.76	2,331,638.08	842,706.68	2,612,024.76	3,454,731.44
38	505,266,304.42	6.00%	6.00%	0.005143	0.00624760	3,156,701.59	2,315,803.90	840,897.69	2,594,266.34	3,435,164.03
39	501,831,140.39	6.00%	6.00%	0.005143	0.00625540	3,139,156.47	2,300,059.39	839,097.07	2,576,608.51	3,415,705.58
40	498,415,434.81	6.00%	6.00%	0.005143	0.00626327	3,121,708.86	2,284,404.08	837,304.78	2,559,050.71	3,396,355.49

27

Valuing and Analyzing Fixed Income Derivatives

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Introduction

The value of a derivative instrument depends on the value of an underlying variable or process among other factors. The functional form of this dependence typically renders traditional asset pricing models, most of which are linear by design, ineffective for the valuation of derivatives. To overcome this challenge, most derivatives valuation models rely on two key assumptions. The first and most critical assumption is the absence of costless arbitrage opportunities, or *no-arbitrage pricing*, which can be defined as the law of one price for equivalent trading strategies. The second assumption of *frictionless markets* is made as a matter of convenience and requires the absence of taxes and transaction costs, unlimited borrowing/lending at a single risk-free rate, unlimited short-selling, and other unrealistic requirements (Whaley 2006). These assumptions give rise to the concept of risk-neutral pricing, which implies that the value of a derivative is determined by its expected payoff under the risk-neutral probability distribution discounted at the risk-free rate.

The time value of money is the driving principle for the importance of the risk-free rate in derivatives valuation, which requires the discounting of future expected cash flows. In the case of fixed income derivatives, the role of the risk-free rate is even more pronounced as the underlying variable's future value is also linked to the risk-free rate through its relation with other interest rates.

As such, the risk-free rate, as the building block for other interest rates, plays a key role in the valuation of derivatives. One common approach in option pricing assumes that a riskless portfolio that earns the risk-free rate can be constructed. This chapter shows other types of derivatives that also require discounting cash flows at the risk-free rate. Many traditional asset pricing models, such as the capital asset pricing model (CAPM) of Sharpe (1964), assume the returns on U.S. Treasury bills or bonds as the risk-free rate. However, these rates are not directly applicable in derivatives pricing as they tend to be artificially low due to tax and regulatory factors (Hull 2018).

Before the financial crisis of 2007–2008, the London Interbank Offered Rate (LIBOR) had been the market standard for the risk-free rate, and interest rate derivatives were valued using LIBOR discounting. Soon after the credit crisis started in the summer of 2007, LIBOR markedly diverged from other commonly used short-term market rates such as Treasury bill yields and overnight indexed swap (OIS) rates. Figure 27.1 illustrates the evolution of the well-known *TED* spread, which is defined as the difference between three-month LIBOR and three-month Treasury bill yield. TED is an acronym formed from T-bill and ED, the ticker symbol for the Eurodollar futures contract. The temporal dynamics of the TED spread exposes the credit risk vulnerability of LIBOR as a discount rate. Even though the TED spread and similarly the LIBOR-OIS spread have returned to the low pre-recession levels, the International Swaps and Derivatives Association (ISDA), which manages the standards for the ISDA Master Agreement used in OTC derivatives transactions, largely abandoned the use of LIBOR discounting in collateral calculations and adopted OIS discounting (ISDA 2013). According to Hull and White (2013), OIS discounting should be the standard for both collateralized and non-collateralized derivatives transactions. This methodology is also called a *multi-curve framework* because the cash flows are still based on LIBOR, but forward rates and discounting are based on OIS rates (Henrard 2014). This chapter presents models and examples based on this new market convention.

The remainder of the chapter is organized as follows. The next section presents an overview of OIS discounting and illustrates how it can be used to determine LIBOR forward rates. The third section provides an OIS-based valuation framework for forward rate agreements (FRA). The fourth section expands on the FRA valuation methodology and provides a detailed implementation of OIS discounting in interest rate

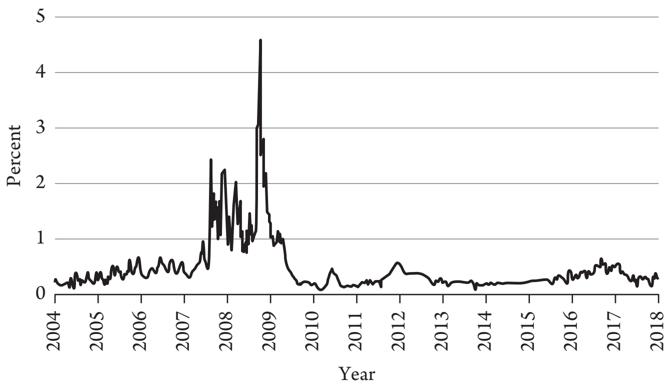

Figure 27.1 Evolution of the TED Spread between 2004 and 2018

This figure shows the spread between 3-month LIBOR based on U.S. dollars and 3-month U.S. Treasury bill yield, also known as the TED spread, which is generally considered as an indicator of the credit risk in the U.S. economy.

Source: Federal Reserve Bank of St. Louis (2018).

swap valuation while demonstrating how the swap rate can be determined. The fifth section presents the valuation and analysis of interest rate futures. The sixth section provides a detailed coverage of option pricing models applied to various interest rate derivatives. The final section offers a summary and conclusions.

OIS Discounting and Determination of LIBOR Forward Rates

The present value of a future cash flow can be computed by multiplying the cash flow and a discount factor, which requires the knowledge of the *zero rate,* also known as the *spot rate,* applicable for the date of this cash flow. When zero rates are plotted as a function of maturity, the resulting chart is called a zero (spot) curve. Zero curves are essential for the valuation of fixed income derivatives for two reasons. First, a zero curve can be used to discount future cash flows promised by the derivative. They also help derive the forward interest rates, which are used to determine the uncertain (floating) cash flows of these derivatives.

One of the most popular zero curves in international capital markets is the hypothetical Treasury zero curve. This curve is constructed from a large set of U.S. Treasury securities. A method called *bootstrapping* infers spot rates from the yields on coupon-paying instruments and is commonly used to ensure that the prices of these securities are matched against the present value of their cash flows discounted using the Treasury zero curve. For maturities with no available securities, interpolation techniques are used to ensure the continuity of the curve. As explained in the previous section, the Treasury zero curve is not usable in the valuation of fixed income derivatives.

When LIBOR was the choice of discount rate for the valuation of fixed income derivatives, the LIBOR zero curve, also called the *swap zero curve,* was produced using Eurodollar futures for maturities up to two years and interest rate swaps for longer maturities. This hybrid approach was sufficient when the TED spread was low, and the same curve was used both to compute the LIBOR forward rates in order to determine the expected cash flows and to find the present value of the cash flows.

Even though LIBOR was discredited as a risk-free rate during the financial crisis of 2007–2008, it has continued to be the main reference rate for most fixed income derivatives. As a result, the need to construct a LIBOR forward curve has remained as an important step in the valuation of such securities. Adopting OIS as the source of risk-free rates implies that two curves should be simultaneously used in the fixed income derivatives pricing. The OIS zero curve is used to discount the derivative cash flows whereas the LIBOR forward curve is used to determine the expected cash flows. The LIBOR forward curve also requires constructing the OIS zero curve because the Eurodollar futures and interest rate swaps are priced using the OIS zero curve to determine the LIBOR forward rates. As Bianchetti (2010) notes, some practitioners tend to make the mistake of computing forward rates based on LIBOR zero curve while discounting the expected cash flows using the OIS zero curve. This section concludes with an example that illustrates how LIBOR forward rates are determined using OIS discounting.

Table 27.1 **Example for Bootstrapping the LIBOR Forward Curve with OIS Discounting**

Maturity (Years) T	*Par Swap Fixed Rate* s_T *(%)*	*OIS Fixed Rate* O_T *(%)*	*OIS Discount Factor* $P_{0,T}$	*LIBOR Forward Rate* $f_{T-0.25,T}$ *(%)*
0.25	2.01	1.40	0.996512	2.0100
0.50	2.08	1.52	0.992457	2.1503
0.75	2.15	1.64	0.987849	2.2909
1.00	2.22	1.76	0.982704	2.4320
1.25	2.30	1.86	0.977045	2.6242
1.50	2.38	1.96	0.971053	2.7867
1.75	2.46	2.06	0.964608	2.9499
2.00	2.54	2.16	0.957718	3.1141

This table presents the results of a bootstrapping example in which LIBOR forward rates are obtained based on OIS discounting using the approach explained in this chapter. For simplicity of exposition, the example uses the 30/360 day count convention.

Source: Authors' calculations.

Table 27.1 provides the par swap fixed rates for three-month LIBOR swaps that are quarterly settled up to a maturity of two years. Similarly, OIS fixed rates are also presented in which only one settlement exists for the OIS with maturities up to one year. For longer maturities, quarterly settlement is assumed just like a LIBOR swap. OIS discount factors (present value of $1 received at the maturity date of the respective OIS) are found directly for the OIS with maturities up to one year and with bootstrapping for the remainder. More explicitly, assuming a simple 30/360 day-count convention, OIS discount factors are calculated using Equation 27.1:

$$P_{0,T} = \frac{1}{1 + O_T T} \tag{27.1}$$

for maturities up to one year where O_T denotes the fixed rate for a T-year OIS. For maturities beyond a year, the calculation is shown in Equation 27.2:

$$P_{0,T} = \frac{1 - 0.25 O_T \sum_{t=0.25}^{T-0.25} P_{0,t}}{1 + 0.25 O_T} \tag{27.2}$$

where 0.25 is simply the day-count factor for three months in 30/360 convention.

The three-month LIBOR rate today ($f_{0,0.25}$) is already known to be equal to the three-month par swap fixed rate ($s_{0.25}$). The three-month LIBOR forward rates for future three-month periods can be calculated with Equation 27.3:

$$f_{T-0.25,T} = \frac{0.25 s_T \sum_{t=0.25}^{T} P_{0,t} - 0.25 \sum_{t=0.25}^{T-0.25} f_{t-0.25,t} P_{0,t}}{0.25 P_{0,T}} \tag{27.3}$$

The results of these calculations are given in Table 27.1.

Valuation of Forward Rate Agreements

A *forward rate agreement* is an over-the-counter (OTC) derivative contract in which a fixed interest rate (*FRA rate*) applies to a given notional principal amount during a predetermined future period of time (*contract period*). The payoff of an FRA depends on the difference between the FRA rate and the underlying reference rate, typically LIBOR, observed at the beginning of the contract period (*fixing date*). As interest payments are typically paid in arrears, the FRA payoff is due at the end of the contract period. This payoff can be calculated using Equation 27.4:

$$L(r_L - r_K)(\tau / B) \tag{27.4}$$

where L is the notional principal; r_K is the FRA rate; r_L is the reference rate observed at the fixing date; τ is the length of the contract period in days; and B is the day count basis (360 for USD and most currencies, 365 for GBP). An FRA is usually cash-settled at the beginning of the contract period (settlement date) and the payment is equal to the present value of the amount in Equation 27.4. The market practice for computing this present value is to use the fixing rate (r_L) and the same day count convention for the payoff calculation as demonstrated in Equation 27.5:

$$L \frac{(r_L - r_K)(\tau / B)}{1 + r_L(\tau / B)} \tag{27.5}$$

Mercurio (2010) suggests that a convexity adjustment is needed if the FRA valuation is performed based on the market practice payoff given in Equation 27.5 and empirically shows that this convexity adjustment is negligible in almost all practical cases. Therefore, this chapter follows Ametrano and Bianchetti (2013) and adopts the representation in Equation 27.4 for the purpose of FRA valuation.

An FRA is typically designed by setting its value to zero at the inception. This convention is only possible if the expected payoff is zero. Therefore, the contract is constructed so that, at time zero, $r_K = r_F$, where r_F is the LIBOR forward rate for the contract period, computed at the beginning. Recognizing that this LIBOR forward rate is computed using bootstrapping based on OIS discounting explained in the previous section is essential.

For a contract entered into previously, r_K remains fixed but r_F is expected to change as the market rates continue to update. Therefore, the FRA contract no longer has a zero value. More explicitly, for the FRA buyer (i.e., fixed rate payer), Equation 27.6 gives the value of the contract after it has been initiated:

$$L(r_F - r_K)(\tau / B)P_{0,T+\tau} \tag{27.6}$$

where L is the notional principal; r_K is the FRA rate; r_F is the forward reference rate for the contract period observed at the valuation date; τ is the length of the contract period in days; B is the day count basis (360 for most currencies including USD, 365 for GBP); and $P_{0,T+\tau}$ is the OIS-based discount factor that is the present value of \$1 received on the maturity date.

This framework is next illustrated with an example in Table 27.2. As the LIBOR forward rate bootstrapped via the OIS zero curve is higher than the FRA rate, the value of this FRA is positive to the FRA buyer who pays the fixed rate.

Table 27.2 **Example for Valuation of an FRA**

Item	*Notation/Calculation*	*Value*
Notional principal	L	\$100,000,000
Days to fixing	T	90
Days in contract period	τ	90
Days in a year	B	360
FRA rate	r_K	1.75%
Forward 3-month LIBOR	r_F	2.1503%
Fixed rate on a 6-month OIS	$r_{0,T+\tau}$	1.52%
Risk-free discount factor for 6 months	$P_{0,T+\tau} = 1/\left(1 + r_{0,T+\tau}(T+\tau)/B\right)$	0.992457
Value of FRA to buyer	$L(r_F - r_K)(\tau / B)P_{0,T+\tau}$	\$99,317

This table shows how to value an existing FRA using OIS discounting explained in this chapter. The valuation is from the perspective of the long party (FRA buyer). For simplicity of exposition, the example ignores the day count convention and assumes each month has 30 days.

Source: Authors' calculations.

Valuation of Interest Rate Swaps

Interest rate swaps can be viewed as a portfolio of FRAs. Each exchange of payments is effectively an FRA in which the fixed swap rate is exchanged for LIBOR. As an FRA can be valued by assuming that the forward LIBOR rates are realized, this feature is used to value an interest rate swap. Forward LIBOR rates can be obtained using the at-market swap rates and the OIS rates via bootstrapping. Swap cash flows are then computed by assuming that LIBOR rates in the floating leg are equal to these forward rates. Finally, all cash flows are discounted at the OIS zero rates. The value of an interest rate swap at initiation (an at-market or par swap) is zero as the swap fixed rate is typically set to satisfy this relation. However, as the swap rates and market discount rates evolve, the value of an existing swap, also called an *off-market swap*, is likely to change.

This approach is illustrated in Table 27.3 for a one-year off-market interest rate swap from the perspective of the fixed rate payer. Each row of the table corresponds to the valuation of an FRA and their sum gives the value of the swap. The value of the first two FRAs are negative because the LIBOR forward rates are less than the swap fixed rate. However, as the LIBOR forward curve is upward-sloping, the remaining two FRAs have a positive value to the fixed rate payer, which raises the value of the swap to a positive level. The positive value for the payer swap is also expected as the at-market swap rate (2.22 percent) is higher than the off-market swap's fixed rate (2.20 percent). The opposite would have occurred if the fixed rate was received in the swap.

Table 27.3 **Example for Valuation of an Off-Market Interest Rate Swap**

Time (in years)	*Floating Cash Flow*	*Fixed Cash Flow*	*Net Cash Flow*	*Discount Factor*	*Present Value*
0.25	502,500	–550,000	–47,500	0.996512	–47,334
0.50	537,571	–550,000	–12,429	0.992457	–12,335
0.75	572,735	–550,000	22,735	0.987849	22,459
1.00	608,011	–550,000	58,011	0.982704	57,008
				Value of the swap	19,798

This table shows how to value an existing interest rate swap using OIS discounting for its FRA components. The valuation is done from the perspective of the fixed rate payer (2.20 percent a year). Notional principal is $100 million. For simplicity of exposition, the example ignores the day count convention and assumes each payment period is 0.25 years. First column corresponds to the payment times in years. LIBOR forward curve in Table 27.1 is used to compute the floating cash flows in the second column, which equal the notional principal times 0.25 multiplied by the LIBOR forward rate at the beginning of the three-month period. Fixed cash flows equal the notional principal times the fixed rate multiplied by 0.25. Net cash flow is the sum of the two columns preceding it. Discount factors that multiply the net cash flows to find the present value in the last column are also taken from Table 27.1. The sum of the last column gives the value of the swap.

Source: Authors' calculations.

Smith (2013) presents a general framework for the valuation of interest rate swaps using OIS discounting and provides a detailed implementation through an example comparing the contemporary result to the old practice of LIBOR discounting. Johannes and Sundaresan (2007) contend that the fixed rate for a non-collateralized swap should be higher than that for a collateralized one and provide empirical evidence in support of this claim. Their reasoning is similar to the convexity bias between Eurodollar futures-based rates and FRA-implied forward rates, a concept explained in the next section.

Interest Rate Futures Pricing

The Chicago Mercantile Exchange (CME) Eurodollar futures contract is similar to an FRA. In this respect, the futures rate implied by the Eurodollar futures price should be close to the forward rate implied by a comparable FRA. For shorter maturities (up to one year) of the futures contract, the difference is negligible (less than one basis point). However, for longer maturities, the futures rate and the forward rate can differ substantially due to both the daily settlement of futures contracts and the end-of-accrual-period payoff realization of the forward contract. The combined impact of these two forces reduces the forward rate relative to the futures rate through a phenomenon called the *convexity adjustment*. As the dominant effect that drives the convexity bias in the long-dated futures is daily settlement, it is worth exploring in some detail.

Assuming that r_C is the futures rate for a Eurodollar futures contract that has a maturity date of T, a comparable FRA is considered with a fixed rate of r_K, settlement date of T, and maturity date of $T+\tau$, where τ is the tenor of the underlying rate (equal to 0.25 years or 90 days in the 360-day convention for the Eurodollar futures contract). If these two rates were equal, the futures contract that is daily settled would have led to a much higher payoff as these rates subtracted from the realized market rate are reinvested in the daily settlement process. As such, the market sets a higher futures rate than the forward rate.

Based on Hull (2018), the theoretical difference between futures and forward rates can be approximated by Equation 27.7:

$$r_C - r_F = \frac{\sigma^2 T(T+\tau)}{2} \tag{27.7}$$

where σ is the standard deviation of the change in the short-term interest rate in one year. Convexity bias for various contract maturities is computed in Table 27.4. As previously mentioned, the convexity adjustment is less than one basis point for maturities up to one year, whereas longer maturities have increasingly larger differences.

Unlike other futures contracts, determining the exact theoretical futures prices for CME's Treasury note/bond futures is impossible because the short party has two options. The short may choose which bond to deliver (delivery option) and when to deliver it during the expiration month (timing option). As the exchange announces the conversion factors daily, identification of the cheapest-to-deliver bond occurs by determining the lowest price-to-conversion-factor ratio. As Tuckman and Serrat (2012) note,

Table 27.4 **Convexity Adjustment between Futures and Forward Rates**

Maturity (Years)	***Convexity Bias (Basis Points)***
0.25	0.09
1	0.90
2	3.24
5	18.90
10	73.80

This table shows the approximate convexity bias between futures and forward rates (in basis points) for three-month LIBOR contracts with selected maturities. Each line corresponds to a three-month Eurodollar futures contract and its FRA counterpart. Similar to Hull (2018), a Ho-Lee-type interest rate model is assumed with a volatility parameter (σ) of 1.2 percent.

Source: Authors' calculations.

the timing option does not appear to have a significant value in practice. Therefore, assuming the cheapest-to-deliver bond and the delivery date are both known, the quoted futures price for a Treasury bond futures contract would be based on the standard cost-of-carry formulation for investment assets providing a known dollar income as shown in Equation 27.8:

$$F_{0,T} = \left(\frac{B_0 + A_0 - C_{[0,T]}}{P_{0,T}} - A_T \right) \Big/ V_{0,T} \tag{27.8}$$

where B_0 is the current quoted price of the underlying bond; $C_{[0,T]}$ is the present value of all coupons that this bond will pay until the delivery date of the futures contract; and $V_{0,T}$ is the conversion factor for this bond as of time 0. A_0 and A_T are accrued interest at times 0 and T needed to convert quoted prices to cash prices for the spot and futures prices, respectively. As the bond/note futures have shorter maturities compared to Eurodollar futures, the convexity bias between bond futures and forwards is negligible compared to that observed in short-term interest rate contracts (Tuckman and Serrat 2012).

Much like a forward contract, a futures contract has a zero value when a position has just been established. As the trading continues and the prevailing futures price changes on the exchange, this value deviates from zero. However, due to the daily settlement process through marking-to-market, at the end of the first trading day, the value of the contract computed as the difference between the daily settlement price and the trade price is reflected in the trader's margin account and the futures value reverts to zero. On each of the following trading days, the daily gain or loss is computed as the difference between consecutive daily settlement prices. As an example, consider the three-month Eurodollar futures contract with December 2018 maturity (CME symbol: GEZ2018). An investor takes a long position in 10 units of this contract on January 25, 2018, when the quoted price was 97.65, which corresponds to a futures rate of 2.35 percent. The settlement price at the end of the day was 97.68. The quoted price is higher, which means that the implied futures rate is lower at 2.32 percent. Since a one-basis-point move implies a $25 change in a contract's value, the investor gains $750. This value can be computed using Equation 27.9:

$$10 \times 25 \times (9768 - 9765) = \$750 \tag{27.9}$$

This gain is reflected in the investor's margin account and the value of the position goes back to zero. The settlement price on January 26, 2018, was 97.64. Assuming that the investor kept his position, the daily loss is $1,000 due to the four basis point (bp) move in the unfavorable direction. As this example illustrates, a long position in the Eurodollar futures is effectively a short position in LIBOR benefiting from rate decreases.

Valuation of Fixed Income Options

The best-known option valuation model is the Black-Scholes-Merton (BSM) model, which was originally developed for European equity options (Black and Scholes 1973; Merton 1973). One of the developers of the BSM model, Fischer Black, later proposed a modified version of the BSM model that applies to European options on futures (Black 1976). Black's model, as it is often referred to in the literature, is perceived to be so versatile that it has become the standard model in the valuation of various fixed income options as well as an alternative to the BSM model for spot currency and equity options.

Black's model assumes that the value of the underlying variable is lognormally distributed at the option's maturity. Even though this assumption is internally consistent for an underlying even under OIS discounting, it is not consistent across various fixed income underlying variables. For example, if future interest rates are lognormally distributed, future bond prices cannot be lognormally distributed. Despite this general inconsistency, practitioners widely use Black's model, although it can be modified in some cases. A common practice for options whose underlying variable is an interest rate is to assume a normal distribution, which has become even more popular when negative interest rates became a common feature due to the monetary policy response after the financial crisis of 2007–2008. A standard lognormal distribution does not allow negative interest rates.

Before OIS discounting, numerical models that represent the future evolution of interest rates or bond prices as binomial or trinomial trees were quite popular. Ho and Lee (1986) propose the first such model using a normal distribution assumption. Hull and White (1994) extend this model within a trinomial tree by further assuming the mean-reversion of interest rates. Black, Derman, and Toy (1990) propose a binomial tree for a mean-reverting lognormally-distributed interest rate. The need for modeling OIS rates jointly with LIBOR has created a major challenge for these models. Hull (2018) suggests building OIS rate trees using one of these models and setting the spreads between the OIS and LIBOR at future dates equal to the current forward spreads. Hull and White (2016) propose a novel approach and model the OIS rate and LIBOR on a three-dimensional tree. Although these lattice models are quite useful for the valuation of American options, their complex nature typically relegates them to the second choice after BSM-type models. This chapter adopts the same strategy and presents formulas based on the Black model.

Valuation of Bond Options

Although Chapter 25 presents the valuation of bonds with embedded options, this chapter provides insights on how Black's model applies to OTC European bond options. In this context, a bond's forward price at the option's expiration date is assumed to be lognormally distributed with a price volatility parameter of σ_B. This assumption results in Equations 27.10 and 27.11 for the value of European call (c) and put (p) options on a bond, respectively:

$$c = P_{0,T}[F_{0,T}N(d_1) - KN(d_2)] \tag{27.10}$$

$$p = P_{0,T}[KN(-d_2) - F_{0,T}N(-d_1)] \tag{27.11}$$

where d_1 is defined by Equation 27.12:

$$d_1 = \frac{\ln\left(F_{0,T}/K\right) + \sigma_B^2 T/2}{\sigma_B\sqrt{T}} \tag{27.12}$$

and d_2 is defined by Equation 27.13:

$$d_2 = \frac{\ln\left(F_{0,T}/K\right) - \sigma_B^2 T/2}{\sigma_B\sqrt{T}} = d_1 - \sigma_B\sqrt{T} \tag{27.13}$$

In these equations, the function $N(x)$ represents the cumulative probability distribution function for variable x with a standard normal distribution. Furthermore, T denotes time to expiration for the option (in years), $P_{0,T}$ is the OIS-based (risk-free) discount factor for time T, which is the present value of $1 received on the expiration date. K is the strike price and is expected to be input as the dirty price (cash price). In other words, if the option terms specify the strike price as the bond's clean price (quoted price), K should be set equal to this price plus the accrued interest at the option's expiration date.

As in Hull (2018), the forward price of the bond, $F_{0,T}$, can be calculated using the standard cost-of-carry formula in Equation 27.14:

$$F_{0,T} = \frac{B_0 - C_{[0,T]}}{P_{0,T}} \tag{27.14}$$

where B_0 is the current spot price of the underlying bond and $C_{[0,T]}$ is the present value of all coupons to be paid by this bond during the option's life. As with the strike price, both the bond's spot and forward price are expected to input as dirty prices.

As with all option pricing models, volatility (σ_B) is the most critical parameter in Black's model when applied to the bond options. Due to the underlying lognormal distribution assumption that applies to the bond price at option expiration, σ_B can be estimated by dividing the standard deviation of the natural logarithm of the bond price at option expiration by the square root of T, hence annualizing this standard deviation. Naturally, this assumption of time invariance also implies that the choice of σ_B for an option on a particular bond should depend on the life of the option. As pointed out in the earlier chapters, the price uncertainty of a bond is zero at its maturity since its price would be equal to its face value. This phenomenon, also called the *pull-to-par effect*, implies that σ_B is typically a decreasing function of an option's life for a given bond. This nonconstant volatility over the option's life makes Black's formula less attractive from a practical perspective in terms of its general applicability. Haug (2007) contends that investors should use Black's formula for pricing European bond options only for those options with short lives relative to the bond's time to maturity. He also explains that some traders adopt a general rule in which the option's life should be less than one-fifth of the time to maturity on the underlying bond.

Traders often quote an option's implied volatility rather than its price. This practice occurs because the implied volatility is less variable than an option's price, which can change due to many other factors, including the passage of time. Because σ_B is not a stable measure of volatility, traders often quote the yield volatility for bond options. The quoted yield volatility is then converted into the price volatility before using it in Equations 27.10 or 27.11. This conversion is achieved by approximating the price-yield relation through duration, a concept introduced in earlier chapters. More specifically, the following approximate relation in Equation 27.15 holds:

$$\sigma_B = D_M y_0 \sigma_y \tag{27.15}$$

where D_M is a bond's modified duration at option expiration, y_0 is a bond's forward yield, and σ_y is the forward yield volatility.

Valuation of Interest Rate Caps and Floors

An *interest rate cap* with n payment dates is effectively a portfolio of n interest rate call options, each of which is called a *caplet*. Similarly, an *interest rate floor* is equivalent to a portfolio of interest rate put options called *floorlets*. In this respect, the value of a cap (floor) is the sum of the values of its caplets (floorlets). Therefore, this section focuses on the valuation of caplets and floorlets.

The payoff for each caplet/floorlet is determined on its *reset date*, which is technically the expiration date of this European put/call option on the floating interest rate. However, this payoff is received by the cap/floor buyer at the end of the accrual period that begins on the reset date and is equal in length to the tenor of the underlying rate. For example, for a cap on three-month LIBOR, payments determined on a reset date are received three months after that date. Given these features, the payoff for a caplet is shown in Equation 27.16:

$$L\tau \max(r_{T,T+\tau} - r_K, 0) \tag{27.16}$$

where L is the notional principal; τ is the length of the accrual period matching the tenor of the underlying interest rate in years (0.25 for three-month LIBOR ignoring the day count convention); T is the reset date in years from today; r_K is the cap rate; and $r_{T,T+\tau}$ is the spot value of the underlying interest rate on the reset date.

Using the same notation and assuming the cap rate and floor rate are the same, the payoff for a floorlet is shown in Equation 27.17:

$$L\tau \max(r_K - r_{T,T+\tau}, 0) \tag{27.17}$$

Assuming the forward LIBOR rates on the reset date are lognormally distributed with a volatility of σ_f, the Black price for a caplet is shown in Equation 27.18:

$$L\tau P_{0,T+\tau}[f_{T,T+\tau} N(d_1) - r_K N(d_1)] \tag{27.18}$$

where d_1 is defined by Equation 27.19:

$$d_1 = \frac{\ln\left(f_{T,T+\tau}/r_K\right) + \sigma_f^2\, T/2}{\sigma_f \sqrt{T}} \tag{27.19}$$

and d_2 is defined by Equation 27.20:

$$d_2 = \frac{\ln\left(f_{T,T+\tau}/r_K\right) - \sigma_f^2\, T/2}{\sigma_f \sqrt{T}} = d_1 - \sigma_f \sqrt{T} \tag{27.20}$$

In Equations 27.18, 27.19, and 27.20, $f_{T,T+\tau}$ denotes the current forward rate with a tenor of τ years on the reset date. The discount factor, $P_{0,T+\tau}$, reflects the lag between the payment date and the reset date. For the same set of parameters, the value of a floorlet is given in Equation 27.21:

$$L\tau P_{0,T+\tau}[r_K N(-d_2)-f_{T,T+\tau}N(-d_2)] \tag{27.21}$$

Each caplet in a cap, and similarly, each floorlet in a floor, is valued separately using these equations. If each caplet or floorlet is valued using a different volatility, these measures are referred to as *spot volatilities*. If the same volatility is used for all the components in a given cap (floor) even though it may change across caps (floors) with different maturities, these measures are known as *flat volatilities*. Spot volatilities can be extracted from flat volatilities using bootstrapping, similar to zero curve construction, resulting in the term structure of caplet volatility. Although traders usually quote the flat volatilities, they are still interested in spot volatilities in order to identify mispriced caplets (floorlets). They do so by comparing the spot volatilities used for caplets (floorlets) on three-month LIBOR against those calculated from the prices of Eurodollar futures put (call) options.

A *collar* is constructed by combining a long cap with a short floor. Therefore, the price of a collar is equal to the price of a cap minus the price of a floor. Typically, the cap and floor rates are chosen to set the price of the cap equal to that of the floor, making the collar a zero-cost instrument. Furthermore, for a cap/floor pair with the same cap/floor rate, r_K, a long cap and a short floor is equivalent to a nonstandard swap, where LIBOR is received in exchange for fixed r_K and no payment occurs on the first reset date.

The negative interest rate environment faced during the post-financial crisis of 2007–2008 era prompted many traders to seek alternatives to Black's model, which does not allow negative rates. Hull (2018) recognizes the shifted lognormal model as a reasonable alternative. The shift parameter, α, which may depend on the maturity of the cap/floor when used with flat volatilities, is added to both $f_{T,T+\tau}$ and r_K. Tuckman and Serrat (2012) maintain that many traders assume normally distributed forward interest rates, which results in the Bachelier normal model. In this framework, the price of a caplet can be computed using Equation 27.22:

$$L\tau P_{0,T+\tau}\left[(f_{T,T+\tau}-r_K)N(d)+\frac{e^{\frac{-d^2}{2}}\sigma_f^*\sqrt{T}}{\sqrt{2\pi}}\right] \tag{27.22}$$

where d is defined by Equation 27.23:

$$d=\frac{f_{T,T+\tau}-r_K}{\sigma_f^*\sqrt{T}} \tag{27.23}$$

Similarly, the price of a floorlet is formulated in Equation 27.24:

$$L\tau P_{0,T+\tau}\left[(r_K - f_{T,T+\tau})N(-d) + \frac{e^{\frac{-d^2}{2}}\sigma_f^*\sqrt{T}}{\sqrt{2\pi}}\right] \tag{27.24}$$

The volatility parameter for the Bachelier normal model, σ_f^*, is not the same as the volatility parameter for the Black lognormal model, σ_f.

Valuation of Swaptions

As the majority of the swaptions available on global markets do not allow for early exercise, this section focuses on the valuation of European swaptions. Depending on the nature of the underlying swap, two types of European swaptions are available. A *payer swaption* gives the purchaser the right to enter an interest rate swap as the fixed rate payer and floating rate receiver. Conversely, the buyer of a *receiver swaption* would have the right to receive fixed and pay floating in the swap.

Although a payer swaption may look similar to an interest rate cap, an important distinction exists between these two fixed income derivatives. A *cap* is a portfolio of options on interest rates (caplets) and can be exercised multiple times (once for each caplet). Conversely, a payer swaption is a single option on the swap rate with multiple payoffs and can be exercised only once. Therefore, although the valuation of an interest rate cap requires summing the values of multiple options, a single option pricing is appropriate for swaptions. A similar comparison applies for receiver swaptions and interest rate floors.

To properly apply Black's model to European swaptions, the swap rate for the underlying swap at the swaption's maturity date is assumed to be lognormally distributed. The *swap rate* is the average of the market quoted bid and ask fixed rates that would be exchanged for LIBOR. Given a maturity of T years and an underlying swap with a tenor of M years, a payer swaption is exercised if the strike rate, s_K, is less than the swap rate at the maturity of the swaption, s_T. If the impact of day count conventions is ignored, exercising this swaption would result in receiving a constant periodic cash flow (i.e., an annuity) in Equation 27.25:

$$L\tau\max(s_T - s_K, 0) \tag{27.25}$$

where τ is the maturity of the underlying floating rate of the swap in years (e.g., 0.25 for three-month LIBOR). This cash flow would be received for M years, so a total of M/τ payments would occur. As a result, the price of the payer swaption can be calculated using Equation 27.26:

$$L\tau A(T,\tau,M)[s_F N(d_1) - s_K N(d_2)] \tag{27.26}$$

where d_1, d_2, and $A(T,\tau,M)$ are defined by Equations 27.27, 27.28, and 27.29, respectively.

$$d_1 = \frac{\ln\left(s_F/s_K\right) + \sigma_s^2 T/2}{\sigma_s\sqrt{T}} \tag{27.27}$$

$$d_2 = \frac{\ln\left(s_F/s_K\right) - \sigma_s^2 T/2}{\sigma_s\sqrt{T}} = d_1 - \sigma_s\sqrt{T} \tag{27.28}$$

$$A(T,\tau,M) = \sum_{i=1}^{M/\tau} P_{0,T+i\tau} \tag{27.29}$$

where s_F is the forward swap rate at time zero; σ_s is the volatility of this forward swap rate; and $A(T,\tau,M)$ is the present value of \$1 received at every payment date for the underlying swap (starting at $T+\tau$ and ending at $T+M$ years).

Using the same line of reasoning, the value of a receiver swaption can be computed using Equation 27.30:

$$L\tau A(T,\tau,M)[s_K N(-d_2) - s_F N(-d_1)] \tag{27.30}$$

To accommodate the presence of negative interest rates, Hull (2018) contends that the shifted lognormal model or the Bachelier normal model can be used much like in the case of caps and floors. As Tuckman and Serrat (2012) note, the normal model fails to match the skew/smile shape of the market implied volatilities as the volatility is assumed to be constant across the strike rates. They also show that Black's model combined with a stochastic volatility model such as SABR (stochastic alpha, beta, rho) proposed by Hagan, Kumar, Lesniewski, and Woodward (2002) can be effective in matching the volatility skew/smile.

Valuation of Options on Short-Term Interest Rate Futures

Black's model can also be effectively used to price exchange-traded options on interest rate futures. Options on Eurodollar futures that trade on the CME are American-style options. According to Tuckman and Serrat (2012), exercising these options early would be optimal only when they are deep in-the-money. Therefore, practitioners still use Black's formula even though it does not strictly apply to American options. In this respect, they sometimes adjust the volatility input upward.

Although the futures price is quoted as $F = 100 - 100r_C$, where r_C is the futures rate corresponding to the three-month LIBOR, modeling the futures price is not desirable for the valuation of options on Eurodollar futures. In the absence of negative interest rates, the futures price is bounded above at 100 and is not a good variable choice for lognormal or normal distributions as it is also bounded below at zero. Therefore, in the spirit of the Black model, r_C is assumed to be lognormally distributed with an annualized volatility of σ_C. This variable change implies that a call option contract on Eurodollar futures contract is a put option on the corresponding futures rate. Using the same line of reasoning, the strike price of the futures option (K) is converted into a strike rate (r_K) using the following equivalence, $K = 100 - 100r_K$. Finally, the Black price for a call option on Eurodollar futures can be computed as shown in Equation 27.31:

$$\$250{,}000 P_{0,T}[r_K N(-d_2) - r_C N(-d_1)] \tag{27.31}$$

where d_1 is calculated using Equation 27.32

$$d_1 = \frac{\ln\left(r_C/r_K\right) + \sigma_c^2\, T/2}{\sigma_C\sqrt{T}} \tag{27.32}$$

and d_2 is calculated using Equation 27.33.

$$d_2 = \frac{\ln(r_C/r_K) - \sigma_C^2\, T/2}{\sigma_C\sqrt{T}} = d_1 - \sigma_C\sqrt{T} \tag{27.33}$$

Similarly, the Black price for a put option on Eurodollar futures can be obtained using Equation 27.34:

$$\$250{,}000 P_{0,T}[r_C N(d_1) - r_K N(d_2)] \tag{27.34}$$

In the previous equations, T denotes the option expiration date in years and the multiplier \$250,000 is needed to compute the contract's dollar value. This multiplier is the product of 10,000, needed to convert the decimal rate to basis points, and \$25, which is the dollar change in the contract value for each basis point change in the futures price.

Short-term interest rate options that trade on the Intercontinental Exchange (ICE), such as options on three-month Euribor futures, do not have premiums paid at the time of purchase. Instead they are settled-to-market daily with futures-style margining. Even though these are specified by ICE as American options, Tuckman and Serrat (2012) show that they should never be exercised early and, therefore, are equivalent to European options. For this reason, Black's model would be quite satisfactory but would need to be modified to address the absence of an up-front premium payment. Asay (1982) provides this simple modification and gives the price of a futures-style call option on short-term interest rate futures as shown in Equation 27.35

$$€250{,}000[r_K N(-d_2) - r_C N(-d_1)] \tag{27.35}$$

Similarly, the price of a futures-style put option on short-term interest rate futures is shown in Equation 27.36:

$$€250{,}000[r_C N(d_1) - r_K N(d_2)] \tag{27.36}$$

As in the case of options on Eurodollar futures, interest rates are assumed to be lognormally distributed and d_1 and d_2 are defined as equations 27.32 and 27.33, respectively.

Tuckman and Serrat (2012) provide formulas for options on Eurodollar futures based on the normal distribution assumption of the Bachelier normal model. These formulas are similar to Equations 27.22, 27.23, and 27.24 but require a different volatility parameter to be estimated.

Valuation of Options on Treasury Note/Bond Futures

Black formulas for OTC European bond options introduced in Equations 27.10 and 27.11 can be applied to CME options on Treasury note/bond futures with some success. An important requirement is the independence of the discount factor and the futures price of the bond at the expiration date of the option. This assumption is reasonable for short-term options on long-term bond futures. However, some caveats exist in addition to those already mentioned for the European bond options.

CME futures options are American style, which makes the Black model unattractive at first. However, as Tuckman and Serrat (2012) note, options on futures are exercised early only when they are deep-in-the money. Therefore, Black's formula can be a reasonable approximation. CME Treasury note/bond futures carry two embedded delivery-related options held by the short party. However, the Black model assumes that these delivery options do not exist. Although reasonable in a low-interest-rate environment where delivery options would be out-of-the-money, practitioners often challenge this assumption. As a result, they usually prefer lattice-based models.

Summary and Conclusions

This chapter provides a comprehensive overview of valuation models for the major types of fixed income derivatives. Before the financial crisis of 2007–2008, LIBOR served as the risk-free rate in the valuation of these instruments. The widening spread between LIBOR and other less risky rates during that period has dramatically changed how various models are implemented. In this respect, the chapter begins with OIS discounting and presents a practical example for obtaining the LIBOR forward rates.

Valuation of a forward rate agreement is also presented with a detailed example as this methodology serves as the building block for the interest rate swap valuation in the following section. Both the similarities and differences among the FRAs and short-term interest rate futures are acknowledged as well as how they impact the forward and futures rates. Important option-like features of CME's Treasury futures are also explained.

The majority of the chapter is devoted to the valuation of fixed income options as these products are much more complex than futures, forwards, and swaps. The versatile Black model is presented and its variants are explained for OTC instruments such as bond options, caps, floors, and swaptions, as well as options on futures. Due to the presence of negative interest rates after the financial crisis of 2007–2008, the Black model had to be modified in practice. These alternative models are also discussed when their use is appropriate.

Valuation and analysis of fixed income derivatives have become more challenging and complex due to market developments in the past decade. As more changes are expected, such as a replacement for LIBOR, this area is likely to continue to be an active domain for academics and practitioners who are interested in developing accurate pricing models.

Discussion Questions

1. Discuss how fixed income derivatives valuation has changed as a result of the interest rate market dynamics during and after the financial crisis of 2007–2008.
2. Identify the differences between the valuation of forward rate agreements and short-term interest rate futures contracts.
3. Identify the differences between the valuation of European OTC bond options and options on Treasury bond futures.
4. Discuss the need for alternatives to the Black model as applied to different types of fixed income options.

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PART VII

SPECIAL TOPICS

28

Credit Analysis and Ratings

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Introduction

At its core, traditional commercial banking is about providing clients with financial products to help operate their businesses. The product that often initially attracts clients to banks is the typical business loan, also referred to as an extension of credit. An extension of credit is a mutually beneficial relationship between the client and the lender. As a result, the client does not have to use its cash reserves to fund its operations, but instead pays the lender interest on this debt. Although the cash flow received from borrowers has limited upside compared to an equity investment, it stems from a relatively low-risk investment.

All financial investments incur an opportunity cost. An investor using cash for one investment cannot use it for another alternative. The difference in the rate of return between these two investments is the *opportunity cost* of the investment. Credit analysis aids investors (lenders) in determining which investments (clients) merit allocating capital (extending credit).

Credit analysis proceeds from a holistic view of a company encompassing both qualitative and quantitative aspects. Each aspect of the analysis is important in arriving at a decision about a company's creditworthiness. This chapter reviews the five Cs of credit analysis (i.e., capacity, capital, collateral, conditions, and character), business and industry analysis, financial metrics, and ratio analysis, followed by a decision about whether to lend to a company. It also discusses rating agencies and their role in the credit analysis process. Credit analysis helps to assess the risk of lending and the appropriate return from taking on the risk. Theoretically, a lender with unlimited capital could always find a way to fund profitable opportunities.

Five Cs of Credit

When contemplating a starting point for credit analysis, five overarching principles are paramount. These principles are called the five Cs of credit analysis: capacity, capital, collateral, conditions, and character. Lenders use the five Cs of credit as a framework to gauge the creditworthiness of potential borrowers, and estimate their chance of default. If an analyst reviews a company with these elements as the backdrop, the factors that drive potential business success as a strong borrower should be clear.

Capacity

Does a company have enough liquidity and flexibility to take on new debt and/or service both existing debt and other debt-like obligations such as leases? Assessing capacity requires the analyst to review a minimum of the three most recent financial statements of a firm, including the income statement, balance sheet, and cash flow statement. Identifying historical trends across financial statements is important. The goal of capacity analysis is to detect any trends affecting the company's financial performance and how these trends may negatively affect future debt and interest repayment. Although the past is not necessarily an indicator of future performance, lending decisions are inherently rooted in quantitative analysis of the company management's ability to keep the business healthy over long periods with sufficient capital and liquid assets.

Capital

How much has management invested or reinvested in the business? This question can be answered by analyzing the investing section of the cash flow statement. If annual operating cash flows are allocated toward investment in capital machinery for a cutting-edge semiconductor manufacturer, this action is probably a good sign of sufficient capital investment. However, an analyst should also note if the company distributes excess capital to shareholders in the form of cash dividends or share repurchases. How much of the cash flow does the business retain? Analysts should also conduct analysis to examine interest and debt service coverage ratios, particularly relative to industry peers and norms. For smaller or middle-market sized businesses, analysts should be keenly aware of the level of the owners' investment in the business. In general, owners with an investment in the business are often more cautious in running the company than managers who have no ownership stake.

Collateral

What are the company's assets that can be reasonably seized and liquidated in the event of non-repayment? *Collateral* is a mechanism for the lender to secure a loan with a cushion against losses as the borrower pledges assets to the lender in the event of default. This assignment of assets to a lender is called a *lien*. The type and tenor of the debt determines the collateral used to secure that debt. For example, a house can be used as collateral on a mortgage because the long-term mortgage finances a property with a useful life at least as long as the tenor of the debt. Determining appropriate assets that could be used to collateralize a loan requires reviewing the balance sheet for line items such as marketable securities, accounts receivable, inventory, property, plant, and equipment, intellectual property, and trademarks. If structured correctly, the lender could use a lien placed on these types of assets in the event of default to repay outstanding debt.

Conditions

What is the intended use of the financing? Although the lender gives some latitude to the borrower, the funds should generally align with the expected source of repayment. If the borrower is using the loan proceeds to finance working capital, the funds should be used toward accumulating product inventory, which is then transferred to customers as accounts receivable that are eventually collected as cash payments. These cash proceeds would then pay down the loan. Additionally, general economic conditions and industry dynamics could affect the borrower's business. For example, if the borrower is taking out a loan to pay a one-time special dividend to private equity owners when the economy is in decline, the analyst would highlight this issue in the credit analysis.

Character

What is the managerial acumen of the company's leaders and/or owners? The key factor here is a qualitative assessment of the level of trustworthiness inspired by company management. These individuals are the ones who are responsible for making repaying stakeholders a priority or directing the business in another direction less beneficial to lenders. An analyst should review the background of the company and its owners, obtain references from vendors, clients, and employees, and ultimately determine their level of confidence in managers and/or owners. Although no quantitative analysis can precisely evaluate character, an analyst can obtain qualitative signals that can be analyzed such as character references that can influence a credit decision.

The Five Cs Case Study

For this brief case study, consider a national apparel retailer generating 80 percent of its sales from brick-and-mortar stores across the country with its online business generating the remainder. The company is actively reducing its capital expenditures (capex) on stores and shifting its focus to its e-commerce division. In contrast, industry competitors are increasing capex across both stores and e-commerce to attract more customers. The company is asking a bank for a $100 million loan. It plans to use the proceeds of the loan to pay a special one-time dividend of $50 million to its private equity owners and to invest the remaining $50 million into a new store concept. The footnotes indicate the firm has $20 million in annual operating leases. The private equity owner receives dividends every two years. The company generates positive *free cash flow* (FCF), driven by decreasing capital expenditures and extending payment terms to vendors. The private equity firm wants to reduce its exposure to the retail industry, reflecting the migration of customers from brick-and-mortar stores to online e-commerce. Customers are also migrating to retailers that stock new products every week and have lower prices. What decision should a lender make about extending $100 million to this company using the five Cs? Tables 28.1, 28.2 and 28.3 highlight the balance sheet, income statement, and cash flow statement, respectively. Broadly, credit analysts will use the balance sheet along with its associated footnotes to examine the firm's assets and liabilities. They will also use the income statement to assess the revenues and expenses of the firm and analyze the statement of cash flows to determine patterns of cash flow generation and uses.

Using the five Cs, the analyst makes the following notes:

- *Capacity.* The balance sheet shows no debt for the past three years. However, the footnotes section of the annual report indicates $20 million in annual operating leases. Further analysis of the footnotes indicates that the company has no pension

Table 28.1 **Five Cs in Practice: Balance Sheet**

Assets		*Liabilities*	
Current Assets		**Current Liabilities**	
Cash	20	Accounts payable	20
Inventory	40	**Owner's Equity**	80
Long Term Assets			
Net property, plant, and equipment	40		
Total	100	Total	100

This table presents selected information from the balance sheet used in the five Cs (capacity, capital, collateral, conditions, and character) case study (all figures are in $ millions).

Table 28.2 **Five Cs in Practice: Income Statement**

Revenue and Profits	*2015*	*2016*	*2017*
Sales	850	800	750
Operating profit	100	90	85
EBITDA	125	110	100
Expenses			
Annual operating leases	30	25	20
Depreciation and amortization expense	25	20	15

This table presents selected information from the income statement used in the five Cs case study (all figures are in $ millions).

Table 28.3 **Five Cs in Practice: Cash Flow Statement**

Cash Flows	*2015*	*2016*	*2017*
Cash from operations	20	25	$30
Cash from investments	–15	–10	–5
Cash from financing	–5	0	–20

This table presents selected information from the cash flow statement used in the five Cs case study (all figures are in $ millions).

obligations, lawsuits, or other outstanding financial obligations. Operating leases are included as part of total debt for the company, reflecting a mandatory financial payment over the 10-year life of the lease term. The company currently has a debt-to-total capital ratio of 20 percent ($20 million in debt/$100 million in capital) and a rent-adjusted debt to adjusted earnings before interest, taxes, depreciation, amortization, and rent (EBITDAR) of 1.3 times. The debt-to-capital ratio is well-below the retail industry average of 43 percent (Damodaran 2017) for a cyclical industry that appears to be facing fundamental shifts in customer buying behavior. The rent-adjusted debt to EBITDAR is below the industry average of 2.12 times (Global Credit Services 2017). Hence, the company has the capacity to take on additional debt, and the lender would view the risk profile of the company as consistent with other peers in its industry.

- *Capacity.* After reviewing the income statement, the analyst observes sales, operating, and earnings before interest, taxes, depreciation, and amortization (EBITDA) margins have decreased over the past three years. The apparel sector of the retail industry is consolidating among quick-turnover fashion merchandise and low-cost retailers compared to seasonal and full-priced merchandise retailers. As a result, the lender would want to assess whether the company can continue to generate sufficient EBITDA to repay its obligations.
- *Capacity.* The cash flow statement indicates that FCF (cash from operations less capital expenditures) is positive and increasing over the past three years. Moreover, this increase results from both an increase in operating cash flow and from decreases in capital expenditures. Cash from operations is also growing but at a much slower rate than FCF because the company is delaying paying its vendors and suppliers. The inventory balance is declining, in line with the decrease in sales. This pattern could indicate further revenue declines because of insufficient stock on hand. Collectively, this pattern is troublesome because it could indicate that the increases in FCF are temporary and are not sustainable. The company is reducing its capex on its brick-and-mortar stores and is spending more on its website and e-commerce divisions every year. This pattern raises a potential red flag as retail stores generate 80 percent of the company's business. The growth in e-commerce cannot offset the weakness in its core stores division. These factors raise further concerns indicating a fundamental shift in the firm's business mix.
- *Capital.* The company has a total debt-to-assets ratio of only 20 percent (i.e., $20 million in liabilities relative to $100 million of assets). When combined with the

relatively high level of liquid assets, creditors are likely to have very high recovery rates in the event of a default.

- *Collateral.* The company has $20 million in cash, $40 million in inventory, and $40 million in property, plant, and equipment. With only $20 million in liabilities, the firm appears to have adequate collateral, with cash equal to total liabilities, and combined cash and inventory almost three times liabilities.
- *Conditions.* The company has no restrictions on using its assets. However, its industry is undergoing consolidation with a few large, well-funded competitors. The company is obligated to pay a dividend every other year to its private equity investors. The increased price competition from industry consolidation could result in shrinking margins and cash flows. The lack of restrictions on asset use in conjunction with the dividend commitment raises the possibility of asset liquidations being used to fund higher dividends.
- *Character.* The private equity owners focus on financial performance. They want to exit the apparel sector within the retail industry, given the changing consumer behavior and increasing competitive outlook. These factors further increase the possibility of higher-than-warranted dividends. This possibility could be exacerbated by declining business prospects within the retail sector that could make the owners more focused on cash payouts than reinvesting in the firm.

Although the firm appears to be currently well capitalized and has sufficient collateral, several factors make an unrestricted $100 million loan to this company a risky proposition. These factors include the owners' history of biannual dividend payouts, questions about the sustainability of increases in FCF, increased levels of competition from online retailers, and the private equity owners' intentions of exiting the retail industry. The lender could mitigate the risk from these factors by lending a smaller amount and placing covenants in the loan that limit dividend payments, limiting the use of the loan proceeds to working capital or new capital investments, limiting asset sales, and/or requiring the firm to maintain credit ratios above predetermined levels.

Business and Industry Analysis

The next two sections of this chapter provide a framework for a qualitative assessment of a company within a given industry, for without context, financial analysis is almost meaningless. Qualitative factors are the bow upon which the arrow of analytics and credit statistics rest. High "financial" risk may be offset with low business risk over the projected time period.

Qualitative assessment includes analysis of a firm's direct competitors, ranking within their peer group, economic climate, management staff, state of the industry, and other factors. Analyzing these factors allows an analyst to determine downside risks that may affect the company's ability to produce cash flow needed to meet its financial obligations.

Qualitative and quantitative analysis are complements rather than substitutes. A responsible credit decision cannot be made solely on the basis of one type of analysis. Companies that fail to meet their obligations are likely to do so not only because of a lack of liquidity or poor cash flow, but also because these factors are combined with the loss of a key management executive, a shift in industry, or an economic downturn.

Qualitative analysis is something of an art and mixes well with the science of the quantitative analysis. Ambiguity in today's world as the result of acceleration in technological advancement, globalization of world markets, the political environment and resulting regulatory pressure, and even forces such as terrorism at home and abroad may have a lasting impact on the creditworthiness of a company.

The objective of these sections is to provide a starting point for qualitative analysis. The analyst must then determine the critical issues and the degree of research required to provide comfort in the potential ability of the company to take on debt.

Business Analysis

Business analysis is often intertwined with industry analysis because they are closely related. An analyst should evaluate a company's operations within its industry context. As such, business analysis touches upon current industry conditions and attempts to anticipate structural shifts. The key focus of this analysis is whether the firm takes the necessary precautions to mitigate risk factors and achieve critical success factors.

Cash Conversion Cycle

As illustrated in Figure 28.1, the cash conversion cycle involves the company's acquisition of raw materials, the paying off of suppliers/vendors, subsequent conversion to finished goods, sale of these goods, and ultimately the collection of cash from customers. This cycle is unique to each company, depending on its business model, and provides valuable insight on the basic operations of the enterprise. For example, a pizza store has a cash conversion cycle of about a day while an airline manufacturer's cycle could be several years. The cash conversion cycle reflects what can be categorized into four main categories of risks: supply, production, demand, and collection.

Supply risks are those factors that would inhibit or completely deter a business from obtaining raw materials at competitive or even reasonable prices. Factors include the following:

- Prices of raw materials and factors affecting prices.
- Availability of substitute raw materials and their effects on production costs, quality of, and demand for the finished product.
- Quantity and availability of suppliers, along with potential replacement suppliers in the event of loss of a major supplier.
- Political or regulatory factors that would prevent procuring supplies such as labor strikes, transportation disruptions, environmental regulations, or international and political events.
- Delivery of supplies and any factors that may disrupt delivery.
- Raw materials that may be disposable or have a usable life that may expire before delivery or processing.
- Paying supplier/vendors for materials.

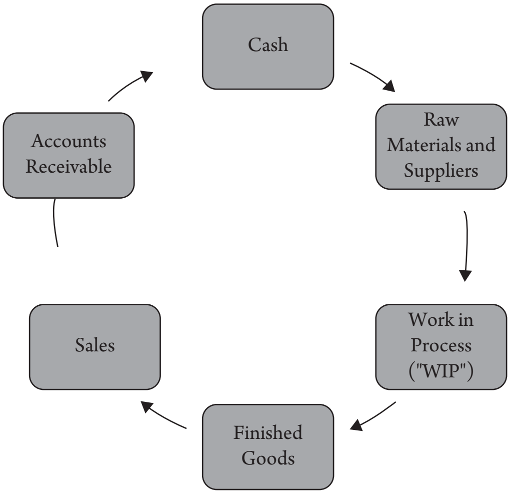

Figure 28.1 Cash Conversion Cycle
This figure presents the sequence of steps in the cash conversion cycle and lists the four main risks associated with these steps.

Production risks are those factors that would inhibit or completely deter a business from completing production of a finished product. Factors include:

- Labor relations and historical experience with labor relations including potential union impacts.
- Availability of labor including strikes, contract expirations, and subsequent negotiations.
- Quality of plant and equipment, need for capital expenditures, and technological advances in plant and equipment, especially compared to competitors.
- Energy consumption and availability of energy during the production process.
- Environmental risks and regulations.
- Location analysis and concentration risk of plant and equipment.
- Potential transportation issues in delivering goods.
- Management ability to manage a production process and its efficiency.
- Management's ability to adapt to rapid changes in the industry, as well as its historical record.

Demand risks are those factors that would inhibit or completely deter a business from moving product off the shelves and into consumer hands. Factors include:

- Company competitive advantage, if any, and market niche.
- Events that may alter a company's ability to maintain a competitive advantage.
- Diversity of products.
- Trends related to luxury products, obsolescence related to technology goods, or volume of demand for inexpensive and widely available products.

- Substitutes for a company's products as well as its competitors' ability to replace the company's key product.
- Primary market and geographic concentrations of customers, as well as market share.
- Distribution method such as the wholesaler systems, in-house sales force, independent agents, franchise systems, and licensed products as well as any advertising.
- Government regulations that may limit a company's ability to sell its products.
- A product's cyclicality or counter-cyclicality.

Collection risks are those factors that would inhibit a business from collecting outstanding receivables and generating cash. Factors include the following:

- Customer demographics including their number, quality, and creditworthiness.
- Concentration risk (i.e., high sales volume spread among a relatively small number of accounts or regions).
- Credit terms extended to purchasers and the policies concerning granting credit.
- Charge-offs and returns and allowances including how often these occur, delinquent accounts, and any history of selling products at a loss.
- Economic conditions that affect customers' ability to pay.

Industry Analysis

In addition to business risk, credit analysis also included an assessment of industry risk. For companies listed on public exchanges with adequate historical reporting, determining the industry in which a company operates is relatively straightforward. However, for private companies that may not report much information to local and national regulatory bodies, the analyst must expend more effort to determine the company's primary product, customer demographics, and how the company compares to its peer group.

Once an analyst accurately describes the industry, the next step is to consider metrics such as potential revenue, competitive margin, number of competitors, market size, recent developments, and future potential attractiveness. Next, business success factors should be identified. For example, the non-luxury, retail apparel industry is extremely competitive and largely fragmented, which means that a brand has difficulty in effectively obtaining the attention of its target demographic. Because many products offered are similar in quality, product design and marketing strength are important success factors in the industry. The ability for the business to attract the attention of its current and potential customers and turn over its inventory is of paramount importance. These factors guide the analyst to study the business' target marketing, product penetration, and popularity with its target demographic.

Michael Porter's "Five Forces of Competitive Position Analysis" provides a simple framework for assessing and evaluating the competitive strength and position of a business organization. These forces are: (1) threat of new entrants, (2) threat of substitutes,

(3) bargaining power of customers, (4) bargaining power of suppliers, and (5) competition (Porter 1979).

- **Threat of new entrants** is the level of risk to the company resulting from the saturation of competitors working to target similar customers with a similar product. For example, the threat of new entrants in the airline industry is low due to the extremely high capital cost of building or acquiring a fleet of airplanes and the regulatory hurdles to navigate before permission is granted to transport passengers through the air. Conversely, the threat of new entrants to the nail salon industry in Manhattan is high, as the initial capital investment is low, and relatively high profit margins are possible.
- **Threat of substitutes** is the level of risk to the company based on customers' ability to locate a product or service that addresses a similar need for the same or cheaper cost. This threat is particularly high for companies that provide a generic product such as soap or laundry detergent. Procter & Gamble, one of the world's largest providers of generic consumer goods deftly avoids this threat by virtue of its massive scale, diversity in product offerings, and extensive marketing campaigns.
- **Bargaining power of customers** is the level of risk to the company and its profitability resulting from consumer leverage in negotiations with the seller. If buyers can exert pressure on the company to increase quality, lower prices, or carry out other costly changes, these scenarios could pose serious risk.
- **Bargaining power of suppliers** is similar in spirit to the bargaining power of customers. External constituents are a key factor in the company's cash conversion cycle and could exhibit negative pressure on the business. If suppliers exert pressure on the company to increase orders to unnecessary levels due to concentration risk or use similar leverage to decrease accounts payable terms forcing quicker repayment, these changes could pose risk to the profitability of the company and damage creditworthiness.
- **Rivalry among competitors** is the level of risk to the company and its profitability created by the intensity of competition within the industry. Industries such as retail apparel face intense price pressure from competitors attempting to gain market share. These competitors routinely target each other's markets, reducing margins and profits. Intense rivalry, however, does not always lead to poor margins and profits, as banks compete with others on the same or very similar products and remain profitable.

A company's performance relative to its peer group can also be analyzed through a SWOT analysis (Humphrey 2005). *SWOT* is an acronym for Strengths, Weaknesses, Opportunities, and Threats, and provides the analyst with a useful framework for reviewing the factors that result in the subject company succeeding or failing in its industry.

A competent analyst uses a SWOT analysis to ascertain whether a company successfully leverages strengths, addresses weaknesses, identifies opportunities, and fights off threats. The SWOT framework requires an analyst to critically examine the positive and negative aspects of the firm's businesses strategies, management, and operations.

Finally, the general economic environment provides the background context in which the company currently operates. The business and economic climate is important to note because during the review of critical success factors the analyst first carries out, the analyst should determine if the subject is cyclical, counter-cyclical, or neutral with respect to economic swings.

If a U.S. domestic company is operating during an economic upturn, a company's performance may move in line with this growth, indicating pro-cyclical properties. In contrast, counter-cyclical companies are those that flourish in an economic contraction. Other factors for consideration in any economic analysis include changes in consumer disposable incomes, national debt, political climate, changing monetary policy, exchange rate fluctuation, housing starts, and borrowing costs. The implications of these factors may greatly affect the subject company. In the years after the financial crisis of 2007–2008, analysts were privy to a wealth of historical information on the performance of their clients in a downturn, and lenders now have information on how to protect themselves when it happens next.

Financial Analysis

This section addresses the main tool analysts use in determining a company's creditworthiness: financial analysis. The ratios defined at the end of the chapter not only quantify relations between various aspects of businesses functions, but also help provide context when comparing a competitor to its peers.

The quantitative aspect of a credit analysis is a critical piece of the decision-making puzzle. This section discusses the analysis of a company's financial statements. This review includes the cash flow statement, ratio analysis, historical trends, seasonality, accounting and financial policies, and capital structure, among others.

The *cash flow statement* provides the sources and uses of a company's cash. This differs from the *income statement,* which displays the net profit/loss to a company in accordance with generally accepted accounting principles (GAAP) and may provide an incomplete picture of cash flow available for debt service. Distinguishing between net profit and cash is important because cash services interest and debt repayment, rather than profits, and the two often differ due to nuances of accrual accounting.

The three sections of a cash flow statement are cash flow from operations (CFO), cash flow from investing activities (CFI), and cash flow from financing activities (CFF). The analyst would review CFO to assess the health of the company's core business activities, CFI to evaluate the extent of capital expenditures, and CFF to gauge the sources of financing and terms related to current obligations.

Cash Flow from Operations

When reviewing the first section of a cash flow statement, a comparison of net income and working capital relative to prior periods is essential. In general, a company that is growing its business, launching new products, or expanding its manufacturing requires greater working capital. When a company is investing capital into launching a new product, it may experience a short-term decline in net income, and a tightening of working capital. At some point, future net income is likely to increase. Theoretically, a company's management could manipulate working capital, but an analyst could detect this intent by analyzing the footnotes for changes in accounting policy or observe major changes in a company's financial metrics.

In general, if CFO is growing, the business is healthy. If CFO is trending downward or growing at a lesser rate than net income, the analyst should take additional steps to review all line items. Ultimately, CFO is an important indicator of the strength of a company's business operations but should be reviewed in conjunction with other financial metrics.

Cash Flow from Investing Activities

The second section of the cash flow statement is termed cash flow from investing (CFI) and represents the net inflow/outflow from disposals and capital expenditures during the time period. A growing company often has a negative CFI due to the purchase of capital goods. If a company has limited investment opportunities or is in a mature or declining industry, its CFI is likely to be small or even negative relative to sales.

Cash Flow from Financing Activities

The final section of the cash flow statement is termed cash flow from financing, or CFF. This section reveals how a company is supporting or funding the investing and operating activities represented in the previous two sections of the cash flow statement.

Did the company issue new stock or take out a new loan? Did the company distribute its profits via a dividend or retain the earnings? A growing company should generate and reinvest its profits as long as value increasing opportunities are available. If a company is consistently accessing the capital markets to fund its business and/or paying shareholders, the potential of an economic downturn represents a major risk. Hence, a contraction in capital markets could negatively affect a company's creditworthiness.

The free cash flow (FCF) calculation, commonly computed as CFO less capital expenditures, is an important part of the analysis. FCF is the amount of cash remaining after making necessary investments in the business. It represents cash generated over a period that the entity could use to repay interest and debt obligations. Management could temporarily boost FCF by reducing investments in working capital and/or capital expenditures, but these short-term changes tend to reverse over time. Consequently, the analyst should examine this metric both over multiple years and relative to its industry peer group to determine its sustainability.

Ratio Analysis

Analysts often use ratio analysis to appraise a company's health, since this analysis can show the deterioration or improvement in business operations. Ratios available to analysts fall into such categories as efficiency, profitability, liquidity, and solvency. Analysts usually compare financial ratios both on a historical basis and against the company's industry peer group. Ratio analysis helps analysts evaluate a company's financial strength and its position within an industry. Analysts should not view a company in isolation, but rather compare it to an industry peer group in order to place its performance in the proper context.

- *Efficiency ratios,* also called activity ratios, measure how efficiently a company generates income from its assets. Examples of efficiency ratios include working capital, accounts receivable turnover, inventory turnover, days' sales in inventory, and total asset turnover. In general, if analysts observe these ratios increasing over time, they could conclude that the company is managing its assets efficiently. However, if the company's ratios are improving on a historical basis but are low compared to industry averages, a lender may be reluctant to extend credit.
- *Profitability ratios* help analysts determine the level of income generated from sales or assets, but focus on profit rather than revenue. Examples of profitability ratios include gross or operating profit margins or returns on assets, invested capital, or equity. In general, if the analyst observes improvement in these ratios, then the business is more likely to be deemed healthy. If the company's profitability ratios are declining, then the company may be struggling to maintain a competitive advantage. If a company's profitability ratios are high relative to industry averages, an analyst should investigate if there are factors supporting a competitive advantage. If so, are these factors temporary or do they have a long-term patent or other advantage that makes the improvement in margins or other metrics sustainable?
- *Liquidity ratios* capture a company's ability to service its short-term obligations, which generally consist of interest and any other obligations due within the next 12 months. These ratios help analysts understand how quickly the company can convert assets into cash, or the extent to which cash or other liquid assets are available to repay short-term obligations. Examples of liquidity ratios include the current, quick, and cash ratios. Analysts try to assess whether a company can, in the worst case scenario, liquidate short-term assets to cover current obligations, and in the best case, can demonstrate the company has a sufficient cushion to easily manage short-term liabilities. Poor liquidity ratios are usually an indication of a fragile business at risk of default without careful management.
- *Solvency ratios* (also know as *leverage ratios)* are analyzed to indicate whether a company has the potential to meet long-term obligations. Although liquidity ratios measure a company's ability to pay off short-term obligations, solvency ratios measure a company's ability to cover long-term obligations. Examples of solvency ratios include debt to equity, total debt to total assets, debt to total capital, and debt to EBITDA. An analyst should review historical trends in solvency ratios to obtain insight on how the balance sheet is capitalized and how aggressively management manages balance sheet risk. Solvency ratios, in particular, should be evaluated in an industry context in order to properly benchmark, as these ratios can vary substantially from one industry to another. For example, companies within the energy or power utility industries such as utility providers have stronger solvency metrics such as lower total debt to-total assets because their assets have historically generated stable revenues, profits, and cash flow. In contrast, other industries, such as the retail

and apparel industries, may have weaker solvency metrics such as a higher total debt to total assets at any given point in time due to the cyclical and sometimes seasonal nature of their business.

The final topic to address regarding ratio analysis involves accounting for factors such as seasonality, adjustments for extraordinary accounting treatments, and consideration of economic and business cycles. Ideally, analysts should incorporate adjustments for seasonal companies into their ratio analysis, due to the volatility in the cash flows and balance sheets of these types of companies. As an example, retail companies typically generate much of their sales in one or two key quarters of the year, while the aforementioned power/utility provider is likely to demonstrate consistent sales and profits throughout the year.

Analysts should carefully analyze the footnotes to the financial statements for important supplemental disclosures. Items to adjust for include pension obligations, judgments and lawsuits against the company, operating leases, and other financial obligations that could affect the cash flow and creditworthiness of the company. These adjustments could have a meaningful impact on the ratio analysis and significantly affect an analyst's opinion about a company's ability to take on additional interest and debt. Finally, analysts should be mindful of economic and business cycles. As mentioned in the section on business and industry analysis, what is the contextual backdrop with which to view the financial ratio analysis? What is the state of the national economy and how is the company's performance in this business cycle and particularly in relation to its peers? The timing with which to begin an extension of long-term credit is important because a lender could end up in a "work-out" with a company, negotiating to reclaim only a fraction of the initial loan, if the loan began in a period of economic upswing and the economy declined in subsequent years and negatively affected the industry.

Management Controls, Accounting, and Financial Policies

Domestic accounting and financial policies are subject to the management style of the operating committee, but ultimately exist within the framework provided by U.S. GAAP. An understanding of these policies and the way in which companies in the subject industry usually behave is critical to determining the aggressiveness of these policies. The infamous Enron and WorldCom collapses resulting from questionable financial accounting practices in the early 2000s serve as prime examples of the ruinous consequences of aggressive or deceitful accounting.

Other areas for review include assessing additional risk created by using non-GAAP adjustments to recurring items and determining whether auditors are properly signing off on published financial statements. Analysts typically listen to earnings conference calls, review 10-Ks, and read the annual report to better understand a company's accounting and financial policies. For example, a technology company capitalizes its marketing expenses because it believes they better match future sales. However, the industry norm is to expense marketing expenses in the year in which the company incurs them. The subject company is aggressively accounting for its marketing expense relatively to industry common practice, and could be inaccurately inflating net income in the short term. Analysts should question management and reflect this red flag in their analysis.

Capital Structure

Capital structure refers to the amounts and types of debt and equity on a company's balance sheet. It represents the sources of financing that a company has used to fund operations and should be assessed both over time and relative to the subject's peer group. Analysts should examine both the types and mix of debt and equity. Factors for consideration include: (1) both secured and unsecured debt, its interest rate (floating or fixed), and currency (home currency or other), (2) hybrid financing (convertible debt or equity), and (3) stock (preferred or common).

A company with assets that generate stable sales and profits such as a regional bank can increase its leverage versus a company with greater volatility of sales and profits such as an apparel company because any debt used to invest in the business is likely to boost retained earnings at the end of the fiscal year due to high (undistributed) net income. Analysts should assess the company's products and the relative stability of their sales compared to the level of debt in the capital structure. A high proportion of debt to equity on a company's balance sheet is an indication of an aggressive capital structure. However, growth in the firm's revenues may be due to the aggressive nature of its capital structure. In general, a higher debt level could indicate a higher probability for bankruptcy (Kirchesch 2004).

Ratios

This section briefly summarizes the commonly used ratios in a credit analysis. It categorizes them in the usual typology of efficiency, profitability, liquidity, and solvency. As discussed previously, each category captures a different dimension of the firm of interest to analysts. Efficiency ratios capture a firm's ability to generate revenue without needing excessive assets that require financing. Profitability ratios capture a firm's ability to generate profits from sales, assets, or equity. Liquidity ratios assess the extent to which a firm has sufficient liquid assets to meet its short-term obligations. Solvency ratios measure a firm's ability to meet long-term obligations.

- *Efficiency ratios*: Working capital, accounts receivable turnover, asset turnover ratio, inventory turnover, days of inventory on hand, and total asset turnover.

$$\text{Working capital} = \text{Current assets} - \text{Current liabilities}$$

$$\text{Accounts receivable turnover} = \frac{\text{Revenue}}{\text{Average accounts receivable}}$$

$$\text{Asset Turnover} = \frac{\text{Revenue}}{\text{Net assets}}$$

$$\text{Inventory turnover} = \frac{\text{Cost of goods sold}}{\text{Average inventory}}$$

$$\text{Day's sales in inventory} = \frac{365}{\text{Inventory turnover}}$$

$$\text{Total asset turnover} = \frac{\text{Revenue}}{\text{Average total assets}}$$

- *Profitability*: gross profit margin, operating profit margin, EBITDA margin, return on assets, return on total capital, and return on equity.

$$\text{Gross Profit Margin} = \frac{\text{Net sales} - \text{COGS}}{\text{Net sales}}$$

$$\text{Operating profit margin} = \frac{\text{Operaing profit}}{\text{Sales revenue}} \times 100$$

$$\text{EBIDTA Margin} = \frac{\text{EBITDA}}{\text{Sales revenue}}$$

$$\text{Return on assets} = \frac{\text{Net income}}{\text{Average total assets}}$$

$$\text{Return on invested capital} = \frac{\text{Net Operating Profits After Tax}}{\text{Total Invested Capital}}$$

$$\text{Return on equity} = \frac{\text{Net income} - \text{preferred dividends}}{\text{Average total equity}}$$

- *Liquidity*: Current, quick, and cash ratio.

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

$$\text{Quick Ratio} = \frac{\text{Current assets} - \text{inventory}}{\text{Current liabilities}}$$

$$\text{Cash Ratio} = \frac{\text{Cash} + \text{marketable securities}}{\text{Current liabilities}}$$

- *Solvency*: Debt to equity, total debt to total assets, debt to total capital, and debt to EBITDA.

$$\text{Debt to Equity} = \frac{\text{Total debt} + \text{Other fixed payments}}{\text{Total Equity}}$$

$$\text{Total debt to total assets} = \frac{\text{Total Debt}}{\text{Total assets}}$$

$$\text{Debt to total Capital} = \frac{\text{Total Debt} + \text{leases}}{\text{Total Equity} + \text{debt}}$$

$$\text{Debt to EBITDA} = \frac{\text{Total Debt}}{\text{EBITDA}}$$

Financial Analysis in Practice

In 2010, a private equity firm bought ABC Inc., a national apparel retailer, for $3.05 billion. The acquirer financed the transaction with $1.85 billion of debt and $1.2 billion of equity. At the time of the acquisition, customers highly regarded the company's products, pricing, and stores. However, the acquirer's management subsequently increased the price points of the products thereby narrowing the market for these products and reduced the quality of the products. As a result, customers flocked to competitors and started buying more products from new online-only brands. The analyst reviewed the company's financial statements from 2013 to 2017. She noticed that ABC's sales grew

2.1 percent from 2013 to 2017. However, its gross profit fell 3.0 percent while its selling, general, administrative (SGA) expenses grew 2.8 percent during this period. As a result, its operating profits declined 33.9 percent and EBITDA decreased 15.8 percent from 2013 to 2017. How would a credit analyst assess the health of ABC Inc.?

The following tables present the firm's financial statements between 2013 and 2017. Table 28.4 presents income statements, Table 28.5 presents balance sheets, Table 28.6 presents statements of cash flows, and Table 28.7 presents selected financial ratios.

Table 28.4 **Financial Analysis in Practice: Income Statement**

Income Statement	*2/2/2013*	*2/1/2014*	*1/31/2015*	*1/30/2016*	*1/28/2017*
Total revenue	$2,227,717	$2,428,257	$2,579,695	$2,505,827	$2,425,462
Cost of revenue	1,240,989	1,422,143	1,608,777	1,610,256	1,550,185
Gross profit	986,728	1,006,114	970,918	895,571	875,277
Selling, General, and Administrative expenses	732,439	754,345	845,953	834,137	818,546
Unusual expense	631	1,874	768,945	1,381,642	8,187
Operating income (Loss)	253,658	249,895	–643,980	–1,320,208	48,544
Interest expense—Other	101,684	104,221	74,352	69,801	79,359
Income tax expense (Benefit)	55,887	57,550	–60,559	-147,333	–7,301
Net income (Loss)	96,087	88,124	–657,773	–242,676	–23,514
Other information					
EBITDA	335,934	345,301	–534,578	–1,200,683	168,587
Depreciation and amortization	82,276	95,406	109,402	119,525	20,043

This table presents selected information from the income statement between 2013 and 2017 (all figures are in $ millions).

Table 28.5 **Financial Analysis in Practice: Balance Sheet**

Balance Sheet	***2/2/2013***	***2/1/2014***	***1/31/2015***	***1/30/2016***	***1/28/2017***
Cash and cash investments	68,399	156,649	111,097	87,812	132,226
Total inventory	265,628	353,976	367,851	372,410	314,492
Prepaid expenses	62,725	59,216	60,734	65,605	59,494
Other current assets	14,686	11,831			
Current assets	411,438	581,672	539,682	525,827	506,212
Property, plant & equipment	324,111	375,092	404,452	398,244	362,187
Other long-term assets	53,629	45,806	26,876	7,261	6,207
Intangible assets—Net	1,010,621	992,735	836,608	460,744	450,204
Goodwill—Net	1,686,915	1,686,915	1,124,715	107,900	107,900
Total assets	3,486,714	3,682,220	2,932,333	1,499,976	1,432,710
Accounts payable	141,119	237,019	244,367	248,342	194,494
Short-term debt	12,000	12,000	15,670	15,670	15,670
Accrued expenses	68,046	18,065	5,408	5,279	7,977
Other current liabilities	104,509	154,796	158,889	164,851	182,356
Total current liabilities	325,674	421,880	424,334	434,142	400,497
Long-term debt	1,567,000	1,555,000	1,532,769	1,501,917	1,494,490
Deferred income tax	392,984	389,403	304,487	148,819	148,200
Other long-term liabilities	109,565	125,517	154,719	184,085	175,734
Long-term liabilities	2,069,549	2,069,920	1,991,975	1,834,821	1,818,424
Total liabilities	2,395,223	2,491,800	2,416,309	2,268,963	2,218,921
Additional paid-in capital	1,003,184	1,008,984	1,014,930	979,333	980,368
Retained earnings	108,496	196,620	–488,853	–1,731,529	–1,755,043
Other equity	–20,189	–15,184	–10,053	–16,791	–11,536
Net worth	1,091,491	1,190,420	516,024	–768,987	–786,211
Total liabilities and equity	3,486,714	3,682,220	2,932,333	1,499,976	1,432,710

This table presents selected information from the balance sheet between 2013 and 2017 (all figures are in $ millions).

Table 28.6 **Financial Analysis in Practice: Statement of Cash Flow**

Cash Flow	*2/2/2013*	*2/1/2014*	*1/31/2015*	*1/30/2016*	*1/28/2017*
Net income	96,087	88,124	– 657,773	–1,242,676	–23,514
Depreciation	72,471	77,520	93,458	103,966	109,503
Amortization	9,805	17,886	15,944	15,559	10,540
Deferred and other tax adjustments	–8,945	–5,234	–75,015	–151,232	–5,140
Unusual items		1,874	768,945	1,381,642	8,187
Other non-cash items	28,716	27,516	17,097	9,756	14,987
Inventories	–22,969	–88,935	–15,071	–5,351	57,798
Prepaid expenses	–3,053	–5,280	–4,585	–4,265	5,989
Other assets	655	–2,021	–832	–701	741
Accounts payable	29,930	108,658	4,934	16,910	–62,965
Taxes payable	–8,474	12,417	11,016	11,945	21,707
Operating assets and liabilities	–3,911	24,839	–4,538	18,538	23,270
Net cash from operations	194,223	232,525	158,118	135,553	137,833
Purchase of fixed assets	–132,010	–131,440	–127,874	–103,657	–80,140
Other investing cash flow			–4,817		
Other cash outflow/inflow			–4,817		
Net cash from investments	–132,010	–131,440	–132,691	–103,657	80,140
Other financing cash flow	–3,216	16	–49,904	–38,314	–1,099
Dividends or distribution	–197,450	0	0	0	0
Long-term debt, net	–15,000	–12,000	–19,588	–15,670	–11,753
Net cash from financing	–215,666	–11,984	–69,492	–53,984	–12,852
Cash and equivalent—start year	221,852	68,399	156,649	111,097	87,812
Cash and equivalents—end year	68,399	156,649	111,097	87,812	132,226
Net change cash & cash equivalents	–153,453	88,250	–45,552	–23,285	44,414

This table presents selected information from the statement of cash flows between 2013 and 2017 (all figures are in $ millions).

Table 28.7 **Financial Analysis in Practice: Ratios**

Ratios	*Fiscal Year Ending*					
	2/1/2014	*1/31/2015*	*1/30/2016*	*1/28/2017*	*Average*	*Industry*
Inventory turnover	4.59	4.46	4.35	4.51	4.48	4.15
Days' sales in inventory	79.5	81.9	83.9	80.9	81.5	88.03
Operating margin	10.3%	–25.0%	–52.7%	2.0%	–16.3%	6.09
EBITDA margin	14.2%	–20.7%	–47.9%	7.0%	–11.9%	9.7
Current ratio	1.38	1.27	1.21	1.26	1.28	2.07
Interest coverage	2.40	–8.66	–18.91	0.61	–6.14	6.62
Debt-to-equity	1.32	3.00	–1.97	–1.92	0.11	0.6
Debt-to-EBITDA	4.54	–2.90	–1.26	8.96	2.33	1.37

This table presents selected financial ratios between 2013 and 2017.

As a result of the financial analysis, the credit analyst made the following observations regarding ABC Inc.:

- *Cash from operations*: CFO declined 8.2 percent on an annualized basis from $194,223 in 2013 to $137,833 in 2017. After further review, the analyst concluded that the reason for the decline was due to net losses and changes in working capital.
- *Cash from investing*: CFI fell 11.7 percent on an annualized basis from $132,010 in 2013 to $80,140 in 2017 due to management cutting back on capital expenditures for its business and reducing new store openings. The analyst is concerned that the company is under-investing in its business in the short term, which could hurt its financial performance in the long term.
- *Cash from financing*: CFI fluctuated from negative $215,666 in 2013 to negative $12,852 in 2017. The board of directors approved and issued a $197.5 million dividend in 2013. Management is making the minimum payments on its debt. The analyst expressed concern about management's choice to make the large dividend in 2013 instead of paying down debt.
- *Efficiency ratios*: The company's inventory turnover ratio declined from 4.59x in 2014 to 4.51x in 2017. Despite a decline in the company's inventory turnover, it remained above the industry average of 4.15x. The company's efficiency ratios declined from

2014 to 2017, but remained above the industry average. The analyst noticed that the inventory turnover was above the industry average, but was concerned about the downward trend in this ratio. After further review, the analyst discovered that the trend in this ratio emerged as a result of management engaging in more frequent pricing promotions to drive sales.

- *Profitability ratios*: The company's operating profit margin decreased from 10.3 percent in 2014 to 2.0 percent in 2017. The average was negative 16.3 percent between 2014 and 2017, which was well below the industry average of 6.1 percent. The company heavily discounted its products to entice customers to buy them. Although such discounting helped increase inventory turnover, it negatively affected the company's profits.
- *Liquidity ratios*: The current ratio fell from 1.38x in 2014 to 1.26x in 2017. The company average was 1.28x, which was well below the industry average of 2.07x. The company's liquidity is weak and continues to deteriorate, which reduces its ability to handle any one-time financial shocks.
- *Solvency ratios*: The debt to EBITDA ratio was 4.54x in 2014 and grew to 8.96x in 2017. The company's average was 2.33x, which was above the industry average of 1.37x. This trend represents a red flag because the company's high debt load increases the probability of a restructuring event (e.g., a creditor restructuring or bankruptcy filing). As a result, the analyst is concerned about the company's solvency.
- *Final analysis*: The analyst is concerned about the company's weak cash flow generation, declining efficiency and profitability ratios, and weakening liquidity and solvency ratios. The analyst believes that ABC Inc. is a distressed company that has a high probability of a credit event such as restructuring or bankruptcy.

Credit Rating Agencies

Credit rating agencies (CRAs) play an important part in the investment process and are considered gatekeepers in the industry. Ratings agencies' opinions assist investors in determining what debt or structured instruments they should consider holding in their investment portfolios given their risk preferences. CRAs complete a thorough credit analysis of a client just as an analyst working for a lender but provide a summary grade based on how creditworthy the firm is to alert investors to potential risks and rewards.

By definition, a CRA is a Nationally Recognized Statistical Rating Organization (NRSRO). The Securities and Exchange Commission (SEC) regulates NRSROs in the United States. The most prominent NSROs are S&P, Moody's, and Fitch, and these carry the most influence in the markets. The rating agencies rate all types of debt, structured products, or credit-related securities. The following are NRSROs as of November 2017: (1) Best Company, (2) DBRS Ltd., (3) Egan-Jones Rating Company, (4) Fitch, (5) Kroll Bond Rating Agency, (6) Moody's, (7) Morningstar, (8) Rating and Investment Information, (9) Realpoint LLC, and (10) Standard & Poor's Ratings Services. Ratings exist on all types of entities in various industries such as corporate, financial institutions, private companies, sovereign governments, structured products, and U.S. and international public finance.

A business that has public debt or wants to be rated provides a comprehensive set of historical financial statements to a rating agency, which in turn grades the issuer and its respective bonds based on industry-specific credit criteria and methodologies. The rating agency conducts an extensive analysis, which includes initial screening, meeting with issuer management, analyzing an issuer's financial results, credit committee decision-making, report publication, and follow-up surveillance. However, during the financial crisis of 2007–2008, various parties levied criticism against the CRAs claiming that they failed in their role (Mallaby 2015). Despite the implementation of the Dodd-Frank Act of 2010 and CRAs updating their credit criteria and methodologies, room for improvement still exists related to their role and influence in the marketplace (Rivlin and Soroushian 2017).

Summary and Conclusions

Credit analysis incorporates both quantitative and qualitative aspects to achieve a holistic view of the strength of a company. The lender uses the five Cs of credit to make the initial qualitative assessment. A review of business, industry, and economic analysis rounds out the qualitative considerations. The assessment of the financial statements, ratios, metrics, and capital structure provide a foundation for quantitative aspects. Rating agencies also provide an important link in the credit decision-making process for investors, lenders, and issuers. The lender uses credit analysis to make a final decision about whether to extend credit to a company. The goal of the lender is to generate a return of interest, including the original principal, to compensate for the risk level for a company.

Discussion Questions

1. Explain why capacity analysis is important when a lender is evaluating a potential credit relationship.
2. Discuss four risks associated with a company's cash conversion cycle and offer some examples.
3. Explain how the cash flow statement is organized and its importance to credit analysts.
4. Explain the role of credit rating agencies in debt markets.

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Introduction

Auctions are an old and established mechanism for government debt issuance and provide important transparency to capital markets. In contrast, issuers have not widely used auctions to sell equities or corporate debt (Jagannathan, Jirnyi, and Sherman 2010). According to McAfee and McMillan (1987), an *auction* is a market with an explicit set of rules determining resource allocation and prices based on bids from potential buyers. The purpose of an auction is to find an allocation and a price such that supply equals demand. That is, in a government debt auction, an equilibrium interest rate exists that clears the market. Globally, a trend exists for central government debt managers to sell government securities exclusively in auctions since the 1990s. In the past, governments had relied heavily on selling securities through underwriting syndicates and private placements (Garbade 2004). The increased financing requirements and more competitive and integrated capital markets generally contributed to the movement toward competitive auction market pricing of securities. Auctions have sold U.S. Treasury bills since 1929 and U.S. Treasury notes and bonds since 1970. In the United States, the borrowing party is the U.S. Department of the Treasury. Therefore, auctions are commonly referred to as the U.S. Treasury auctions. The Federal Reserve Bank of New York runs the auctions as the fiscal agent of the Department of the Treasury. For conformity with the literature, this chapter uses "treasury auctions" or "sovereign/government debt auctions" interchangeably across countries, "treasuries" or "governments" for the associated debt management authorities (e.g., departments of treasury, ministries of finance, or central banks), and finally "Treasury" specifically for the United States.

The sheer size of the issuance of treasury securities makes central governments one of the largest security issuers in their respective capital markets. For example, Figure 29.1 shows the annual issuance of marketable Treasury securities in the United States. The annual issuance

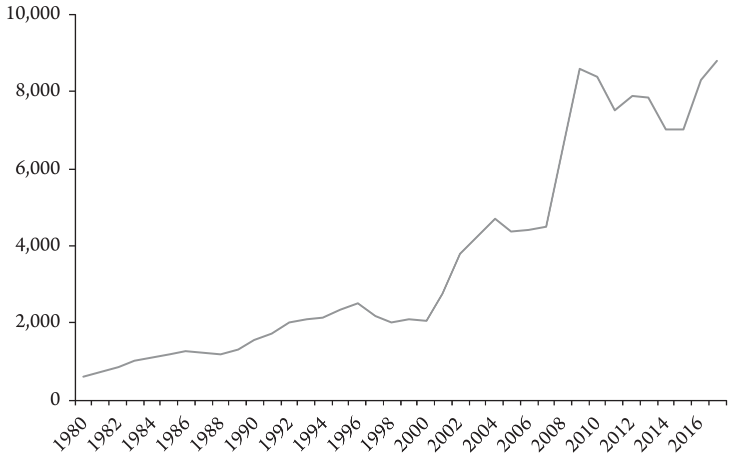

Figure 29.1 Issuance of Treasury Securities
This figure plots the annual issuance (in $ billions) of marketable U.S. Treasury securities between 1980 and 2017.
Source: TreasuryDirect (2017).

has steadily increased since 1980 and at a substantially greater rate since 2000 due to mounting budget deficits and borrowing needs. In 2017, the U.S. government auctioned $8.79 trillion of marketable securities. This astonishing amount is more than 40 percent of the U.S. gross domestic product (GDP) for that same year. As a result, the widespread growth of public debt in the United States and similarly in other countries has intensified policymakers' concern with implementing effective methods to sell government securities. By broadening participation in treasury auctions and increasing auction revenues, governments could potentially save billions of dollars, and ultimately lower the cost of borrowing for their taxpayers. At the same time, treasuries around the world have sought to ensure that auctions are run in a fair and competitive way, free from collusion or market manipulation.

The purpose of this chapter is to provide investors and policymakers with a comprehensive understanding of treasury auctions including theoretical and empirical findings from the extant literature. Although the focus is particularly on U.S. Treasury auctions, the similarities and differences in other countries' markets are also discussed. The remainder of the chapter is organized as follows. The next section discusses the basics of treasury auctions including securities, bidders, and the bidding process. The following section then focuses on auction design and two of the most widely used treasury auction methods. Next, a section is dedicated to discussing some important issues related to treasury auctions including common value and private information, pre-auction selling, and auction underpricing. The final section provides a summary and conclusions.

Treasury Auction Basics

The auction is the primary (i.e., original issue) market for government securities. Secondary market trading typically happens in a dealer market after the auction. Central governments around the world are the auctioneers in the auction framework. They have three main objectives: (1) maximizing auction revenue, (2) preventing market manipulation, and (3) promoting a liquid post-auction secondary market. Bidders' or investors' goals are to buy securities at low prices and either hold them in their portfolios or potentially resell them in the secondary market at higher prices.

Securities

The U.S. Department of the Treasury currently auctions four types of marketable securities: bills, notes and bonds, Treasury Inflation-Protected Securities (TIPS), and floating rate notes (FRNs).

- *Bills* are single-payment securities that are sold at a discount and pay a specific par value at maturity. The Treasury occasionally offers cash management bills—securities having very short maturities issued to bridge temporary funding needs.
- *Notes* and *bonds* are interest-bearing securities that pay interest semi-annually and repay principal at maturity.
- *TIPS* are interest-bearing securities whose payments are indexed to the monthly non-seasonally-adjusted *U.S. City Average All Items Consumer Price Index for All Urban Consumers*, published by the U.S. Bureau of Labor Statistics (Garbade and Ingber 2005).
- *FRNs* are bonds that have a variable coupon rate, equal to a money market reference rate, such as the London Interbank Offered Rate (LIBOR) or the federal (Fed) funds rate, plus a quoted spread.

Similar government security types are also sold in auctions in other countries, with the issuing volume concentrated in the traditional bills and bonds. In the United States, out of the $8.79 trillion total auctioned in 2017, $6.56 trillion was T-bill issuance, $1.74 trillion was T-note issuance, $170 billion was T-bond issuance, $139 billion was TIPS issuance, and $172 billion was FRNs issuance (TreasuryDirect 2017).

Treasury auctions follow a very organized schedule. In the United States and many other countries, the terms of the tender are announced one week in advance of the auction. Table 29.1 provides a summary of auction schedules for all security types in U.S. Treasury auctions. Every week the Department of the Treasury auctions four-, 13-, and 26-week bills. Less frequently, the Treasury auctions bills, notes, and bonds with longer maturities, but the issuance follows structured cycles. The issue or settlement date is when the allotted securities are delivered to the winning bidders. Settlement typically takes from two business days to a week.

Besides auctioning new securities, the treasury may also decide to issue an additional supply of an outstanding security. This practice is called *reopening*. Securities with larger amounts outstanding tend to be more liquid, making them more attractive to investors. The U.S. Treasury systematically reopens T-bills, but only infrequently reopens notes and bonds. Countries with smaller markets use reopening more often. For example, in Swedish Treasury auctions about 90 percent of all auctions reopen previously issued securities (Nyborg, Rydqvist, and Sundaresan 2002). By concentrating on a limited number of securities, reopening enhances secondary market liquidity.

Table 29.1 **Auction Schedule**

Security	*Maturity*	*Auction Frequency*	*Announcement*	*Auction*	*Issue*
T-bills	4-week	Weekly	Monday	The following Tuesday	Thursday
	13-week	Weekly	Thursday	The following Monday	Thursday
	26-week	Weekly	Thursday	The following Monday	Thursday
	52-week	Every four weeks	Thursday	The following Tuesday	Thursday
T-notes	2-year	Monthly	The second half of the month	A few business days later	The last day of the month
	3-year	Monthly	The first half of the month	A few business days later	The 15th of the month
	5-year	Monthly	The second half of the month	A few business days later	The last day of the month
	7-year	Monthly	The second half of the month	A few business days later	The last day of the month
	10-year*	Quarterly	The first half of February, May, August, and November	A few business days later	The 15th of the month
T-bonds	30-year*	Quarterly	The first half of February, May, August, and November	A few business days later	The 15th of the month
TIPS	5-year*	Annually	Mid-April	A few business days later	The last business day of the month
	10-year*	Semi-Annually	Mid-January and Mid-July	A few business days later	The last business day of the month
	30-year*	Annually	Mid-February	A few business days later	The last business day of the month
FRN	2-year*	Quarterly	The second half of January, April, July, and October	A few business days later	The last day of the month

This table summarizes the current schedules and cycles of U.S. Treasury auctions.

Source: TreasuryDirect (2017).

*The reopening schedules for these securities are not included in this table.

Bidders

The dominant players in treasury auctions are primary dealers, which are the firms that buy government securities directly at auctions. Primary dealers act as market makers of these securities post-auction. Many governments use primary dealer systems. For example, in the United States, 23 primary dealers operate at the time of this writing. The Federal Reserve Bank of New York selects these dealers as counterparties for open market operations (i.e., government securities transactions related to the Federal Reserve's implementation of monetary policy). They are required to participate meaningfully in both open market operations and Treasury auctions and to provide policy-relevant market information to the Federal Reserve Bank of New York. Along with the consolidation of the financial industry worldwide has come a decline in the number of primary dealers. Table 29.2 provides the current list of primary dealers. Detailed historical lists of primary dealers are available on the Federal Reserve Bank of New York's (2017) website.

Foreign countries and institutional investors (customers or clients of primary dealers) such as mutual funds, pension funds, insurance companies, and other sovereign funds can route their bids through primary dealers, but usually cannot bid directly at treasury auctions. As a result, a primary dealer can submit bids for its own account as well as on behalf of its customers and must indicate whether a bid is a customer bid. All buyers including retail investors can also participate in auctions by submitting noncompetitive bids. A *noncompetitive bid* is a bid that only specifies the quantity of securities

Table 29.2 **List of Current Primary Dealers**

Primary Dealers	
Bank of Nova Scotia, New York Agency	J.P. Morgan Securities LLC
BMO Capital Markets Corp.	Merrill Lynch, Pierce, Fenner & Smith Inc.
BNP Paribas Securities Corp.	Mizuho Securities USA LLC
Barclays Capital Inc.	Morgan Stanley & Co. LLC
Cantor Fitzgerald & Co.	Nomura Securities International, Inc.
Citigroup Global Markets Inc.	RBC Capital Markets, LLC
Credit Suisse Securities (USA) LLC	RBS Securities Inc.
Daiwa Capital Markets America Inc.	Societe Generale, New York Branch
Deutsche Bank Securities Inc.	TD Securities (USA) LLC
Goldman Sachs & Co. LLC	UBS Securities LLC.
HSBC Securities (USA) Inc.	Wells Fargo Securities, LLC
Jefferies LLC	

This table lists the current primary dealers of U.S. Treasury auctions as of February 23, 2018.

Source: Federal Reserve Bank of New York. For a complete list of historical primary dealers, additions, removals, and name changes, see https://www.newyorkfed.org/markets/primarydealers#primary-dealers.

demanded up to a maximum allowed (up to $5 million of face value of debt per bidder per auction) without indicating a price the bidder is willing to pay. All noncompetitive demand is filled at the competitive price determined during the auction. In this way, a noncompetitive bidder guarantees winning but does not have to bear the risk of bidding. Klemperer (2002) contends that small bidders' ability to bid through large intermediaries and retail bidders' ability to make noncompetitive bids alleviate the auction entry problem (i.e., the problem that auctions are only accessible to a limited group of bidders), and therefore are beneficial to the auction operation. According to Fleming (2007), in U.S. Treasury auctions, primary dealers obtain 70 percent of the awards with the remainder split between customers (25 percent) and noncompetitive bids (5 percent).

Bidding

A competitive bid submitted by a primary dealer, called a *tender*, consists of a quantity and a price. In practice, bidders submit quantity-interest rate (yield) pairs. For expositional convenience, the discussion here is in terms of quantity-price pairs. A single bidder's combined quantity-price pairs are aggregated into a *demand schedule*. The price indicates how much a bidder is willing to pay for the associated quantity of securities. In the United States, no limit exists on the number of bids that a bidder can submit. Other countries may have such limits. For example, in Canadian Treasury auctions, one bidder cannot submit more than seven competitive bids in an auction (Rydqvist and Wu 2016). Noncompetitive bidders submit only quantity bids and competitive bidders submit demand schedules. In U.S. Treasury auctions, noncompetitive bids are due before 12:00 noon Eastern Standard Time (EST) on the auction day, and competitive bidding usually closes at 1:00 p.m. EST. After the close of bidding, the Treasury subtracts the noncompetitive demand from the total supply and then sorts the submitted competitive bids by price. The remaining offering amount is awarded from the highest price bid to the last winning bid (also called the *cut-off* or *stop-out bid*), at which the offering amount is exhausted (i.e., demand equals supply). Bids at lower prices than the stop-out bid are rejected. If multiple bids occur at the stop-out, the remaining supply is distributed on a pro-rata basis on the quantities demanded at the stop-out bids.

After each auction, the Department of the Treasury announces summary statistics of the bids submitted, including the total tender amount, bid-to-cover ratio (i.e., total demand divided by total supply), amount of noncompetitive bids, highest winning bid, lowest winning bid, proportion of bids accepted at the lowest price, and quantity-weighted average winning price. Table 29.3 provides an example of a recent 30-year U.S. Treasury auction. The auction tender is announced on August 2, 2017, and the announcement (displayed on the left hand side of the table) includes security-specific information (30-year, new issuance with a coupon rate of 2.75 percent and a maturity date on August 15, 2047); amount offered ($15 billion of face value), minimum bid amount and quantity multiples (100); tick size (0.1 basis point in yield); noncompetitive quantity limit ($5 million); total award limit ($5.25 billion, which is 35 percent of the total amount offered); and, finally, bidding closing times. On the right hand side of the table, the auction results from this particular auction are announced to the market.

Table 29.3 **Example of Auction Announcement and Auction Results**

	Auction Announcement		**Auction Results**	
	Wednesday, August 02, 2017		**Thursday, August 10, 2017**	
Security	30-year	Bid-to-cover ratio		2.32
CUSIP	912810RY6	High yield		2.818%
Offering amount	$15,000,000,000	(All tenders at lower yields were accepted in full)		
Currently outstanding	None	Price		98.629
Auction date	Thursday, August 10, 2017			
Issue date	Tuesday, August 15, 2017	Median yield		2.760%
Maturity date	Thursday, August 15, 2047	Low yield		2.388%
Interest payment dates	February 15 and August 15			
Coupon rate	2.75 percent		Tendered	Accepted
		Noncompetitive	$2,818,600	$2,818,600
Yield	Determined at auction	Competitive	$34,785,389,000	$14,997,186,500
Minimum bid amount and multiples	$100			
Competitive bid yield increments	0.001 percent		Competitive Bidding	
Maximum award	$5,250,000,000	Primary dealer	$21,604,000,000	$4,172,865,000
Maximum noncompetitive award	$5,000,000	Direct bidder	$1,587,035,000	$807,035,000
Noncompetitive closing time	12:00 noon EST	Indirect bidder	$11,594,354,000	$10,017,286,500
Competitive closing time	1:00 pm EST	Total	$34,785,389,000	$14,997,186,500

This table summarizes the auction announcement and results of a 30-year U.S. Treasury bond auction (CUSIP number 912810RY6). *Bid-to-cover ratio* is the ratio of total competitive tendered over total competitive accepted. *High yield* refers to the last winning yield. *Price* corresponds to high yield. Bids at lower yields than high yields or higher prices than price were accepted in full. A total of 50 percent and 5 percent of the amount of accepted competitive tenders were at or below the median yield and low yield, respectively.

Source: TreasuryDirect (2017).

The bid-to-cover ratio is 2.32, implying a total demand of $34.8 billion ($15 billion times 2.32). The highest winning yield is at 2.818 percent with this yield corresponding to the lowest winning price of 98.629 percent of par. All bids below this price (above this yield) are rejected, and all bids above this price (and below this yield) are accepted in full. The Treasury also reveals the highest winning bid has a yield of 2.388 percent, and the median of all winning bids has a yield of 2.760 percent.

The last part of the auction result announcement details the award distribution. In this auction, primary dealers demand a total of $21.6 billion (62.1 percent of total demand), other non-primary-dealer direct bidders demand a total of $1.6 billion (4.6 percent of total demand), and finally indirect bidders or "customers" demand a total of $11.6 billion (33.3 percent of total demand). The results of the amount awarded are quite different: the percentage of amount awarded for primary dealers, non-primary-dealer bidders, and customers is 28 percent, 5.3 percent, and 66.7 percent, respectively. The result of this 30-year Treasury auction is interesting in its own right, indicating that customers tend to submit higher prices when bid through primary dealers, but primary dealers tend to submit high demand with lower prices.

This section provided some basic information about treasury auctions, including the securities being auctioned, the bidders, and the bidding process. Several important questions remain: What price(s) do winning bidders pay? Do winning bidders pay at their own prices bid, or do they all pay at the average winning price or the stop-out price? The next section addresses these key issues.

Treasury Auction Methods

A long-standing debate in the treasury auction literature focuses on ranking auction methods. One reason is that this issue closely links to studies of single-unit auctions, an area where much research has addressed the ranking of different auction methods (Vickrey 1961). Treasury auctions belong to the more general category of multi-unit auctions in which more than one identical unit of goods (bonds in this case) are sold. The other, more important reason is that the monetary amounts involved in treasury auctions are so large that a tiny improvement in auction performance would generate large amounts of additional revenue for central governments, therefore lowering the cost of debt financing. Within the multi-unit auction setting, governments choose between two widely used auction methods to issue debt: the discriminatory method and the uniform-price method. Roughly speaking these methods correspond to the first-price and the second-price methods in single-unit auctions, respectively. In a discriminatory auction, each winning bidder pays its own bid, whereas in a uniform-price auction, all winning bidders pay the lowest winning price (the stop-out price).

For example, suppose that at an auction for two T-bills, each worth $1,000, participants A, B, C, and D bid $990, $960, $950, and $920, respectively, for a single bill. A discriminatory auction would award one bill to A for a charge of $990 and one bill to B for a charge of $960. By contrast, a uniform-price auction would award the bills to A and B for a common charge of $960. Although some may conclude that a uniform-price auction leads to lower expected revenues for the seller, the theory suggests that bidders in a uniform-price auction are likely to bid more aggressively. Before bidding, bidders are aware of the auction rules, and know whether they will pay the price they bid or the last winning bid. A uniform-price auction reveals more information to all bidders—namely, the private information of the last winning bidder(s). Consequently, the fear of the *winner's curse*—the tendency for a successful bidder to pay a price higher than the value assessed by other bidders in a uniform-price auction—should be lower than in a discriminatory auction. In other words, by mitigating the winner's curse, the uniform-price auction may elicit more aggressive bids. As a result, the average selling price in a uniform-price auction could be greater than in a discriminatory auction, and the seller could generate more revenue in uniform-price auctions. If the auction in this simple example were to use the uniform-price method, the bids might have been more aggressive, for instance, $1,000, $990, $970, and $960. In this case, the uniform-price auction would generate more revenue to the seller ($990 times two units), compared to the original discriminatory auction ($990 for one unit and $960 for one unit).

According to Nobel Prize winner Milton Friedman, the uniform-price auction is likely to produce higher expected revenue by encouraging entry of smaller, less informed bidders (Friedman 1960). Collectively, the U.S. Treasury switched from the discriminatory method to the uniform-price method for certain maturities during the 1990s, and completely switched the method for all its auctions in October 1998. An overhaul of the auction system following the Salomon Brother's short squeeze scandal also motivated the switch (Joint Report on the Government Securities Market 1992).

Figure 29.2 illustrates the theoretical arguments of changes in bidding, price, and revenue in these two auction methods. In the figure, on the left side is the demand and supply curves of a discriminatory auction, and on the right side is the new demand curve that shifts up in a uniform-price auction as a result of more aggressive bidding. The seller's revenue is represented by the shaded trapezoid area to the left and by the shaded rectangular area to the right. However, theoretical research still does not provide conclusive revenue rankings between these two methods (Wilson 1979; Milgrom and Weber 1982; Bikhchandani and Huang 1989, 1993; Back and Zender 1993; Kremer and Nyborg 2004). In particular, Back and Zender show that implicit collusion among bidders to maintain a low price is likely to be more difficult in the discriminatory

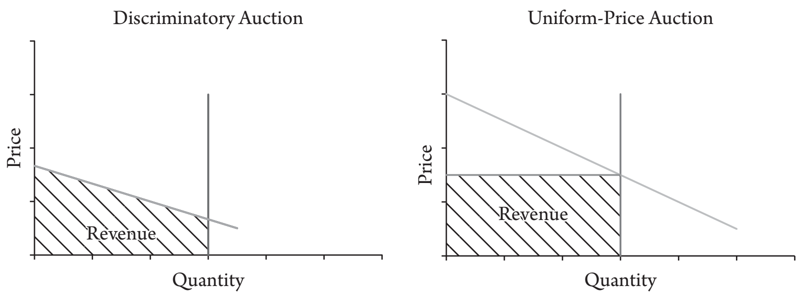

Figure 29.2 Discriminatory Auction versus Uniform-Price Auction
The figure illustrates the difference in revenue generation for the auctioneer (central governments in treasury auctions). On the left side is a discriminatory auction, and the auctioneer's revenue is represented by the shaded trapezoid area. On the right side is a uniform-price auction, in which the demand curve shifts up, and the auctioneer's revenue is represented by the shaded rectangular area.

auction, which thus may produce higher expected revenue than the uniform-price auction. Whether a discriminatory or uniform-price auction raises more revenue is an empirical question, which can be tested by comparing auction prices and secondary market prices. The results are inconclusive in this regard, even when evaluating the U.S. experiment in the 1990s (Cammack 1991; Simon 1994; Nyborg and Sundaresan 1996; Malvey and Archibald 1998).

How much governments could benefit or lose from auction mechanism changes is still an open question and no consensus exists on the best method. Since 1998, all U.S. Treasury securities have been auctioned using the uniform-price method, but across all the countries using auctions to sell government securities, the experience is equally divided, with about half using each method. This finding is also evidence of the inconclusiveness of method ranking in treasury auctions. Table 29.4 compiles the results from Blommestein (2009), Brenner, Galai, and Sade (2009), other individual country studies, and information from the treasuries.

Although the ranking between discriminatory and uniform-price methods is inconclusive, the academic literature agrees that underpricing exists with both methods. Underpricing in treasury auctions, similar to equity initial public offerings (IPOs), is computed as the percentage difference in price between what winning bidders pay at the auction and what they can resell or have sold at in the secondary or when-issued market. In the most recent calibration, Goldreich (2007) reports that in U.S. Treasury bond auctions, underpricing is estimated to be 3.5 cents per $100 (0.59 basis points in

Table 29.4 **Treasury Auction Format**

Discriminatory	*Uniform-Price*	*Both*
Austria	Argentina	Australia*
Belgium	Colombia	Brazil
France	Denmark	Canada*
Germany	Finland	China
Hungary	Ireland	India
Japan	Portugal	Italy**
Poland	South Korea	Mexico
Spain	Norway	Singapore**
Sweden	Switzerland	
Turkey	United States	
United Kingdom		

This table summarizes the treasury auction format across countries based on information from individual debt management offices, individual country studies, Blommestein (2009), and Brenner et al. (2009).

*Discriminatory auctions for nominal treasury securities and uniform-price auctions for index-linked treasury auctions.

**Discriminatory auctions for treasury bills and uniform-price auctions for treasury bonds.

yield) on average in discriminatory auctions and 1.3 cents per $100 (0.32 basis points in yield) on average in uniform-price auctions. Therefore, primary dealers appear to earn a profit, on average, when buying at auctions.

Related Issues

This section starts with discussing the common value assumption, role of private information, and winner's curse. Large and active markets coexist before and after the auctions, creating possibilities of a short squeeze. When comparing prices in the pre- or post-auction markets with auction prices, the literature documents positive bidder profits (auction underpricing) on average.

Common Value, Winner's Curse, and Private Information

The auctioneer can control the rules and design of the auctions but may be unable to control the valuation of the bidders, which are largely determined by the nature of the objects being auctioned. Whenever bidders buy an object for resale rather than for personal consumption, the common value assumption is reasonable. A barrel of crude oil is an example of a common value auction, whereas a rare painting is not. Under the *common value assumption*, each bidder has the same value for the objects. The "same value" does not mean that bidders literally know what the object will be worth, but rather that whoever gains the object receives the same amount for the object. In a treasury securities auction, the common value assumption is appropriate because the value for each bidder is a common and unknown resale price in the secondary market post-auction.

Although the resale value is unknown at the time of bidding, each bidder is presumed to have some private, imperfect information about the value on which to base a bid. The usual assumption is that each dealer's estimate is unbiased (i.e., on average the bidders' estimates of value are correct). In the Treasury markets, the primary dealers' private information comes from two sources. First, primary dealers have their own forecasts of the movements of the term structure of interest rates. Second, and potentially more important, before the auction, institutional buyers such as mutual funds, pension funds, and insurance companies place orders for the to-be-auctioned securities with primary dealers. As market makers, the order flows from customers illustrate the demand for the securities, and each primary dealer privately observes this information (Hortacsu and Sareen 2006).

As previously mentioned, bidders with common values are susceptible to the winner's curse. This outcome unfolds as follows. Assume that one indivisible object is for sale and that bidders calculate their bids based on their estimates of true underlying value. Remember that in a common value auction with many bidders, even though each bidder's estimate is unbiased, some estimates will be high and others low. As a result, the highest bidder (the winner) is usually the one who is most optimistic about the true value. That is, upon winning, the successful bidder then learns something striking: all other bidders had lower estimates of true value! A bidder who fails to take this factor into account may easily bid too high, thus winning the auction but losing money from overpaying. This phenomenon is called the *winner's curse*. In multi-unit auctions, such as treasury auctions, the risk of the winner's curse would be multiplied over the winning quantity. Ausubel and Cramton (2002) refer to this process as "champion's plague"—the more a winner wins in the auction, the worse news it is for the winner.

The winner's curse has two implications for optimal bidding strategies in treasury auctions. First, as the uncertainty about the object's value increases, bidders worry more about winning due to overestimation. As a result, they bid more conservatively, and the selling price typically goes down due to increased bid shading. Nyborg et al. (2002) use volatility as a proxy for uncertainty about the value of the securities and show that bidders respond to the winner's curse risk by bid shading and dispersing theirs bids more when uncertainty is higher. *Bid shading* refers to the fact that bidders bid at prices below their valuation of the securities. Herb (2017) finds a similar impact of volatility on auction outcomes. Second, as the number of bidders increases, bidding more conservatively is usually optimal. This rationale is because the highest of, say, 10 estimates is likely to be much greater than the higher of two estimates. Thus, as the number of bidders increases, it reinforces the winner's curse and, despite the increased competitive pressure, it often causes bidders to shade their bids below their estimates of true underlying value by a greater amount (Bikhchandani and Huang 1993). Given the consolidation in the financial industry and the associated decline in primary dealers, using a long time-series data set is now plausible to empirically test the effect of the number of bidders on bid shading and auction underpricing.

The rewards to bidding in a common value auction must be based on the value of private information. If everyone knows the true value, then no bidder has private information and the expected profit is zero. If the true value is uncertain, then bidders who possess useful private information earn positive expected profit, and the more uncertain the true value the greater is the expected profits for these bidders. In turn, the greater the uncertainty about the true value, the lower is the seller's revenues. Therefore, governments have an interest in alleviating the winner's curse problem in treasury auctions. One way to achieve this objective is to reduce uncertainty by promoting a liquid and transparent secondary market and communicating effectively to the market about interest rate targets and monetary policies.

Pre-Auction Market, Post-Auction Market, Squeeze, and Liquidity

Investors are more familiar with the *post-auction* secondary market: after settlement the Treasury securities can be traded in the market. The market for government securities is an over-the-counter (OTC) market in which participants trade with one another on a bilateral basis rather than on an organized exchange. Treasury securities are officially registered at the New York Stock Exchange, but trading in that market is negligible. The overwhelming majority of trading activity takes place among primary dealers, non-primary dealers, and clients of these dealers, including financial institutions, non-financial institutions, and individuals.

Many dealers, particularly the primary dealers, "make markets" in Treasury securities by standing ready to buy and sell securities at specified prices. In the process of making markets, dealers purchase securities at the bid price and sell the same securities at the slightly higher offer (ask) price. Through these sales and purchases, the dealer can facilitate transactions between customers while taking only temporary positions in the security. In doing so, the dealer earns the difference between the bid and offer prices, referred to as the *bid-offer (bid-ask) spread*. Besides transacting directly with customers, primary dealers frequently trade with one another.

Bikhchandani and Huang (1989) show some interesting connections between the secondary market and the auction. They note that the primary dealers are all large financial institutions, who generally have better term structure of interest rates estimation and better information about the demand for the Treasury securities compared to smaller institutions and individual investors who are natural buyers in the secondary market. As bids submitted in the auction reveal the private information of competitive bidders, the secondary market prices will be responsive to these bids. Therefore, the large primary dealers have an incentive to bid higher than they would have to signal to the buyers in the secondary market that the bidders' private information is very favorable.

As early as after an auction announcement, primary dealers begin trading among themselves and with their institutional clients before the actual auction takes place until the security's settlement date. This process is known as the *when-issued* market, in which market participants essentially enter into forward contracts pre-auction. The seller of a forward contract guarantees to deliver the underlying securities after settlement at a pre-determined forward price. As a result, market makers for Treasury securities (i.e., primary dealers) often enter auctions with negative (short) pre-auction inventory positions. Institutional investors are natural counterparties because they can ensure delivery void of the uncertainty of the auction. A difference exists between buying from a primary dealer in the when-issued market and submitting auction bids via a primary dealer. A common belief is that trading before the auction enhances price discovery and improves risk sharing by stretching the distribution process (Bikhchandani and Huang 1993). Using a bid-level data set with a unique variable of pre-auction positions, Rydqvist and Wu (2016) find that most dealers enter auctions with short positions, and in auctions where pre-auction positions are stretched out, underpricing and therefore reducing the cost of borrowing.

Bidders with short pre-auction positions expect to cover their short positions in the auction. However, the post-auction securities ownership may end up in the hands of a single securities dealer who can exercise market power over dealers with negative post-auction inventory. This situation is commonly referred to as a *short squeeze*, which can result in secondary market prices rising above their competitive level. This issue circles back to the other two objectives of the treasury outlined previously discussed. Besides maximizing auction revenue, the goal is to prevent market manipulation and promote a liquid secondary market. The long-standing debate of treasury auction method ranking focuses on a method that would result in the highest possible revenue and is least subject to possible manipulations by any individual or cartel. To combat a potential squeeze, award or bidding limits are put in place by the treasuries. In the United States, no bidder can receive more than 35 percent of the issue under its name. To illustrate, the award limit in the example in Table 29.3 is $5.25 billion, which is 35 percent of the $15 billion total offering amount. Even with this limit in place, Salomon Brothers was able to circumvent and break the rule in an attempt to squeeze the market in May 1991 for two-year Treasury notes. As a result, the two-year notes started trading at abnormal premiums in the secondary market (i.e., the securities became very illiquid). An illiquid secondary market could be detrimental to both the investors and the Treasury, and increase the Treasury's cost of financing in subsequent auctions. This scandal eventually led to the regulators overhauling U.S. Treasury auctions in the 1990s and the ultimate switch of auction methods. Joint Report on the Government Securities Market (1992) and Jegadeesh (1993) provide details of the Salomon episode.

For countries with smaller markets, the treasuries typically choose to prevent squeeze and increase liquidity by frequently reopening outstanding securities. *On-the-run treasury securities* are the most recently issued treasury securities for a particular maturity. For example, when a new 10-year bond is issued, the security goes on-the-run, while previously issued 10-year bonds become off-the-run. On-the-run securities tend to be more liquid than off-the-run securities of comparable maturity. When a treasury reopens instead of issuing new securities, it injects liquidity to the outstanding securities and essentially keeps the securities on-the-run.

The pre-auction, when-issued, and the post-auction secondary market are integral parts of the entire auction process. A repurchase (repo) market for Treasury securities also exists. It is a market for short-term loans for which a lender holds a specific Treasury security as collateral. Borrowers who want funds from the repo market place their securities as collateral and agree to repurchase these securities at a future date (often overnight) at a predetermined price. The repurchase price is generally higher than the loan amount, the difference is the interest earned (repo rate) unless the collateralized Treasury security is in short supply resulting in a low or "special" repo rate. Under normal circumstances, both the pre-auction and post-auction markets are extremely liquid. Fleming (2003) estimates that the annual turnover in U.S. Treasury markets is around 2,000 percent and Engle, Fleming, Ghysels, and Nguyen (2013) estimate the bid-ask spreads in the secondary market to be less than one basis point for two-year Treasury notes. The heavy trading indicates the pivotal role of U.S. Treasury securities in global financial markets. Many types of investors, commercial banks, investment banks, security dealers, money market funds, insurance companies, individual investors, and foreign central banks use the Treasury market for investing and hedging purposes. Market participants often view yields on the securities as benchmarks in the pricing of other debt securities. Treasury auctions are different from other types of auctions because of the presence of such large, active, and liquid pre-auction and post-auction markets.

Measuring Underpricing

As mentioned previously, *underpricing* in treasury auctions is the percentage difference in price between what winning bidders pay at the auction (bidders' costs) and what they can resell or have sold in the secondary or when-issued market (bidders' revenues). Underpricing is a measure of auction outcome and bidder profit. Measuring underpricing is an empirical task that is highly sensitive to the selection of the benchmark in secondary market prices. Although countries, sample periods, securities, and methodologies may differ, the consensus in the literature is that substantial positive underpricing (bidder profit), on average, exists. Furthermore, underpricing is an increasing function of the maturity of the security. Table 29.5 summarizes the various case studies including the United States, Mexico, Sweden, Finland, and Canada.

Cammack's (1991) study of market prices shortly before and after U.S. Treasury auctions provides support for the view that auctions release information that helps with price discovery in the secondary market. According to Spindt and Stolz (1992), the observed underpricing is compensation for primary dealers' risks. Simon (1994) as well as Nyborg and Sundaresan (1996) report on the results of underpricing when the U.S. Treasury was experimenting with auction methods in the 1970s and 1990s. Umlauf (1993) reports on a similar experiment in Mexico. Goldreich (2007) offers a more detailed calibration for U.S. Treasury auctions using a new secondary market data set (GovPX). From a review of these studies, debate still exists about the effect of switching from a discriminatory to a uniform-price auction. Goldreich estimates underpricing in U.S. Treasury bond auctions to be 3.5 basis points in discriminatory auctions and 1.3 basis points in uniform-price auctions, on average. By way of comparison, the magnitude of the estimated underpricing with the secondary market bid-ask spread is one basis point for two-year U.S. Treasury notes (Engle et al. 2013).

Although debate continues as to which type of auction is likely to produce the higher average revenue, a perhaps more critical issue is to explain underpricing. A common explanation of underpricing is that primary dealers, in equilibrium, need to be compensated for the risk of participating in every auction (Lou, Yan, and Zhang 2013; Herb 2017) and making the market for government securities (Spindt and Stolz 1992). The recent class action lawsuit puts Treasury auctions and particularly underpricing in the spotlight. The State-Boston Retirement System, the pension fund for Boston public employees, filed a lawsuit in 2015, alleging that the primary dealers sell to investors in the when-issued market at high prices, and deflate prices when they buy at the auction to cover their pre-auction sales (Reuters 2015). The investors are essentially suing the primary dealers for underpricing. Although the literature offers the risk-based explanations for Treasury auctions underpricing, whether the level of underpricing observed provides an appropriate level of compensation for the risk involved in participating in the auction and later making the market is unclear. Also, in a recent study of Canadian Treasury auctions, Rydqvist and Wu (2016) document that primary dealers with large short positions actually bid more aggressively in auctions to cover their short positions. However, this evidence does not rule out excess primary dealer profits because the prices in the privately negotiated when-issued contracts between primary dealers and investors are unknown. Availability of such data would encourage future research to investigate bidder-specific profits and whether underpricing is too much or appropriate.

Summary and Conclusions

Each week, market participants use auctions to buy extremely large amounts of government securities (dollar-denominated and non-dollar-denominated) around the world. Central governments have three main objectives in the process of issuing their debt: (1) maximizing auction revenue, (2) preventing market manipulation, and (3) promoting a liquid post-auction secondary market. This chapter attempted to provide some context to the scope, design, and procedures of treasury auctions. Treasury auctions are unique

Table 29.5 **Summary of Average Underpricing in Empirical Studies**

Study	*Country*	*Sample Period*	*Securities*	*Benchmark*	*Underpricing (in bps)*	
					Discriminatory Auctions	*Uniform-Price Auctions*
Cammack (1991)	U.S.	1973–1984	3-month bills	Daily average of the on-the-runs	4.00	n.a.
Spindt and Stolz (1992)	U.S.	1982–1988	bills	Intraday bid	1.30	n.a.
Umlauf (1993)	Mexico	1986–1991	1-month bills	Daily bid	1.84	–0.30
Simon (1994)	U.S.	1973–1976	15- to 30-year bonds	Intraday bid	15.80	19.20
Nyborg and Sundaresan (1996)	U.S.	1992–1993	2-year bonds	Intraday transaction	1.05	–0.10
			5-year bonds	Intraday transaction	2.22	3.49
Bikhchandani, Edsparr, and Huang (2000)	U.S.	1986–1988	bills	Intraday bid	1.00	n.a.
Nyborg, Rydqvist, and Sundaresan (2002)	Sweden	1990–1994	bills	Daily bid	–1.00	n.a.
			bonds	Daily bid	9.60	n.a.
Keloharju, Nyborg, and Rydqvist (2005)	Finland	1991–1999	bonds	Intraday bid	n.a.	4.10
Goldreich (2007)	U.S.	1991–2000	bonds	Intraday transaction	0.59	0.32
Rydqvist and Wu (2016)	Canada	1998–2011	bills	Daily mid	–0.30	n.a.
			bonds	Daily mid	9.80	n.a.

This table summarizes the findings of average underpricing in treasury auctions in various empirical studies. Benchmark refers to the secondary market or when-issued market prices, with which the studies use to compare against auction prices. Underpricing (in basis points) is reported if the countries use discriminatory or uniform-price auctions, or experiment with both.

in the sense that they are multi-unit, common value auctions, and are accompanied with large and active pre- and post-auction markets. Despite their size and transparency, much work is still needed to know about treasury auctions' ranking methods, optimal auction mechanisms, level of underpricing, and bidder strategies. One promising aspect is that central government debt management authorities are now willing to share sensitive auction data set with researchers to produce policy analysis and empirical research. Consider, for example, the savings that might be realized by a country auctioning $1 trillion of securities annually. If a more cost-effective design could be identified and adopted, each 0.1 percent reduction in underpricing achieved through the design improvement would lower that country's annual cost of borrowing by $1 billion.

Discussion Questions

1. List the auctioneers' main objectives in treasury auctions.
2. Differentiate between a discriminatory auction and a uniform-price auction.
3. Discuss the roles of primary dealers and the reason for underpricing in U.S. Treasury auctions.
4. Discuss the role of private information in treasury auctions.
5. Discuss how governments prevent a short squeeze in the treasury markets.

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30

Bond Accounting

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Introduction

The bond market is the largest source of funding available to private and public entities to raise capital to finance their economic activities surpassing the equity market by a ratio of three to two. According to the Securities Industry and Financial Markets Association (SIFMA) (2018), the outstanding value of bonds and bond related instruments in the United States was $39.44 trillion at year-end 2016. Industry professionals need to be able to properly record and report bond transactions on financial statements.

A bond can be a liability or an asset. When a company issues bonds to finance its short- and long-term projects, it incurs a liability on the balance sheet. Conversely, when a company or other entity buys or invests in bonds, it records an asset or investment on the balance sheet. The type of the bond transaction also determines whether interest paid or received on the bond is recorded on the income statement as an income or as an expense. Therefore, bond issuances and purchases result in similar but opposite accounting entries and classifications.

When a bond is issued or acquired at par value, the impact on the income statement is limited to the interest paid or received on the bond, and the book or unamortized balance stays the same until the issuer repays the principal at a future date or the debt is otherwise properly extinguished. However, bonds can trade at par or sell at a premium or a discount. Therefore, the amortization income or expense generated from bond instruments must be recognized in the income statement at every reporting period. The amortization of income or expense must also be considered for the purpose of calculating the book value of debt. Over time, the book value of a bond issued at a discount eventually accretes to par while that of a bond issued at a premium amortizes to par. Equations 30.1 and 30.2 show how earned interest income and incurred interest expenses can be calculated respectively.

$$\text{Earned Interest Income} = \text{Cash Interest Received} + / - \text{Premium / Discount Amortization} \quad \mathbf{(30.1)}$$

$$\text{Incurred Interest Expense} = \text{Cash Interest Paid} +/- \text{Premium}/\text{Discount Amortization} \quad \textbf{(30.2)}$$

Bonds issued or acquired are generally carried at book value on the balance sheet, but a company may elect to use the fair value option to record the transaction at the outset if it chooses. However, if a company chooses to record its bonds at book value, it must review the structures of such bonds to ensure that they do not have any embedded derivatives or contingent claims. If they do, these embedded derivatives must be bifurcated from the original instrument and recorded at fair market value. The Statement of Financial Accounting Standards (SFAS) 133 requires all derivative instruments to be reported at fair value at every reporting period. Changes in the fair value of such instruments from period to period must then be recorded as earnings or in a component of shareholder's equity known as Other Comprehensive Income (OCI). OCI items are income, revenue, and expense items that bypass the net income on the income statement but rather are reflected as changes to shareholders' wealth listed after net income on the income statement.

The chapter provides a discussion of bond accounting from the perspective of both assets and liabilities. It begins by reviewing relevant accounting standards and guidance on bond accounting under the U.S. generally accepted accounting principles (U.S. GAAP). Specifically, it examines the key provisions in SFAS 91 now codified in Accounting Standards Codification (ASC) 310-20 on Amortization of Premium and Discount, SFAS 115 now codified in ASC 320 on the Classifications of Certain Investments in Debts and Securities, ASC 820 (formerly SFAS 157) on Fair Value Measurement, and ASC 815 on Derivatives and Hedging.

The chapter provides a discussion of the accounting and amortization entries necessary to properly record different types of bond instruments, namely, zero-coupon, fixed rate, and floating-rate bonds using a case study approach. Additionally, the chapter covers the accounting entries necessary to record, report, and disclose derivatives transactions (swaps) entered to hedge the fluctuations in the fair value of a bond instrument.

Literature, Standards, and Pronouncements on Bond Instruments

This section discusses the core requirements and provisions of the relevant bond accounting standards.

Accounting for a Bond Liability Where the Fair Value Option is Not Elected

Bond liabilities for which the fair value option is not elected are carried at book value. This situation occurs either because such bonds do not qualify for such option or the company has decided to forgo the option. Regardless of whether a bond is recorded at book value or fair value, a company must track the book balances and amortization expenses or income on such bonds. This process occurs because the amortization of premium, discount, and issue costs affects a company's net interest income (interest income minus interest expenses) for every reporting period and the carrying value needs to be tracked for disclosure purposes. For bond liabilities for which the fair value option is not elected, the burden is on the reporting entity to evaluate the bond indenture and to ensure that any embedded derivatives are bifurcated from the host contract. The bifurcated derivative should then be separately fair valued with changes in the fair value of such an instrument reported in the earnings of the company according to SFAS 133.

A bond for which the fair value option is not elected is carried on the balance sheet at book value and accretes or amortizes to par.

- *Par bond*. If the market rate at issuance and the stated rate are the same, the bond is issued at par. In this case, the net income impact of the bond is limited to the cash interest paid or received (i.e., the cash interest expense is the same as the interest payment incurred) ignoring issuance fees. Similarly, the *carrying value* is the original principal balance net of any principal repayment.
- *Discount bond.* If the market rate at which a bond is issued is higher than the stated rate, the bond is issued at a *discount*. For example, a zero-coupon bond is a type of bond that must be issued at a discount and the balance accretes to par at maturity.
- *Premium bond.* If a bond is issued at a market rate that is lower than the stated rate, the bond is issued at a *premium* and the unpaid principal balance ultimately amortizes to par.

For floating rate notes (FRNs), if the issue spread is equal to the discount margin, the note is issued at *par*. If the issue spread is greater (less) than the discount margin, the note is issued at a premium (discount). Regardless of whether a bond was issued at a premium or a discount, the carrying amount of the debt remains the unpaid principal balance plus (minus) discount (premium) amortization and unamortized issue cost.

Table 30.1 offers examples of fixed rate bonds that are issued at par, a premium, and a discount. Table 30.2 shows examples of pricing relations for FRNs based on the issue spread (IS) and the discount margin (DM). The IS refers to the fixed initial spread above the reference rate over the bond's life. The DM is the spread above the reference rate, which may vary from period to period, ensuring that the present value of the expected future cash flow equals the market price of the FRN.

Table 30.1 **Examples of Fixed Rate Bonds Issued at Par, Premium, and Discount**

Description	*Coupon (%)*	*Yield (%) (YTM)*	*Present Value (PV)*	*Type*
Coupon = YTM	6	6	$1,000,000.00	Par
Coupon > YTM	9	6	$1,126,370.91	Premium
Coupon < YTM	6	9	$883,310.46	Discount

This table illustrates the relation between the coupon and yield of a fixed rate bond.

Table 30.2 **Examples of Floating Rate Notes Issued at Par, Premium, and Discount**

Description	*Coupon*	*Yield (YTM)*	*Present Value (PV)*	*Type*
IS = DM	0.0075	0.0075	$1,000,000.00	Par
IS > DM	0.0075	0.0045	$1,014,907.04	Premium
IS < DM	0.0045	0.0075	$985,234.90	Discount

This table illustrates the relation between the issue spread and discount margins of FRNs.

According to Bushee (2014), noncash interest expenses resulting from amortization of discounts must be added back in the operating section of the Statement of Cash Flow (SCF) under indirect method under a line item often called amortization of bond discount.

The effective interest rate is the market yield on a bond or the internal rate of return (IRR) that sets the net present value (NPV) of future cash flows on the bond to zero. SFAS 91 (paragraph 18) states that the "net fees or costs that are recognized as yield adjustments over the life of the related loan(s) shall be recognized by the interest method" (Financial Accounting Standards Board [FASB] 1986). It further states that the objective of this method is to arrive at a periodic income, including recognition of fees and costs, at a constant effective yield. The net implication is that the difference between the interest calculated based on the stated interest rate and that calculated based on the effective interest rate or the IRR is adjusted to income at every reporting period. Essentially, the discounts/premiums are amortized as a proportion of the carrying value. For bonds issued at a discount, amortization expenses are initially lower and then progressively increase as the amortized balance accretes. For bonds issued at a premium, amortization income is greater in the beginning and then becomes progressively smaller as the bond amortizes.

This methodology is straightforward to implement for bonds such as zero-coupon and fixed rate bonds with deterministic cash flows (i.e., where the future cash flow stream is known from the outset). But what about bonds whose cash flow streams change over time or are nondeterministic as in the case of FRNs? As Alexander (2008) states, FRNs are a sequence of fixed coupon bonds that mature at every payment date, reset to par, and automatically become newly issued bonds. Because the coupon payments on FRNs change on every interest rate reset date, the estimated future cash flow payments at one reset date may differ from the cash flow streams at a future date depending on whether the benchmark reference rates move up or down. The solution is to use the current rate to calculate amortization expenses/income on the security as if these cash flows persist over the bond's life. Then, at a future reporting period when the rate resets, the task is to recalculate the effective yield on a prospective basis as if the bond were newly issued treating the amortized balance and the undiscounted premium or discount as the starting point.

The treatment in the previous paragraph is not unlike using estimated prepayments to calculate amortization amounts for loans and then restating the estimated prepayment total to the actual amount and recalculating the amortization amounts prospectively

Table 30.3 **Sample Presentation of a Bond Liability at Book Value**

Description	***20X2***	***20X1***
Principal amount	$30,000,000	30,000,000
Less: Unamortized discount/issue cost	−4,700,000	−5,000,000
Long-term liability less unamortized discount and issue cost	$25,300,000	$25,000,000

This table illustrates a bond liability in the financial statement at book value for comparative years.

from that point onward. For example, SFAS 91 (paragraph 19) states that if the enterprise anticipates prepayments in applying the interest method and a difference arises between the prepayments anticipated and actual prepayments received, the enterprise recalculates the effective yield to reflect actual payments to date and anticipated future prepayments. The standard also states that net investment in the loans are adjusted to the amount that would have existed had the new effective yield been applied since the acquisition of the loan (FASB 1986).

Based on guidance in SFAS 91, the amortization income or expenses on a bond and a loan, respectively, should be calculated over the "contractual" life of the financial instrument using the "effective interest" method (FASB 1986). Reporting entities cannot use other methods unless they can prove that the amortization amounts generated using the different method are not materially different from those generated using the prescribed method.

GAAP now requires deducting transaction costs including third-party costs and creditor fees from the carrying value of the financial instrument and not recording them as deferred charges or deferred credits. Only costs that are directly related to the issuance should be so recognized while indirect and other costs not directly related to the specific issuance should be expensed as incurred. These expenses should also be amortized into income using the effective interest method. Table 30.3 shows a sample presentation of a long-term liability using a two-year comparison.

Accounting for Bond Liability Using the Fair Value Option

Although a company could elect to use amortized balances to record and report its bond assets and liabilities, this treatment or election is not automatic. A reporting entity must review the structure of its bond instruments and ensure that they do not contain embedded options or contingent claims before deciding to use the book value basis to account for them. However, bond instruments are becoming increasingly complex and often integrate many features such as call, put, or credit risk components to meet an organization's ever-evolving capital financing needs. Upon evaluation, if a bond is determined to contain a derivative, a company must either elect the fair value option to record the bond instrument or, alternatively, must ensure that the derivative is bifurcated from the host instrument and separately fairly valued. Changes in the market value of such embedded instruments must be recorded in earnings or as a component of shareholders' equity. Unlike the amortized cost basis where the cost basis recorded in the balance sheet can deviate substantially from the market value, under the fair value option, bond liabilities are carried at current market value (Bushee 2014).

According to Fabozzi (2014), to value a bond with an embedded option, interest rate volatility must be considered as a factor that affects the probability of the option being exercised. The valuation of these types of instruments is implemented by using a binomial or trinomial interest rate tree that models the random evolution of interest rates and then by using backward induction to calculate the value of the instrument at each time step. Using this approach, the value of the hybrid bond instrument can be calculated at each node so that the value of the embedded option can be bifurcated from that of the host instrument. As Kalotay, Williams, and Fabozzi (1993) noted, a straight bond is related to both a callable and puttable bond by the relation described in Equations 30.3 and 30.4.

$$\begin{aligned}&\text{Value of a Callable Bond}\\&\quad= \text{Value of a Straight Bond} - \text{Value of Issuer Call Option}\end{aligned} \tag{30.3}$$

$$\begin{aligned}&\text{Value of a Puttable Bond}\\&\quad= \text{Value of a Straight Bond} + \text{Value of Investor Put Option}\end{aligned} \tag{30.4}$$

However, bifurcating the value of an embedded option from that of the host instrument and treating them separately could create an additional layer of complexity for the reporting entity. Hence, many corporations simply elect to use the fair value option for such instruments and take changes in the fair value into income. A company may also elect to use the fair value option to record its bond transactions even if it qualifies to use the book value method. This option can be elected if in the company's view, future interest rate movements are likely to result in fair value gains for the company thus boosting its bottom line.

The key provisions, definitions, and guidelines in SFAS 157, now codified in ASC 820, are important to understand. A working knowledge of this standard is vital because it explains the framework within which U.S. corporations build their valuation practices and, by extension, the fair value option for bond instruments. A strong grounding in this standard helps industry professionals in properly preparing, recording, and reporting their bond instruments under the fair value option.

According to SFAS 157 (FASB 2006), *fair value* is the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date. This definition assumes that the transaction to sell the asset or transfer the liability occurs in the principal or most advantageous market. SFAS 157 identifies the following three valuation techniques (FASB 2006):

- *Market approach.* This approach uses prices and other relevant information generated by market transactions involving identical or comparable assets or liabilities.
- *Income approach.* This approach uses valuation techniques to convert future amounts (cash flows or earnings) to a single present value discounted amount.

- *Cost approach.* This approach is based on the amount that currently would be required to replace an asset's service capacity, which is often called the *current replacement cost*.

To ensure consistency and comparability in fair value measurements and related disclosures, SFAS 157 paragraphs 22–25 (FASB 2006) categorizes inputs used in the different valuation techniques into three levels:

- *Level 1 inputs* are quoted prices (unadjusted) in active markets for identical assets or liabilities that the reporting entity has the ability to access at the measurement date (e.g., stocks).
- *Level 2 inputs* are prices other than quoted prices that are observable for the asset or liability (e.g., interest rates and yield curves observable at commonly quoted intervals).
- *Level 3 inputs* are unobservable inputs for assets and liabilities and therefore based on the reporting entity's own assumptions (e.g., mortgage-backed securities).

The SFAS 157 fair value hierarchy gives the highest priority to Level 1 inputs and the least priority to Level 3 inputs.

Accounting for Investments in Debt Securities

The accounting treatment for recording debt investments and debt liabilities differs. The accounting treatment for an investment in debt and equity securities is guided by pronouncements in SFAS 115 now codified in ASC 320 entitled "Accounting for Investments in Equity & Debt Securities" (FASB 1993). When a company invests in debt securities such as mortgage backed securities (MBS), collateralized mortgage obligations (CMO), U.S. Treasury debt, and corporate bonds, it must categorize such securities at the outset into one of three buckets:

- *Trading securities.* Debt and equity securities that are bought and held principally for the purpose of selling them in the short-term are classified as trading securities and reported at fair value, with unrealized gains and losses included in earnings. Time frames that are less than one year are generally considered short-term.
- *Held-to-maturity (HTM).* Debt securities that the enterprise has the intent and ability to hold to maturity are classified as HTM debt and reported at amortized cost. HTM debt securities are recorded at amortized cost (i.e., cost as adjusted for accretion, amortization of premium/discount, cash payments or receipts, or previous other-than-temporary impairment recognized in earnings, less any cumulative effect)
- *Available-for-sale (AFS).* Debt and equity securities not classified as trading securities or HTM and reported at fair value, with unrealized gains and losses excluded from earnings and reported in a separate component of shareholders' equity as part of OCI adjustments.

Accounting for Derivatives Entered to Hedge the Fair Market Value of Debt Securities

When a company elects the fair value option to record its investment in debt securities, it must mark to market such instruments and record changes in the market value in earnings or OCI at every reporting period. However, marking financial instruments to market and taking changes in the fair value of such instruments into income make a company's earnings highly vulnerable to market fluctuations. Therefore, companies may enter into interest rate swap transactions or other types of derivatives to minimize the fluctuations in their earnings and to achieve other risk management objectives.

To motivate further discussion on accounting for derivative instruments used to hedge the fluctuations in the fair market value of debt securities, an understanding of why corporations use modified duration hedging (i.e., the weighted average time to receive cash flows from an instrument) to reduce the susceptibility of their balance sheets to mark-to-market fluctuations is necessary. Table 30.4 presents a hypothetical company's balance sheet including information on the modified duration of both assets and liabilities.

If the benchmark interest rate moves up or down by one percentage point, the net worth of the corporation may decrease or increase. However, the company may prefer to immunize itself against these market movements and enter into offsetting transactions to reduce the likelihood of fluctuations in its earnings from period to period. To achieve this goal, the company needs to determine the modified duration of its net worth, which is simply the weighted average modified duration of its assets and liabilities shown in Equation 30.5.

$$D_{NW} = 2M(0) + 5M(0.75) + 3.5M(1.5) - 4.5M(15) - 0.6(0.5) = -5.60 \quad \textbf{(30.5)}$$

Using the modified duration of –5.60 for the net worth, the amount by which the net worth will move up or down if interest decreases or increases by a certain percentage or basis points can then be determined using Equation 30.6.

$$\Delta_{NW} = -D_{NW} * NW * \Delta y \quad \textbf{(30.6)}$$

Table 30.4 **Duration Hedging of the Balance Sheet**

Description	*Assets*	*Modified Duration*	*Description*	*Liabilities*	*Modified Duration*
Cash	$2,000,000	0.00	Long-term debt	$4,500,000	5.00
Treasury-bills	5,000,000	0.75	Short-term debt	600,000	0.50
Bonds	3,500,000	1.50	Net worth	5,400,000	
	$10,500,000			$10,500,000	

This table shows the balance sheet of a hypothetical company illustrating the assets and liabilities and the modified duration of each line item.

where Δ_{NW} is the change in net worth;$-D_{NW}$ is the change in duration of net worth; and Δ_y is change in interest rate.

$$\Delta_{NW} = -(-5.6) * 5.4M * 0.01$$

$$\Delta_{NW} = \$302,400.00$$

The company has identified an interest rate swap to hedge its net worth. The swap features a fixed leg modified duration of 5.0 years and a floating leg modified duration of 0.5 years.

The notional principal required to hedge the fluctuations can then be calculated as shown in Equations 30.7 and 30.8:

$$\Delta_S = -(D_{fixed} - D_{floating}) * NP * \Delta_y \quad \textbf{(30.7)}$$

$$NP = \Delta_S / -((D_{fixed} - D_{floating}) * \Delta_y) \quad \textbf{(30.8)}$$

where Δ_S is the change in value of interest rate swap; $-D_{fixed}$ is the duration of fixed swap leg; $-D_{floating}$ is the duration of swap floating leg; Δ_y is the change in the interest rate; and NP is the notional principal of the interest rate swap.

$$NP = \frac{-\$302,400}{-(5.0 - 0.5 * 0.01)}$$

$$NP = \$6,720,000 \Delta_S = -(5.0 - 0.5) * 6,720,000 * 0.01$$

$$\Delta_S = \$302,400$$

Without the hedge, the net worth would have increased by $302,400 when the interest rate increased by one percentage point. When interest rate increases by one percentage point, the hedge loses $302,400 in value effectively offsetting the increase in net worth. The company is the floating rate payer and fixed rate receiver. The opposite position would be taken if the company was trying to offset a decrease in its net worth. That said, according to SFAS 133 on Derivatives and Hedging (FASB 1988), a derivative transaction can be accounted for in one of two ways.

- *Speculative/Undesignated.* A company uses the speculative/undesignated method when a derivative does not qualify for hedge accounting or in instances in which a derivative qualifies for hedge accounting but the entity has decided to use speculative accounting. When a company uses speculative accounting, it recognizes the derivative as an asset or liability and changes in the fair value of the derivative are recognized in income at every reporting period.

- *Hedge accounting.* A company uses the hedge accounting method when it is concerned about the volatility that the use of a derivative instrument may introduce into its earnings. A company must meet certain strict criteria to use the hedge accounting method. For example, the risk management objective of the hedging relation must be documented in detail and the hedge must be expected to be highly effective in offsetting the variability in the fair value or cash flow of the underlying amongst others.

Hedge accounting is further divided into three main buckets: (1) fair value hedge, (2) cash flow hedge, and (3) foreign currency hedge. A *fair value hedge* is used to mitigate losses that may arise from exposure to changes in the fair value of an underlying item. Under this type of hedge, both the changes in the derivatives' fair value and the underlying are reported in income. A *cash flow hedge* is used to reduce the variability in the cash flow of an underlying item such as a forecasted transaction or a firm commitment. Under this type of hedge, the effective portion of the change in the fair value or cash flow of the underlying is recorded in OCI and the ineffective portion is recorded in income. A *foreign currency hedge* is used to hedge exposures to adverse movements in foreign currency transactions.

Accounting for Bond Transactions

This section focuses on implementing the theories discussed in the preceding section. Specifically, the accounting and amortization treatments for different types of bond transactions are discussed.

Accounting for Fixed Rate Liabilities

A fixed rate bond is issued at a discount, par, or premium and pays a coupon based on the stated interest rate every interest payment date. The issuer pays both the principal and final interest on the maturity date. Table 30.5 shows the details of a plain vanilla 2 percent fixed rate bond issued on January 26, 2017, that matures on January 26, 2022.

Consider the plain vanilla bond instrument described in Table 30.6. On the settlement date (i.e., January 26, 2017), Table 30.6 shows how the organization should record the entries to account for the bond issuance.

After the initial entries, the organization must calculate and record cash interest expense and discount amortization on the bond. Suppose the next reporting date is July 26, 2017, which is exactly six months after issuance. The organization can determine the discount amortization expense using the effective interest method as explained in Table 30.7. Table 30.7 shows the calculation of the discount amortization on the bond using the effective interest rate method and assuming a constant yield over the bond's life.

On July 26, 2017, the general ledger entry to record the amortization calculated in Table 30.7 is shown in Table 30.8.

Assuming July 26, 2017 is the fiscal year end of the organization, the company presents the bond liability in the footnotes to the financial statement as shown in Table 30.9. This

Table 30.5 **Analysis of Fixed Rate Bond**

Description	***Detail***
Issuer rating	Aaa/AAA
Tranche	5-year
Total amount	$5 billion
Settlement date	1/26/2017
Maturity date	1/26/2022
Coupon	2%
Coupon payment dates	Paid semi-annually on January 26 and July 26 of each year
Issue price	99.46%
Issue yield	2.115%
Issuance cost	Zero (Assumed)

This table provides the terms of a fixed rate bond used to illustrate the accounting, amortization, and valuation of a coupon paying bond.

Source: *World Bank Treasury* (2017).

Table 30.6 **Accounting Entries to Record Issuance of a $5 Billion Bond at 99.457 Percent**

Date	***Ledger Entry***	***Description***	***Amount ($)***	
			Debit	***Credit***
1/26/2017	Debit	Cash/bank account (0.99457) ($5,000,000,000)	4,972,850,000	
1/26/2017	Debit	Bond discount (plug)	27,150,000	
1/26/2017	Credit	Bond liability/payable		5,000,000,000
		Total	**5,000,000,000**	**5,000,000,000**

Memo: To record a five-year bond for $5 billion issued on January 26, 2017, at 99.457 percent.

This table shows the accounting entries necessary to record the fixed rate bond detailed in Table 30.5 at issuance.

table shows a comparative presentation of the liability for the current and prior fiscal years. The principal liability is presented net of any unamortized discount and issuance cost.

Assume that on January 26, 2018, the organization decides to repurchase the bond and the market interest rate on this date has risen to 3 percent. This repurchase is known as a *bond retirement before maturity*. To retire the bonds from the balance sheet, the

Table 30.7 **Amortization Calculations Using the Effective Interest Method**

A	*B*	*C*	*D*	*E*	*F*
	5B(0.02)(180/360)	*Yield (0.021150161) Previous Book Value (Column E)*	*(C – B)*	*Previous Book Value + Discount Amount*	*Previous Unamortized Discount – Discount Amount (Column C)*
Date	*Coupon Payment*	*Interest on Book Value*	*Discount Amortized*	*Book Value*	*Unamortized Discount*
1/26/2017	—	—	—	4,972,850,000.00	27,150,000.00
7/26/2017	50,000,000.00	52,588,290.24	2,588,290.24	4,975,438,290.24	24,561,709.76
1/26/2018	50,000,000.00	52,615,661.62	2,615,661.62	4,978,053,951.86	21,946,048.14
7/26/2018	50,000,000.00	52,643,322.45	2,643,322.45	4,980,697,274.31	19,302,725.69
1/26/2019	50,000,000.00	52,671,275.80	2,671,275.80	4,983,368,550.11	16,631,449.89
7/26/2019	50,000,000.00	52,699,524.76	2,699,524.76	4,986,068,074.86	13,931,925.14
1/26/2020	50,000,000.00	52,728,072.45	2,728,072.45	4,988,796,147.31	11,203,852.69
7/26/2020	50,000,000.00	52,756,922.03	2,756,922.03	4,991,553,069.34	8,446,930.66
1/26/2021	50,000,000.00	52,786,076.71	2,786,076.71	4,994,339,146.05	5,660,853.95
7/26/2021	50,000,000.00	52,815,539.69	2,815,539.69	4,997,154,685.75	2,845,314.25
1/26/2022	50,000,000.00	52,845,314.25	2,845,314.25	5,000,000,000.00	0.00

Actual Yield: 0.021150161—Calculated Using MS Excel Goal Seek

This table shows an amortization schedule calculated using the effective interest method for the fixed rate bond detailed in Table 30.5.

Table 30.8 **Accounting Entries to Record Interest Expense on July 26, 2017**

Date	*Ledger Entry*		*Description*	*Amount ($)*	
				Debit	***Credit***
7/26/2017	Debit		Interest expense	52,588,290.24	
7/26/2017		Credit	Cash		50,000,000.00
7/26/2017		Credit	Unamortized discount (plug)		2,588,290.24
			Total	**52,588,290.24**	**52,588,290.24**
Memo: To record interest expense on July 26, 2017.					

This table shows the accounting entries necessary to record the fixed rate bond detailed in Table 30.5 on July 2017, which is the next financial reporting date immediately after issuance.

Table 30.9 **Presentation of Bond Liability at Book Value as of July 26, 2017**

Description	*January 26, 2016*
Principal amount	$5,000,000,000.00
Less: Unamortized discount/issue cost	−24,561,709.76
Long-term liability less unamortized discount and issue cost	$4,975,438,290.24

Table 30.9 shows how the principal amount and unamortized discount for the bond detailed in Table 30.5 would be presented in the financial statement on a reporting date.

organization needs to determine the bond's fair market value but, in practice, it may use the fair value observable in the market. The organization then posts any gain or loss emanating from the retirement. The fair market value can be inferred from the yield using Equation 30.9:

$$\text{Market or Risky Price} = \sum_{x=1}^{n} \frac{CF_{t_x}}{\left(1+\frac{r_{t_x}}{2}\right)^{2t_x}} \qquad \textbf{(30.9)}$$

where CF_{tx} is the cash flow of the bond or coupon and principal at t_x; t_x is the time to receive each cash flow; and r represents the yield, which is assumed constant until maturity. Table 30.10 shows the fair value calculation for the bond detailed in Table 30.5 on January 28, 2018.

The issuer can then retire the bonds using the general ledger entries shown in Table 30.11. According to Bushee (2014), a gain or loss is recorded on the income statement as the difference between the bond's book value and its market price. This gain or loss should be backed out of the operating section of the SCF. It is considered a financing activity because the profit or loss from the bond retirement is not attributable to normal company operations.

Table 30.10 **Fair Market Value Calculations as of January 28, 2018**

A	*B*	*C*	*D*	*E*	*F*
		$\$5B * (Coupon - 2\%) \left(\frac{180}{360}\right)$		$E = C + D$	$\frac{E}{\left(1+\frac{0.03}{2}\right)^{\left(\frac{A}{2}\right)2}}$
#	*Date*	*Coupon*	*Principal*	*Coupon and Principal*	*Discounted Coupon and Principal*
1	7/26/2018	50,000,000	—	50,000,000	49,261,083.74
2	1/26/2019	50,000,000	—	50,000,000	48,533,087.43
3	7/26/2019	50,000,000	—	50,000,000	47,815,849.69
4	1/26/2020	50,000,000	—	50,000,000	47,109,211.51
5	7/26/2020	50,000,000	—	50,000,000	46,413,016.27
6	1/26/2021	50,000,000	—	50,000,000	45,727,109.63
7	7/26/2021	50,000,000	—	50,000,000	45,051,339.53
8	1/26/2022	50,000,000	5,000,000,000	5,050,000,000	4,482,941,175.19
			Fair market value		**4,812,851,873.00**

The value of a $5 billion bond with a 2 percent coupon rate and a yield of 3 percent compounded twice per annum for four years is $4,812,851,873.

This table shows the calculation of the fair value of the bond detailed in Table 30.5 on January 28, 2018.

Although this example focuses on a fixed rate bond issued at a discount, the accounting entries are similar for a bond issued at a premium. For illustration purposes, this example assumes that the reporting date coincides with the interest payment dates. In practice, this assumption may not hold and the reporting entity has to consider this fact. For example, if the interest rate payment falls on a date other than the reporting date, the reporting entity should account for accrued interest payable.

Accounting for a Zero-Coupon Bond

A zero-coupon bond is issued at a discount, pays no interest, and matures at par. The example illustrated in Table 30.12 is similar to the fixed rate bond example shown in Table 30.5 except that in this case the issuer is assumed to have incurred an issuance cost during origination. Table 30.12 shows the details of a zero-coupon bond with an issuance cost that matures on July 1, 2036.

Table 30.11 **Accounting Entries to Record Bond Retirement on January 26, 2018**

Date	*Ledger Entry*	*Description*	*Amount ($)*	
			Debit	*Credit*
1/26/2018	Debit	Bond liability/ payable	5,000,000,000.00	
1/26/2018	Credit	Unamortized discount		21,946,048.14
1/26/2018	Credit	Cash-Fair market value of bond		4,812,851,873.00
	Credit	Gain/loss on retirement of bond		165,202,078.86
		Total	**5,000,000,000.00**	**5,000,000,000.00**
Memo: To record bond retirement on January 26, 2018.				

This table shows the accounting entries necessary to retire the bond detailed in Table 30.5 on January 28, 2018.

Table 30.12 **Analysis of Zero-Coupon Bond with Issuance Cost**

Description	*Detail*
Issuer	Heathrow Funding Limited
Tranche	€50,000,000
Issue price	€50,000,000
Net proceeds	€50,000,000
Calculation amount	€100,000
Issue date	7/1/2014
Maturity date yield	7/1/2036
Redemption amount	€180,611.12346 per calculation amount
Day count	Actual/Actual ICMA
Accrual yield	3% per annum
Interest basis	Zero coupon
Issuance cost	€500,000.00 (assumed)

This table details the terms of a zero-coupon bond used to illustrate the accounting and amortization of a zero-coupon bond with issuance cost.

Source: London Stock Exchange (2014).

Table 30.13 **Accounting Entries to Record Zero Coupon Issuance on July 1, 2014**

Date	*Ledger Entry*		*Description*	*Amount ($)*	
				Debit	*Credit*
7/1/2014	Debit		Cash-Net proceeds	50,000,000.00	
7/1/2014	Debit		Bond discount	40,305,561.73	
7/1/2014		Credit	Zero-coupon bond payable		90,305,561.73
			Total	**90,305,561.73**	**90,305,561.73**
Memo: To record zero-coupon bond issuance on July 1, 2014.					

Date	*Ledger Entry*		*Description*	*Amount ($)*	
				Debit	*Credit*
7/1/2014	Debit		Issuance Cost	500,000.00	
7/1/2014		Credit	Cash		500,000.00
			Total	**500,000.00**	**500,000.00**
Memo: To record zero-coupon bond issuance cost on July 1, 2014.					

This table shows the accounting entries necessary to record the principal and issuance cost of the zero-coupon bond issued on July 1, 2014. The terms of the zero-coupon bond are detailed in Table 30.12.

On the issue date, July 1, 2014, the issuance can be recorded using the journal entries shown in Table 30.13.

After the initial entries, the organization has to calculate and record discount amortization on the bond. Supposing the next reporting date is July 1, 2015, which is exactly one year after issuance, the organization can determine the discount amortization expense using the effective interest method as shown in Table 30.14. The actual yield, which is assumed constant throughout the bond's life for zero-coupon bonds, can be calculated using "Goal Seek" or "Solver" (optimization tools) in Excel. Tables 30.14 and 30.15 show the effective interest method as applied to the bond discount and issuance cost.

If July 1, 2015 is the end of the reporting period, the amortization and interest expense can be recorded as shown in Tables 30.16 and 30.17:

Accounting for a Floating Rate Note

A *floating rate note* (FRN) or a floater is a bond with a coupon that is linked to a reference or an interbank-offered rate such as LIBOR or EURIBOR (not to be confused with Euro LIBOR) or some other reference coupon rate. The coupon rate for a floater is set at the beginning of the reset period and interest is paid at the end (i.e., in arrears). A floater usually pays a reference rate, which can vary, and an issue spread that stays constant throughout the life of the instrument. The reference rate and the initial spread

Table 30.14 **Zero-Coupon Bond Amortization Using the Effective Interest Method**

A	*B*	*C*	*D*	*E*	*F*
		Yield (0.027235937) Previous Book Value (Column E)	*(C – B)*	*Previous Book Value + Discount Amount*	*Previous Unamortized Discount – Discount Amount (Column C)*
Date	*Coupon Payment (Zero)*	*Interest on Book Value*	*Discount Amortized*	*Book Value*	*Unamortized Discount*
7/1/2014	—	—	—	50,000,000.00	40,305,561.73
7/1/2015	—	1,361,796.83	1,361,796.83	51,361,796.83	38,943,764.90
7/1/2016	—	1,398,886.64	1,398,886.64	52,760,683.48	37,544,878.25
7/1/2017	—	1,436,986.63	1,436,986.63	54,197,670.11	36,107,891.62
7/1/2018	—	1,476,124.31	1,476,124.31	55,673,794.42	34,631,767.31
7/1/2019	—	1,516,327.94	1,516,327.94	57,190,122.36	33,115,439.37
7/1/2020	—	1,557,626.55	1,557,626.55	58,747,748.91	31,557,812.82
7/1/2021	—	1,600,049.97	1,600,049.97	60,347,798.88	29,957,762.85
7/1/2022	—	1,643,628.83	1,643,628.83	61,991,427.70	28,314,134.03
7/1/2023	—	1,688,394.60	1,688,394.60	63,679,822.30	26,625,739.43
7/1/2024	—	1,734,379.61	1,734,379.61	65,414,201.91	24,891,359.82
7/1/2025	—	1,781,617.06	1,781,617.06	67,195,818.97	23,109,742.76
7/1/2026	—	1,830,141.07	1,830,141.07	69,025,960.03	21,279,601.70
7/1/2027	—	1,879,986.67	1,879,986.67	70,905,946.71	19,399,615.02
7/1/2028	—	1,931,189.87	1,931,189.87	72,837,136.58	17,468,425.15
7/1/2029	—	1,983,787.64	1,983,787.64	74,820,924.22	15,484,637.51
7/1/2030	—	2,037,817.95	2,037,817.95	76,858,742.17	13,446,819.56
7/1/2031	—	2,093,319.83	2,093,319.83	78,952,062.01	11,353,499.72
7/1/2032	—	2,150,333.36	2,150,333.36	81,102,395.36	9,203,166.37
7/1/2033	—	2,208,899.70	2,208,899.70	83,311,295.07	6,994,266.66
7/1/2034	—	2,269,061.15	2,269,061.15	85,580,356.22	4,725,205.51
7/1/2035	—	2,330,861.16	2,330,861.16	87,911,217.38	2,394,344.35
7/1/2036	—	2,394,344.35	2,394,344.35	90,305,561.73	(0.00)

IRR: 0.0272359366516602—Calculated Using MS Excel Solver

This table shows the discount amortization schedule for the zero-coupon bond using the effective interest method.

Table 30.15 **Zero-Coupon Bond Issuance Cost Amortization Using the Effective Interest Method**

A	*B*	*C*	*D*	*E*	*F*
		Yield (0.027235937) Previous Book Value (Column E)*	*(C – B)*	*Net Proceeds + Amortized Issuance Cost*	*Previous Unamortized Issuance Cost – Issuance Cost Amortization (Column C)*
Date	*Coupon Payment (Zero)*	*Interest on Book Value*	*Issuance Cost Amortized*	*Net Proceeds + Amortized Issuance Cost*	*Unamortized Issuance Cost*
7/1/2014	—	—	—	49,500,000.00	500,000.00
7/1/2015	—	22,618.42	22,618.42	49,522,618.42	477,381.58
7/1/2016	—	22,628.76	22,628.76	49,545,247.18	454,752.82
7/1/2017	—	22,639.10	22,639.10	49,567,886.28	432,113.72
7/1/2018	—	22,649.44	22,649.44	49,590,535.72	409,464.28
7/1/2019	—	22,659.79	22,659.79	49,613,195.51	386,804.49
7/1/2020	—	22,670.15	22,670.15	49,635,865.65	364,134.35
7/1/2021	—	22,680.50	22,680.50	49,658,546.16	341,453.84
7/1/2022	—	22,690.87	22,690.87	49,681,237.02	318,762.98
7/1/2023	—	22,701.24	22,701.24	49,703,938.26	296,061.74
7/1/2024	—	22,711.61	22,711.61	49,726,649.87	273,350.13
7/1/2025	—	22,721.99	22,721.99	49,749,371.86	250,628.14
7/1/2026	—	22,732.37	22,732.37	49,772,104.22	227,895.78
7/1/2027	—	22,742.76	22,742.76	49,794,846.98	205,153.02

7/1/2028	—	22,753.15	22,753.15	49,817,600.13	182,399.87
7/1/2029	—	22,763.55	22,763.55	49,840,363.67	159,636.33
7/1/2030	—	22,773.95	22,773.95	49,863,137.62	136,862.38
7/1/2031	—	22,784.35	22,784.35	49,885,921.97	114,078.03
7/1/2032	—	22,794.76	22,794.76	49,908,716.74	91,283.26
7/1/2033	—	22,805.18	22,805.18	49,931,521.92	68,478.08
7/1/2034	—	22,815.60	22,815.60	49,954,337.52	45,662.48
7/1/2035	—	22,826.03	22,826.03	49,977,163.54	22,836.46
7/1/2036	—	22,836.46	22,836.46	50,000,000.00	(0.00)

IRR: 0.000456937812178077—Calculated Using MS Excel Solver

This table shows the issuance cost amortization schedule for the zero-coupon bond using the effective interest method.

Table 30.16 **Accounting Entries to Record Interest Expense and Issuance Cost Amortization on July 1, 2015**

Date	*Ledger Entry*		*Description*	*Amount ($)*	
				Debit	*Credit*
7/1/2015	Debit		Interest expense	1,361,796.83	
7/1/2015		Credit	Zero coupon discount		1,361,796.83
			Total	**1,361,796.83**	**1,361,796.83**
Memo: To record interest expense on zero-coupon bond on July 1, 2015.					

Date	*Ledger Entry*		*Description*	*Amount ($)*	
				Debit	*Credit*
7/1/2015	Debit		Income statement	22,618.42	
7/1/2015		Credit	Issuance cost		22,618.42
			Total	**22,618.42**	**22,618.42**
Memo: To record issuance cost amortization on zero-coupon bond on July 1, 2015.					

This table shows the accounting entries necessary to record the interest expense and discount and issuance cost amortization as of July 1, 2015, in the general ledger.

Table 30.17 **Presentation of Zero-Coupon Bond Liability at Book Value as of July 26, 2017**

Description	*July 1, 2015*	*July 1, 2014*
Principal amount	90,305,561.73	90,305,561.73
Less: Unamortized discount/issue cost	–39,421,146.48	(40,805,561.72)
Long-term liability less unamortized discount and issue cost	$50,884,415.25	$49,500,000.01

Table 30.17 is closely related to Table 30.12 and shows how the principal amount and unamortized discount would be presented in the financial statement on a reporting date.

determine the gross (undiscounted) cash flow at each payment date. Equation 30.10 shows how to calculate the coupon rate on an FRN.

$$\text{FRN Coupon} = \text{Interbank Offered Rate (e.g. LIBOR)} + \text{Issue Spread} \quad (30.10)$$

Aside from the issue or initial spread, floaters also have another spread known as the required or discount margin. The *discount margin* (DM) is the spread above the reference rate ensuring that the present value of the expected future cash flow equals the market price of the FRN. Unlike the issue spread that remains constant throughout the term of the note, the DM may change from period to period and is entirely driven by the bond's credit risk, maturity, and liquidity. Equation 30.11 shows how the discount margin on an FRN can be determined.

$$\begin{aligned}&\text{FRN Discount Margin}\\&\quad = \text{Interbank Offered Rate (e.g., LIBOR)} + \text{Discount Margin}\end{aligned} \tag{30.11}$$

Equation 30.12 can be used to value a FRN on the payment or reset date assuming a constant term structure or constant forward rate (Smith 2014):

$$PV = \frac{\frac{(\text{Index}+\text{IS})}{M}}{\left(1+\frac{(\text{Index}+\text{DM})}{M}\right)^{1}} + \frac{\frac{(\text{Index}+\text{IS})}{M}}{\left(1+\frac{(\text{Index}+\text{DM})}{M}\right)^{2}} + \cdots + \frac{\frac{(\text{Index}+\text{IS})}{M}}{\left(1+\frac{(\text{Index}+\text{DM})}{M}\right)^{N}} \tag{30.12}$$

where PV is the present value or market price; index represents the reference index rate or the interbank-offered rate; IS is the issue spread; DM is the discount margin; M is the number of interest rate payments per annum; and N is the number of years to maturity.

Consider the FRN detailed in Table 30.18. This example illustrates the accounting entries necessary to record an FRN issued at a premium:

On the settlement date, the company posts the entries shown in Table 30.19 to record the issuance. Specifically, Table 30.19 details the entries necessary to record the cash receipt, liability, and premium on the bond liability on settlement date.

After the initial entries, the organization calculates and records the bond's cash interest expense and premium amortization. Suppose the next reporting date is March 21, 2017, exactly three months after issuance. Of note is that the three-month EURIBOR was negative on the interest payment date. This relation implies that the issuing company will receive interest payments rather than pay interest on the bond payable. The company can determine the premium amortization using the effective interest method as explained in Table 30.20.

On March 21, 2017, the general ledger entries used to record the above is documented in Table 30.21.

Suppose the three-month EURIBOR rate increased from –0.0346 to –0.0306 on September 19, 2017, two days before the beginning of the next interest payment period ending on December 21, 2017. The coupon payments are prospectively affected thus changing the IRR originally calculated. As mentioned earlier, FRNs are simply a collection of fixed rate notes that mature on the reset date and become a new note. The solution here is to take the book value and the unamortized premium on the reset date as the starting point as if the bond was a new issue and use these balances to calculate the quarterly amortization on a prospective basis. This relation is explained in Table 30.22.

Table 30.18 **Analysis of a Floating Rate Note Issued at a Premium**

Description	*Detail*
Issuer	HSBC Holdings Plc
Tranche	€900,000,000
Issue price	100.5671%
Calculation amount	€100,000
Issue date	12/21/2016
Maturity date	12/21/2018
Benchmark	EURIBOR
Interest payment dates	March 21, June 21, September 21, December 21
Relevant periods	3 months
Interest basis	3-month EURIBOR + 0.60 percent
Redemption basis	Par
Margin	0.6% per annum
Day count	Actual/360
Business day convention	Modified Following Business Day
Final redemption Amount	€100,000.00 per Calculation Amount
Issuance cost	€0 (Assumed)

This table details the terms of an FRN used to illustrate the accounting and amortization of a bond issued at a premium.

Source: HSBC (2016).

Table 30.19 **Accounting Entries to Record Issuance of €900,000,000 FRN at 100.5671 Percent on December 21, 2016**

Date	*Ledger Entry*		*Description*	*Amount (Euros)*	
				Debit	*Credit*
12/21/2016	Debit		Cash-Net proceeds	905,103,900	
12/21/2016		Credit	Bond premium		5,103,900
12/21/2016		Credit	FRN note payable		900,000,000
			Total	**905,103,900**	**905,103,900**
Memo: To record FRN bond issuance on December 21, 2016.					

This table shows the accounting entries necessary to record the floating rate note detailed in Table 30.19 at issuance.

Table 30.20 **FRN Amortization Using the Effective Interest Rate Method**

Par Value	900,000,000		
Issue Price	905,103,900		—
Premium	5,103,900		
3m EURIBOR	–0.0346	A	
Issue Spread	0.006	B	
FRN Coupon	–0.0286	C = A + B	
IRR	–0.025720672		
Objective Function	0.00	(Last Row of Column E – Par Value)	

(*continued*)

Table 30.20 **Continued**

A	B	C	D	E	F
		*Yield (–0.0257206723780578) *Previous Book Value (Column E)*	*(C – B)*	*Previous Book Value – Premium Amortization*	*Previous Unamortized Premium – Premium Amount 'D*
Date	*Coupon Payment*	*Interest on Book Value*	*Premium Amortized*	*Book Value*	*Unamortized Premium*
12/21/2016	—	—	—	905,103,900.00	5,103,900.00
3/21/2017	(6,435,000.00)	(5,819,970.22)	615,029.78	904,488,870.22	4,488,870.22
6/21/2017	(6,578,000.00)	(5,945,260.26)	632,739.74	903,856,130.48	3,856,130.48
9/21/2017	(6,578,000.00)	(5,941,101.23)	636,898.77	903,219,231.71	3,219,231.71
12/21/2017	(6,506,500.00)	(5,872,383.17)	634,116.83	902,585,114.88	2,585,114.88
3/21/2018	(6,435,000.00)	(5,803,774.01)	631,225.99	901,953,888.89	1,953,888.89
6/21/2018	(6,578,000.00)	(5,928,597.68)	649,402.32	901,304,486.57	1,304,486.57
9/21/2018	(6,578,000.00)	(5,924,329.12)	653,670.88	900,650,815.68	650,815.68
12/21/2018	(6,506,500.00)	(5,855,684.32)	650,815.68	900,000,000.00	0.00

IRR: –0.0257206723780578 - Calculated Using MS Excel Solver

This table shows the amortization schedule for the FRN before interest rate reset. The amortization schedule was calculated using the effective interest method.

Table 30.21 **Accounting Entries to Record Interest Income on March 21, 2017**

Date	*Ledger Entry*		*Description*	*Amount (Euros)*	
				Debit	*Credit*
3/21/2017	Debit		Cash	6,435,000.00	
3/21/2017	Debit		Bond premium	615,029.78	
3/21/2017		Credit	Interest income		7,050,029.78
			Total	**7,050,029.78**	**7,050,029.78**
Memo: To record FRN Interest Income on March 31, 2017.					

This table shows the accounting entries necessary to record the issuance of the FRN on March 21, 2017. The issuer of the note is receiving payment rather than paying interest because the interest rate is negative.

Accounting for Interest Rate Swaps Entered to Hedge Fair Value of Bond Investments

A hypothetical company invested $200 million in a 24-month, 7 percent, fixed rate bond on January 1, 2000. The company is concerned that interest rates may rise in the near term, thus decreasing the bond's fair market value based on the inverse relation between yield and bond price. To hedge this risk, the company enters into an interest rate swap to pay fixed and receive variable interest rate benchmarked to LIBOR. Table 30.23 contains other details about these transactions.

According to Hull (2003), the value of an interest rate swap receiving floating and paying fixed can be calculated as shown in Equations 30.13, 30.14, and 30.15.

$$V_{swap} = B_{floating} - B_{fixed} \tag{30.13}$$

where $B_{floating}$ the present is value of bond with underlying floating interest payment; B_{fixed} is the present value of bond with underlying fixed interest payment; and V_{swap} is the value of the swap.

$$B_{fixed} = \sum_{i=1}^{n} Ke^{-r_{i-t_i}} + Le^{-r_{n-t_n}} \tag{30.14}$$

where K is the fixed payment made each payment date; L is the notional principal; t_i time until the next payment; r_i is the LIBOR rate corresponding to maturity t_i; and e is the exponential function.

$$B_{floating} = (L + K^{*})e^{-r_i - t_i} \tag{30.15}$$

Table 30.22 **FRN Amortization Using the Effective Interest Rate Method After Interest Rate Reset**

Par value	900,000,000		
Issue price	905,103,900		-
Premium	5,103,900		
3m EURIBOR	–0.0306	A	
Issue spread	0.006	B	
FRN coupon	–0.0246	C = A + B	
IRR	–0.021729307		
Objective function	(0.00)	(Last Row in Column E – Par Value)	

B		*C*	*D*	*E*	*F*
		Yield (–0.0217293068956645) Previous Book Value (Column E)*	*C – B*	*Previous Book Value – Premium Amortization*	*Previous Unamortized Premium – Premium Amount 'D*
Date	*Coupon Payment*	*Interest on Book Value*	*Premium Amortized*	*Book Value*	*Unamortized Premium*
12/21/2016	—	—	—	905,103,900.00	5,103,900.00
3/21/2017	(6,435,000.00)	(5,819,970.22)	615,029.78	904,488,870.22	4,488,870.22
6/21/2017	(6,578,000.00)	(5,945,260.26)	632,739.74	903,856,130.48	3,856,130.48
9/21/2017	(6,578,000.00)	(5,941,101.23)	636,898.77	903,219,231.71	3,219,231.71
9/21/2017	—	—	—	903,219,231.71	3,219,231.71
12/21/2017	(5,596,500.00)	(4,961,099.55)	635,400.45	902,583,831.26	2,583,831.26
3/21/2018	(5,535,000.00)	(4,903,130.27)	631,869.73	901,951,961.52	1,951,961.52
6/21/2018	(5,658,000.00)	(5,008,579.92)	649,420.08	901,302,541.44	1,302,541.44
9/21/2018	(5,658,000.00)	(5,004,973.66)	653,026.34	900,649,515.10	649,515.10
12/21/2018	(5,596,500.00)	(4,946,984.90)	649,515.10	900,000,000.00	(0.00)
IRR: –0.0217293068956645—Calculated Using MS Excel Solver					

This table shows the updated amortization schedule after an interest rate reset.

Table 30.23 **Analysis of an Interest Rate Swap Entered to Hedge Bond Investments**

Description	***Detail***
Issuer	Hypothetical Company
Notional	\$200,000,000
Fixed rate	7%
Floating rate	LIBOR + 0.0 percent
Issue date	1/1/2000
Maturity date	12/31/2002
Benchmark	LIBOR
Reporting date	3/31/2000
Interest payment dates	3, 9, 15, 21 months
Relevant periods	3 months
LIBOR rates on interest payment dates	9.1%, 10.2%, 11.3%, and 12.4% continuously compounded
LIBOR at last reset date	8.00%

This table details the terms of an interest rate swap used to illustrate the accounting and valuation of derivative instruments entered to hedge the fluctuation in the fair value of a bond security.

where K^* is the floating payment due on the next payment date; L is the notional principal; t_i time until the next payment; r_i is the LIBOR rate corresponding to maturity t_i; and *e* is the exponential function.

Valuation of Bond and Interest Rate Swap

Assuming June 1, 2000 is the next interest payment date, the instruments can be valued as shown in the following calculations.

$$K = 200\left(\frac{7\%}{2}\right) = 7$$

$$B_{\text{fixed}} = 7e^{\left(-0.091\left(\frac{3}{12}\right)\right)} + 7e^{\left(-0.102\left(\frac{6}{12}\right)\right)} + 7e^{\left(-0.112\left(\frac{15}{12}\right)\right)} + 207e^{\left(-0.124\left(\frac{21}{12}\right)\right)} = \$186,033,029.50$$

The above calculation is the value of the swap's fixed leg as well as the bond's market value under a continuous time paradigm.

$$B_{\text{floating}} = 8e^{\left(-0.091\left(\frac{3}{12}\right)\right)} + 200e^{\left(-0.091\left(\frac{3}{12}\right)\right)} = \$203,321,420.63$$

Table 30.24 **Accounting Entries to Record Bond Investment on January 1, 2000**

Date	*Ledger Entry*		*Description*	*Amount ($)*	
				Debit	*Credit*
1/1/2000	Debit		Bond receivable	200,000,000	
1/1/2000		Credit	Cash		200,000,000
			Total	**200,000,000**	**200,000,000**
Memo: To record bond investment on January 1, 2000.					

This table shows the accounting entries necessary to record the bond investment detailed in Table 30.23.

Therefore, the value of the swap to the party paying fixed and receiving floating is:

$$V_{swap} = \$203,321,420.63 - \$186,033,029.50 = \$17,288,391.12$$

Accounting for a Bond and Interest Rate Swap

According to SFAS 133, for a derivative designated as hedging the exposure to changes in the fair value of a recognized asset or liability or a firm commitment (referred to as a fair value hedge), the gain or loss is recognized in earnings in the period of change together with the offsetting loss or gain on the hedged item attributable to the risk being hedged. The net effect on the income statement reflects the extent that the hedge is ineffective in offsetting changes in the fair value of the underlying. This accounting convention assumes that the company has elected the speculative accounting method rather than the hedge accounting method. These accounting entries also assume that the bond is carried at fair value perhaps because it is designated as a trading investment.

On January 1, 2000, when the firm consummated the transactions, Table 30.24 shows the entries that are required to be booked into the general ledger. Theoretically, the value of an interest rate swap is zero at inception. Since no cash flows are exchanged, only memorandum entries are required for the swap at the outset.

On March 31, 2000, the reporting date, no interest is payable or receivable but it needs to be accrued and recorded for reporting purposes.

$$\text{Fixed}_{\text{rate}} = \$200\text{M}(7\%)\frac{3}{12} = \$3,500,000.00$$

$$\text{Floating}_{\text{rate}} = \$200\text{M}(8\%)\frac{3}{12} = \$4,000,000.00$$

$$\text{Net}_{\text{receipt}} = \$4,000,000 - 3,500,000 = \$500,000.00$$

$$\text{Bond}_{\text{interest}} = \$200\text{M}*7\%\frac{3}{12} = \$3{,}500{,}000.00$$

$$\text{Bond}_{\text{FVChange}} = \$200{,}000{,}000 - \$186{,}033{,}029.50 = \$13{,}966{,}970.50$$

The accounting entries required to record the fair value changes and interest income are shown in Tables 30.25 and 30.26, respectively. Table 30.25 shows the entries to record interest income and expenses on the interest rate swap and bond; Table 30.26 shows the entries required to record changes in the fair market value of the instruments.

Summary and Conclusions

This chapter reviewed the finance and accounting methods and standards relating to bond instruments. It also illustrated how to record and report different types of bond

Table 30.25 **Accounting Entries to Interest Income and Expenses on March 31, 2000**

Date	*Ledger Entry*	*Description*	*Amount ($)*	
			Debit	*Credit*
3/31/2000	Debit	Net swap interest receivable	500,000	
3/31/2000	Credit	Bond interest receivable	3,500,000	
3/31/2000	Credit	Income statement		4,000,000
		Total	**4,000,000**	**4,000,000**
Memo: To record interest income and expenses on March 31, 2000.				

This table shows the accounting entries necessary to record the interest income and expenses on the bond investment and related interest rate swap on March 31, 2000.

Table 30.26 **Accounting Entries to Record Fair Value Changes on March 31, 2000**

Date	*Ledger Entry*	*Description*	*Amount ($)*	
			Debit	*Credit*
3/31/2000	Debit	Interest rate swap	17,288,391.12	
3/31/2000	Credit	Bond investment		13,966,970.50
3/31/2000	Credit	Income statement		3,321,420.63
		Total	**17,288,391.12**	**17,288,391.12**
Memo: To record fair value changes on March 31, 2000.				

This table shows the accounting entries necessary to record mark-to-market valuation on the bond investment and related interest rate swap on March 31, 2000.

instruments and interest rate swaps entered to hedge fluctuations in the fair market value of bond instruments. Bond instruments are an important source of capital to corporate, public, and not-for-profit entities. The discussions in this chapter explain how to navigate the onerous accounting challenges reporting entities face in properly recording and reporting their bond investments and liabilities using real life and practical bond accounting problems.

Discussion Questions

1. Define prepayments and discuss how they are estimated and how an entity should account for them when calculating premium/discount amortization on a bond or loan transactions.
2. Explain the difference between a discount and premium amortization and the impact on net income.
3. Explain the difference between the effective interest and straight-line methods of amortization and indicate which is permissible under U.S. GAAP.
4. Discuss how a negative interest rate may alter the cash flow payable or receivable by a bond issuer and explain why bond investors still invest in such bonds.

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31

High Yield Bonds

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Introduction

High yield bonds (HYBs) became an important component of the fixed income landscape in the 1980s. This chapter reviews HYBs from the perspectives of both issuers or users of capital and the providers of capital, also called the sell-side and buy-side, respectively. Issuers use HYBs for general corporate purposes and for financing leveraged buyouts (LBOs). Important factors affecting the level of issuance include general economic activity, number and size of transactions requiring financing, level of interest rates, and availability of substitute financial products such as leveraged loans. The issuance volume over time and across industries is one aspect for assessing the role of HYBs. HYB transactions brought to market involve an important eco-system of lawyers and investment bankers familiar with the specific covenant requirements of HYBs. Leveraged loans and bridge loans are also vital elements of the higher-risk credit landscape and are additional options for those undertaking a financing transaction.

HYBs have become a common component of well-diversified portfolios capable of generating superior returns for investors on a risk-adjusted basis. Some restrictions exist on the types of investors able to buy HYBs. Exchange-traded funds (ETFs) may provide exposure to the HYB universe for investors who cannot purchase HYBs directly. The next wave of increased volume of HYB issuance may come from markets outside the United States as their economies and financing sources grow and develop.

This chapter reviews the definition and designation of the term HYB, equity-like nature of HYBs, history and issuers of HYBs, LBOs, and factors affecting HYB issuance. It also covers HYB returns and defaults over time, restrictions on investments in HYBs, HYB returns compared to other asset indices, debt features and red herrings (prospectus), bond deal origination and marketing, and covenants. The chapter also discusses case studies of Toys "R" Us and Del Monte, bridge loans, leveraged loans, the role of FINRA, bond liquidity and trading, Markit CDX versus CDS, and ETFs.

Meaning of High Yield Bonds

Although the term HYBs came into common usage in the 1980s, the origins of the HYB market stretch back much farther and go directly to the core relation between risk and return. Although market participants often use the colloquial term "junk bonds" to refer to HYBs, this chapter confines itself to the formal HYB terminology. Technically, a HYB is any bond with a rating below an investment grade (IG) rating by a rating agency. Credit rating agencies registered with the Securities and Exchange Commission ("SEC") are Nationally Recognized Statistical Rating Organizations (NRSROs). A *credit rating* is a rating of the issuer's ability to meet or repay its financial obligations and is measured using a scale to indicate relative creditworthiness. Rating agencies are typically remunerated by issuers to rate a bond. The rating agencies use their own proprietary criteria to assess the creditworthiness of a debt instrument such as an HYB. The HYB issuer provides the agency with information, such as historical and projected financial statements. The NRSRO conducts its own independent analysis and develops a view that would typically consider additional factors such as the market outlook for the issuer and the experience of the management team. The analysis essentially evaluates a mix of both financial and business risk attributes.

An issuer can issue a bond with a rating from one or more NRSROs but occasionally a bond may lack a rating. Table 31.1 outlines the three largest rating agencies, Standard & Poor's, Moody's, and Fitch, each of which have their own distinct ratings scales. Consistency exists across the scales in general terms. Rating agencies can also periodically update a rating by either upgrading, downgrading, or reconfirming a rating based on updated information.

A bond issued as an investment grade bond (IGB) can be recategorized as a HYB after rating reassessments by two or more rating agencies. These "fallen angels" often are the first versions of HYBs, as they appeared on the credit landscape before the emergence of bonds issued below investment grade. Investors in such fallen angels hope to profit from a possible debt workout in a reorganization or liquidation (Antczak, Lucas, and Fabozzi 2009). If a bond is rated IG by two or more agencies and downgraded to HY by only one of the agencies, then the bond is considered a "crossover," meaning that is both IG and HY rated, denoted "XO." Once two or more agencies downgrade a bond, it is then considered HY. When only one agency rates a bond IG, it immediately becomes a "fallen angel" after the rating reassessment to HY.

As Figure 31.1 shows, considerable temporal variation exists in the issuance frequency at different credit ratings within the HYB spectrum. The years with the highest levels of issuance at the higher quality end of the spectrum (e.g.,1990 and 1991) and the years with highest issuance at the lower end of the spectrum (e.g., 2008 and 2009) reflect broader market activity and receptivity at those respective times. For example, during the recession of the early 1990s, issuance at BB level increased and issuance at CCC level decreased.

Table 31.1 **Credit Rating Agency Scale—Long Term Rating**

Fitch	***Moody's Investor Services***	***Standard & Poor's***
Investment-Grade	Investment-Grade	Investment-Grade
AAA	Aaa	AAA
AA	Aa	AA
A	A	A
BBB	Baa	BBB
Non-Investment-Grade	Non-Investment-Grade	Non-Investment-Grade
BB	Ba	BB
B	B	B
CCC	Caa	CCC
CC	Ca	CC
C	N.A.	C

This table shows the scale and identifiers used by the major NRSROs. Moody's appends numerical identifiers 1, 2, 3 to each general rating classification to indicate relative strength within a category; 1 indicates a higher ranking than 3. For Standard & Poor's and Fitch, the ratings from AA to CC may be modified by adding a (+) or (–) to show relative standing within a category, + being a higher ranking than –. A D rating indicates the issuer is in default and typically the credit rating will be withdrawn.

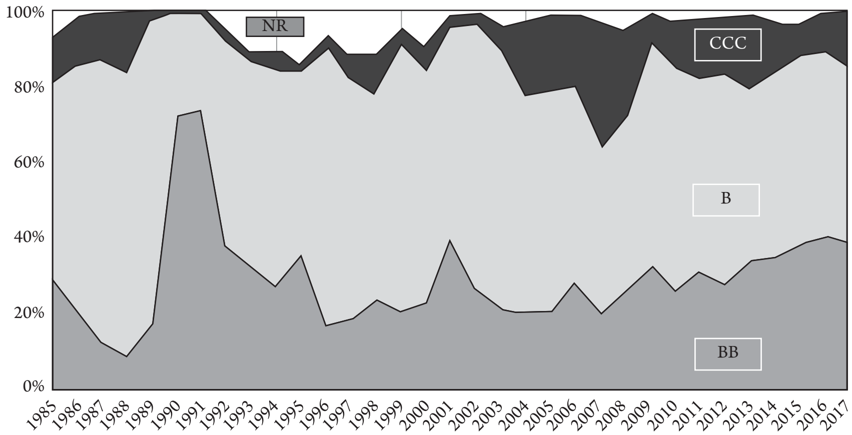

Figure 31.1 Issuance by Credit Rating Based on Value

This figure shows the issuance by credit rating based on the percent of value of total issuance. The trend shows that during periods of recession more issuance of BB bonds occurs and less at the lower end of the scale.

Source: BofA Merrill Lynch Global Research data.

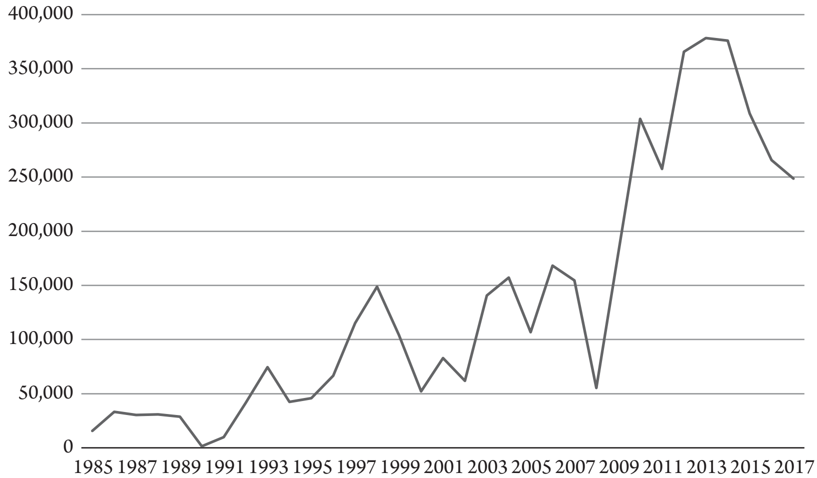

Figure 31.2 High Yield Bond Issuance by Year (USD in Millions)
This figure shows the issuance of HYBs in millions of USD and the long-term trend shows increasing issuance of HYBs.
Source: BofA Merrill Lynch Global Research data.

Figure 31.2 illustrates that while issuance over time has fluctuated in tandem with the broader market and market conditions, the long-term trend shows increasing usage of HYBs. Since 1985, the lowest year in terms of issuance proceeds was 1990 ($1.4 billion) and the highest year was 2013 ($378 billion).

A HYB is riskier than an IGB by virtue of its credit rating. The designation of HYB captures some aspects of risk but ignores others. The most important risk factor captured by a designation of HYB is *default risk*, which is the risk that the issuer will be unable to meet its financial obligations. Notably, a designation of HYB does not capture *liquidity risk*, which is the risk of not finding a counterparty without a substantial price concession.

Equity-Like Nature of HYBs

Unlike other fixed income products, HYBs are less sensitive to traditional fixed income levers on value, such as changes in interest rates, and more sensitive to equity-like forces, such as individual company performance and broad market trends. For this reason, some refer to HYBs as "equity-like" instruments. One continuing and notable difference is that bond holders unlike equity holders have priority within the capital structure. Thus, HYBs may be closer to yielding equity-like returns while having some protection as a fixed income component of the capital structure. This relation should not distract from appreciating the fundamental placement of HYBs on the riskier end of the credit spectrum.

Figure 31.3 outlines the positive correlation between equity returns and HYB returns over time. This correlation varies and appears to strengthen during periods of economic expansion.

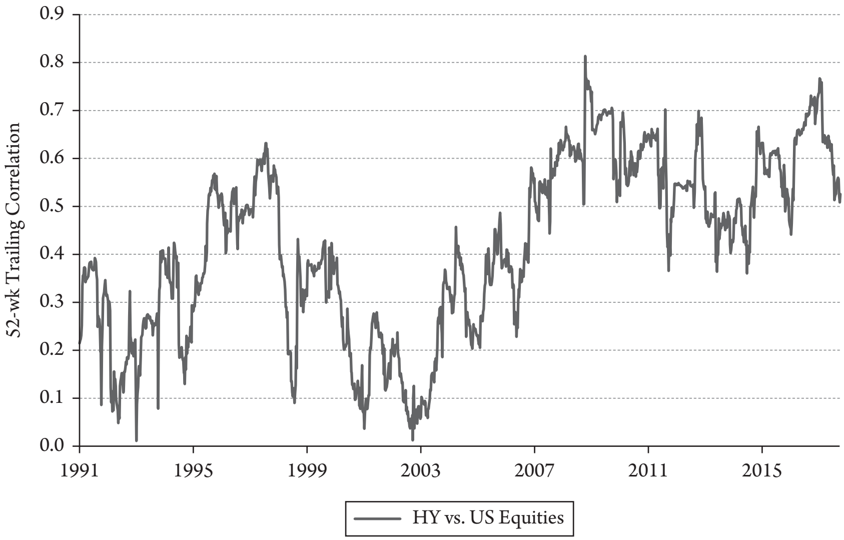

Figure 31.3 Correlation of High Yield Bond Return versus U.S. Equities
This figure shows the correlation between equity returns and HYB returns over time. The correlation varies and appears to strengthen during periods of economic expansion.
Source: BofA Merrill Lynch Global Research data.

History and Issuers

Corporate issuance of HYBs is often associated with the now defunct securities firm Drexel Burnham Lambert (DBL). DBL focused much of its activity on financing companies with lower initial credit ratings. According to Frederick Joseph, Chief Executive Officer (CEO) of DBL, as quoted in the *New York Times* on May 26, 1985, "Our view is that there are 18,000 companies in this country with assets of $25 million or more and only 765 of them have investment grade ratings" (Williams 1985).

Most of the DBL-originated transactions were for small- and medium-size businesses with less than $500 million in sales. DBL was also a major market maker in HYBs, providing an important source of liquidity for the HYB market. Notably, DBL financed LBOs, which used HYBs as a form of financing. DBL worked with many of the well-known LBO actors of that time, including T. Boone Pickens and Irwin L. Jacobs.

In December 1988, Michael Milken, who led DBL's high yield business, pled guilty to violating securities laws, including conspiracy, mail fraud and assisting in the filing of a false tax return. He received a 10-year prison sentence, which the authorities later reduced to two years. Milken had to pay $600 million in fines, penalties, and restitution. In September 1989, DBL pleaded guilty to six felonies and paid $650 million in fines and restitution. Following the guilty plea and fine, DBL appeared to retain much of its business in the HYB market yet found itself in financial difficulties in early 1990 primarily from its inventories of unsold HYBs in transactions that it had brought to market. The firm filed for bankruptcy in February 1990, ending its dominance of the HYB market.

The Michael Milken–DBL era and its link to the rise of HYB or "junk" issuance led to a negative association in the public's mind that prevails to this day. In November 2017, a play entitled *Junk*, written by Ayad Akhtar, debuted at Lincoln Center in New York City. This play is set in 1985 and focuses on the takeover of an American manufacturing company and the ultimate detriments of the takeover to the company's workforce. In a recent interview (Lincoln Center Theater Review 2017, p. 10), Akhtar comments, "I didn't go to business school but I had a deep familiarity with the kind of iconic histories that operate as myth within the business world . . . and the titanic figures from that era."

Leveraged Buyouts

Market participants often link the issuance of leveraged securities to LBO activity. According to one estimate, acquisition financing between 1999 and 2009 accounted for 31.8 percent of leveraged loans proceeds (Antczak et al. 2009). According to Opler and Titman (1993), LBOs accounted for more than 2,500 transactions, with an aggregate value in excess of $250 billion between 1979 and 1989. Black Monday (i.e., the October 1987 stock market crash), coupled with a more difficult economic environment and increased default rates, led to a slowdown in the number of LBOs and, consequently, a slowdown in issuance of HYBs. Since then, the market has had periods of expansion and contraction coinciding with overall market trends and acquisition activity, among other factors. The period between 2005 and 2007 showed very strong growth in both HYB issuance and the number of LBOs, with a strong contraction in 2009 and subsequent increased activity afterwards.

Industries frequently issuing HYBs include automotive, energy, media, health care, real estate, and telecommunications, among others. Between 1997 and 2017, media and telecommunications were the two most consistent HYB issuers in the United States.

Factors Affecting HYB Issuance

Various factors cause ebbs and flows in the volume of HYB issuance. In particular, the state of the economy is an important factor that influences HYB issuance. The financial crisis of 2007–2008 led to an initial decrease in issuance, with subsequent years experiencing an increased volume of HYB transactions as the economy improved.

Another factor affecting the number of HYB deals is the volume of corporate merger and acquisition (M&A) and private equity (PE) LBO transactions (Miller 2015). Because HYBs finance a large percentage of M&A and LBO activity, a strong positive correlation exists between HYB issuance and the frequency of these transactions. Estimates indicate that high yield securities account for between 25 and 30 percent of LBO financing (Yago 1991).

A third factor that motivates HYB issuances is the level of interest rates. High yield issuers typically must compensate investors for the inherent risk in the securities by paying higher coupon rates, which makes these corporations strongly motivated to refinance at lower interest rates when the market allows. Thus, a decrease in interest rates can spur new issuance.

Finally, competition from other debt-financing products influences the relative attractiveness of HYB. *Leveraged loans*, also known as *bank loans*, are a form of corporate debt historically extended by commercial banks to corporate borrowers that have credit profiles similar to HYB issuers. In recent years, the demand for leveraged loans created by the growth of PE ownership of businesses has served to increase the number of institutional investors with leveraged loans in their portfolios (Miller 2015).

Leveraged loans have features that are more attractive than HYBs for issuers. For example, borrowers can prepay leveraged loans extended by banks without penalty. This prepayment feature of leveraged loans provides more flexibility to companies to repay debt and/or sell assets. As Miller (2015, p. 184) notes, "balancing the benefits of leveraged loans over HYB is the fact that bank loans historically have covenants that are more lender-friendly than in a bond indenture." *Covenants* are a set of financial tests that restrict an issuer's activities, such as limitations on additional indebtedness or asset sales. They are included for the benefit of the investor, as they mitigate the risk of default. This chapter later provides an overview of the various types of covenants.

Returns and Defaults over Time

The returns on HYBs typically exceed those on IGBs because of the risk premium required to compensate investors for the additional credit risk taken. A positive correlation exists between the yield for a HYB and the number of defaults and the outlook for credit risk in the HYB market. Therefore, as the outlook for defaults increases and consequently credit risk is higher, the required yields in HYBs also increase.

Because of their credit profile, HYB issuers are highly susceptible to deteriorating economic conditions and are likely to experience increased defaults. According to Acciavatti, Linares, Jantzen, and Li (2016), HYB default rates (par-weighted) increased from the average long-term default rate of 4.0 percent to 10.3 percent in 2009, immediately after the financial crisis of 2007–2008 ensued. Additionally, challenging conditions in one area of the HYB market can affect the overall default rates in HYBs. This scenario occurred in early 2016 when oil prices dropped and default rates of HYB issuers doubled compared to 2015. About 15 percent of the HYB index consists of energy exploration and production companies. These companies' revenues, proven reserves, and land values are highly correlated with the price of oil. As oil prices declined, so did earnings expectations, followed by analyst downgrades as well as public and PE valuations for these companies. As earnings and equity prices decline, leverage increases forcing credit rating downgrades, which in turn increase the cost of borrowing. Thus, 2016 was the perfect storm for HY defaults. Despite having no direct impact on the non-energy industries, the negative sentiment toward the energy sector spilled over to HY companies in other industries and the HY market overall experienced substantial pressures. Analysis by Acciavatti et al. (2016) reveals that 84 percent of HYB defaults in 2016 were from commodity-driven companies. Figure 31.4 demonstrates that default rates among U.S. HYB issuers from 1989 to Q1 2017 have remained within a narrow band outside of the two economic events mentioned previously, as well the dot.com bubble burst in 2001, when defaults dramatically increased.

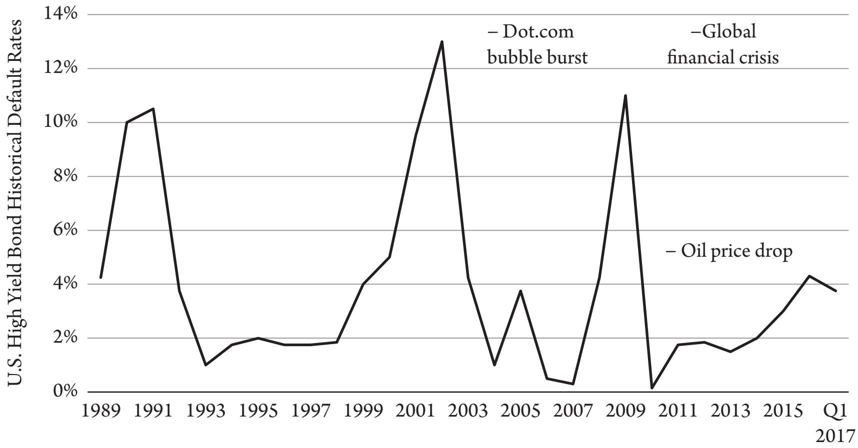

Figure 31.4 High Yield Default Rates
This figure shows the default rates of HYBs as observed from 1989 to Q1 2017. A notable increase in default rates occurs during times of broader economic slowdowns or shocks.
Source: Edward Altman (NYU Solomon Center).

Restrictions on Investments in HYBs

The Securities Act of 1933 (the "Act") requires an issuer of public securities to file and disclose material information on initial public offerings (IPOs) and secondary offerings for investors to use when making decisions to purchase an issuer's securities. The U.S. Congress established the Act after the stock market crash of 1929 to provide for more transparency in financial statements and to protect against fraud and misrepresentation in financial markets. SEC Rule 144(a) provides an exception from the registration requirements of the Act pertaining to certain private sales and resales of restricted securities to Qualified Institutional Buyers (QIBs). The purpose of Rule 144(a) is to make the sale and resale process for restricted securities more efficient and less costly, while operating within the framework of the Act. Although most issues of HYBs come under Rule 144(a) bonds, QIBs are the only buyers of these securities.

A *QIB* is an investor whom financial market regulators deem to be more sophisticated than a typical investor in the public financial markets and thus needs less protection from issuers. The SEC requires that a QIB own and manage at least $100 million of assets from issuers unaffiliated with the entity itself. Other QIB requirements exist for banks or registered broker-dealers acting on their own account. The three largest QIB types holding HYBs are mutual funds, insurance companies, and pension funds. Based on the criteria outlined in this section, most individual investors would not meet the classification requirements of a QIB. The chapter later discusses how non-QIB investors can gain exposure to the HYB asset class through bond funds and ETFs.

Returns in High Yield Bonds Compared to Other Asset Indices

Multiple methods exist to measure portfolio return. According to Kricheff (2015, p. 420), "The possible ways to measure and analyze a portfolio relative to an index or another market proxy seem almost as limitless as the imagination." Nonetheless, indices capturing market returns are valuable tools for measuring relative returns and risk for an asset or a portfolio. As an example, Figure 31.5 presents HYB total returns relative to the total returns of several asset classes, including equities, mortgages, municipal bonds, sovereign bonds, and Treasuries. The U.S. high yield market has shown strong total returns relative to other asset classes during the 12-year period depicted. The only asset class in the figure that is perhaps not self-explanatory is Treasury inflation-protected securities (TIPS) (i.e., bonds designed to protect against rising consumer prices).

Role of Investment Banks

Investment banks play an important role in bringing together providers and users of capital, essentially keeping the business ecosystem funded. Major corporations, with the advice of investment bankers, raise debt or equity capital to fund their business needs and growth. Institutional investors typically buy the securities issued by these companies through these same investment banks.

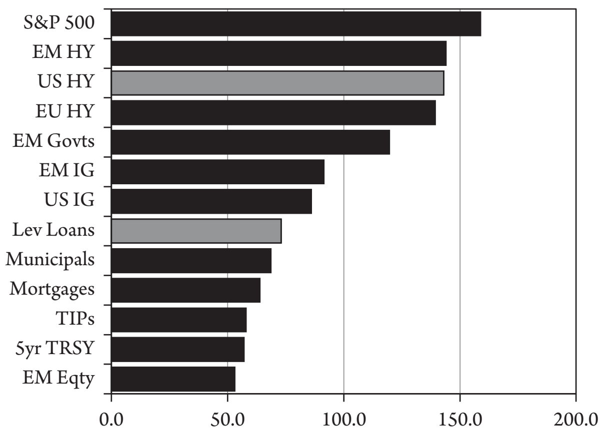

Figure 31.5 Cross-Asset Total Return Performance between December 31, 2005, and September 30, 2017

This figure shows cross asset total return performance between December 31, 2005 and September 30, 2017. HY total returns have been higher than many other asset classes, with the exception of the S&P 500 index.

Note: EU is Europe, EM is Emerging Markets, and TIPs are Treasury inflation-protected securities.

Source: BofA Merrill Lynch Global Research data.

Investment banking relationships develop over time. Mutual trust and loyalty are very important. J.P. Morgan (2017) describes investment banking as a service "supporting a broad range of corporations, institutions and governments by providing strategic advice, capital raising and risk management expertise." Therefore, investment bankers are financial advisors to institutional clients and corporations, similar to how financial advisors help individual retail investors make appropriate investing decisions. Some larger institutional clients manage assets in-house while others choose to outsource some capital to professional money managers, including asset management firms, hedge funds, and PE firms.

When capital is readily available, investment bankers may advise their clients to raise equity capital to delever or issue new debt to refinance the more expensive existing debt. Financially and strategically, investment bankers also advise corporations when to dispose of divisions of their companies, acquire divisions of other companies, or sell to or merge with other businesses. Investment bankers guide companies through the process of issuing public debt, equity, and more esoteric, structured products.

Red Herring (Prospectus) with Debt Features

When an investment bank syndicates and markets a bond or loan, sell-side banks provide a red herring prospectus or offering memorandum, as applicable, that includes pertinent information related to the security. The *red herring prospectus* is essentially the authoritative source for investors for a security offering. Figure 31.6 shows a sample red herring prospectus for T-Mobile (TMUS) and highlights some important characteristics. First, information in the agreement is "subject to completion, dated March 13, 2017." It also demonstrates that TMUS is seeking to raise $1.5 billion of capital across multiple bond maturities. Lastly, the prospectus lists four banks that are leading the transaction: Deutsche Bank Securities, Barclays, Citigroup, and J.P. Morgan.

A prospectus provides, among other information, issuer financial statements and the intended use of proceeds for the capital raised. Furthermore, this document details the covenants to be set within the bond indenture.

Companies can issue bonds with various maturities similar to how banks offer a range of possible mortgage maturities. IGBs have maturities that range from one year to 30 years, with just a few examples greater than 30 years. Because HYBs are riskier, investors rarely lend beyond 10 years; thus, most HYB issues have five-, seven-, eight-, or 10-year maturities. Figure 31.6 demonstrates that T-Mobile USA is looking to issue five-, eight-, and 10-year bonds. Another feature that determines pricing is whether interest payments are fixed or floating over the bond's life. Lastly, an issuer can embed optionality into the bond, allowing the company to retire the bonds before maturity (i.e., a call provision) from the investor or allowing the investor to sell the bond back to the company at a price at or near par (i.e., a put provision). The latter is very rare and most bonds issued today are not puttable. Investors are interested in knowing the bond terms to assess the pricing of the instrument, thus allowing them to decide whether they receive proper compensation for the inherent risks of owning the bonds.

Many HYB issuers are fallen angels or PE-owned companies acquired using minimal equity; both issuer types typically have a substantial amount of debt outstanding. In either case, for new debt issuances these companies are likely to pay higher interest

The information in this preliminary prospectus supplement is not complete and may be changed. This preliminary prospectus supplement and the accompanying prospectus are part of an effective registration statement filed with the Securities and Exchange Commission under the Securities Act of 1933. This preliminary prospectus supplement and the accompanying prospectus are not an offer to sell these securities and are not soliciting an offer to buy these securities in any state or other jurisdiction where the offer or sale is not permitted.

Filed Pursuant to Rule 424(b)(5)
Registration No. 333-210920

Subject to Completion, dated March 13, 2017

PRELIMINARY PROSPECTUS SUPPLEMENT
(To Prospectus dated April 25, 2016)

$1,500,000,000

T-Mobile

T-Mobile USA, Inc.

% Senior Notes due 2022
% Senior Notes due 2025
% Senior Notes due 2027

T-Mobile USA, Inc. (the "Issuer") is offering $500,000,000 aggregate principal amount of its % Senior Notes due 2022 (the "2022 notes"), $500,000,000 aggregate principal amount of its % Senior Notes due 2025 (the "2025 notes") and $500,000,000 aggregate principal amount of its % Senior Notes due 2027 (the "2027 notes" and together with the 2022 notes and the 2025 notes, the "notes"). The Issuer intends to use the net proceeds from this offering to redeem certain existing notes. See "Use of Proceeds."

The 2022 notes will bear interest at a rate of % per year and mature on , 2022. The 2025 notes will bear interest at a rate of % per year and mature on , 2025. The 2027 notes will bear interest at a rate of % per year and mature on , 2027. The Issuer will pay interest on the notes on each and commencing , 2017.

Investing in the notes involves risks. See "Risk Factors" beginning on page S-14 of this prospectus supplement. You should also consider the risk factors described in the documents incorporated by reference into the accompanying prospectus.

	Per 2022 note	Per 2025 note	Per 2027 note
Public Offering Price	%	%	%
Total	$	$	$
Proceeds to T-Mobile USA, Inc.(1)	$	$	$

(1) Before expenses. The underwriting discount is % of the principal amount thereof, resulting in total underwriting discounts of (i) $ for the 2022 notes, (ii) $ for the 2025 notes and (iii) $ for the 2027 notes.

Neither the Securities and Exchange Commission nor any state securities commission has approved or disapproved of these securities or passed upon the adequacy or accuracy of this prospectus. Any representation to the contrary is a criminal offense.

We do not intend to apply for the notes to be listed on any securities exchange or to arrange for the notes to be quoted on any quotation system. Currently, there is no public market for the notes.

The underwriters are offering the notes as set forth under "Underwriting." Delivery of the notes is expected to be made in New York, New York on or about , 2017 through the facilities of The Depository Trust Company.

Joint Book-Running Managers

Deutsche Bank Securities Barclays Citigroup J.P. Morgan

The date of this prospectus supplement is , 2017.

Figure 31.6 T-Mobile Preliminary Prospectus Cover Excerpt
This figure shows a preliminary prospectus cover from an issuance of bonds by T-Mobile.

rates relative to IG issuers. Should fallen angels turn their businesses around or the PE-owned firms go public, these HYB issuers could pay down debt and delever. Thus, their preference is to issue callable bonds that borrowers can repay early given that such prepayments could potentially trigger an upgrade back to IG. Additionally, if interest rates decrease, these companies can call the bonds and then refinance at lower rates, thus decreasing their cost of capital.

Bringing a Bond Deal to Market

While investment bankers prepare the bond offering, a bank's capital markets team prepares to market the bond to potential investors. As mentioned, the relations between companies and their investment bankers are very important. Although companies usually have multiple bankers, a lead bank exists among the consortium of other banks. This lead investment bank is called the "lead left" and plays a general coordination role in the transaction. For example, if a deal involves five banks, the red herring will have the lead bank first and leftmost in a list on the cover. Figure 31.6 lists four banks. Since Deutsche Bank is leftmost, it serves as the "lead left" for the T-Mobile deal.

In an effort to mitigate risk, multiple banks share risk with the lead bank in the syndication and distribution of the bonds to investors; these banks are on the "right." In this case, Barclays, Citigroup, and J.P. Morgan are in this group. Buyside portfolio managers familiar with the issuing company's business and possessing an understanding of the company's potential need for capital may reach out to the lead bank before a deal is even announced, a process called a *reverse inquiry*. Similarly, banks interested in determining investors' interest in a potential bond deal may call clients and ask if they would like to be taken "behind the wall" on a potential issuer and receive non-public information. If the client chooses to receive the information before becoming public, they would have to cease trading HYBs for that issuer because the client now possesses sensitive or *material non-public information*, which refers to information that would affect a security's market value or trading of a security if disseminated to the public. Once the execution of the deal is complete, the investor can once again trade the security and return to the other side of the wall.

Covenants

Covenants ultimately protect bond holders and issuers must adhere to them during the bond's life (Whelan 2010). Covenants protect lenders from certain detrimental actions the company and/or its subsidiaries can take that could hinder the company from paying interest payments and principal at maturity. Although limiting for the bond issuer, covenants help lower the issuer's borrowing cost by providing assurances to lenders. Any subsequent violation of a covenant triggers a "credit event." During bond bull markets, such as for most of the 2010s, bond issuances become covenant "light." Whelan mentions that most bond indentures have the same covenants also known as the "market" standard. Covenants that are "market" have evolved over time and depend on the issuer type, strength of the high-yield market, prospective rating on the bonds, and other factors. Whelan further highlights that covenants are either "incurrence-based," which require that issuers follow preset rules until maturity, or "maintenance-based," which are tied to a company's financial health.

Some incurrence-based covenants are limits on indebtedness, restricted payments, dividend stoppers, asset sales-restrictions, and transactions with affiliates (Tresnowski and Nowak 2004).

- The *limits on indebtedness covenant* prevent a company from issuing additional debt unless it meets the coverage ratio and permitted debt levels.

- The *restricted payments covenant* prevents the company from issuing dividends to equity holders, lending to a third party and/or guaranteeing debt of affiliates.
- The *dividend stoppers covenant* ensures that cash generated by any subsidiaries or joint ventures can be forced to flow up to the parent to service interest and principal liabilities.
- The *asset sales-restrictions covenant* determines how the proceeds from such sales (not the restriction on the actual asset sale) are used, such as to repay outstanding debt.
- The *transactions with affiliates covenant* generally imposes limitations depending on the size of the transaction, with those above a material amount requiring board approval.

Typical maintenance-based covenants involve interest coverage and leverage tests, which usually require quarterly examination. *Interest coverage* refers to earnings before interest, taxes, depression, and amortization (EBITDA) divided by interest expense. The leverage test is net debt divided by EBITDA. The higher and lower the ratio, for the interest coverage and leverage tests, respectively, the better. For example, an interest coverage covenant might require 3.0 times or more EBITDA to interest whereas a leverage test covenant might hold that a level of 6.0 times EBITDA should not be exceeded.

According to Whelan (2010), the large number of HYB investors increases a borrower's inability to amend a maintenance-based covenant before violating or "tripping" the covenant. Conversely, a leveraged loan has a lead arranger, usually a bank that monitors the maintenance covenants and works with both the borrowers and lenders over the life of the loan on covenant amendments should the borrower get close to violating a covenant thus avoiding potential defaults.

TOYS "R" US and Del Monte Case Studies

Toys "R" Us (TOY) began in 1948 as a children's supermarket in Washington, D.C., ultimately becoming a dominant retail toy chain. Its stores and brand are represented by the well-known mascot Geoffrey the Giraffe. A consortium of investors, Bain Capital, KKR, and Vornado Realty Trust, transacted an LBO of TOY in 2005 for $6.6 billion plus assumption of debt, investing $1.3 billion of cash and borrowing the remainder. As discussed previously, an LBO transaction involves a group of investors acquiring a public or private company while using minimal equity and borrowing against the cash flow of the soon-to-be purchased company. After an LBO, rating agencies often downgrade IG acquired companies to HY. LBO transactions require a large amount of financing, sometimes prearranged by the investment bank representing the seller. This process is known as *staple financing*, which Mandis (2013, p. 141) defines as "a prearranged financing package offered by investment banks to potential bidders during an acquisition." The investment bank traditionally stapled this financing to the deal term sheet. Staple financing raises concerns over a potential conflict of interest because the investment bank may be implying a price floor on what a buyer must pay to acquire the company. One example is when Barclays advised Del Monte on its 2010 sale while concurrently marketing financing for the winning bidder. In 2011, litigation of this transaction occurred in Delaware's Court of Chancery. As White (2013, pp. 93–94) notes, in the case *In re Del Monte Foods Co. Shareholders Litigation*,

> The court identified four instances of misbehavior throughout the sale process: (1) Barclays met secretly with potential bidders to solicit interest in acquiring Del Monte before the company was up for sale, and prior to being hired as the company's sell-side advisor; (2) once the company was up for sale, Barclays facilitated a relationship between two competing bidders in violation of confidentiality agreements between the bidders and the company; (3) Barclays planned to and in fact did obtain the company's permission to provide the acquirers' financing; and (4) subsequent to the approval of the merger agreement, Barclays conducted the go-shop despite an agreement to finance the acquirers.

Essentially, the court found that Del Monte's board breached its fiduciary duty to its shareholders by allowing Barclays to benefit in earning more than $40 million in fees from advising the seller while also providing staple financing to the buyer. The outcome of the case is too complex to discuss in detail, but White (p. 109) highlights that "the parties settled in November 2011 for $89.4 million. . . . Del Monte paid $65.7 million, $20 million of which was owed to Barclays for its work on the deal; Barclays contributed $23.7 million." Any deals that involve staple financing should expect an extra level of scrutiny from investors and regulators.

In the TOY transaction, the investment bank representing TOY wanted to have staple financing in place at the start of the sale process. TOY's board of directors opposed the investment bank arranging the financing until a merger agreement was in place (Mandis 2013). Once the agreement was in place, TOY's investment bank, Credit Suisse First Boston (CSFB), requested approval from TOY's board of directors again and, upon receiving approval, arranged financing for the PE sponsor acquirers. As Mandis (p. 142) notes, "CSFB earned $10 million in financing fees in addition to its $7 million in sell-side advisory fees." Thus, CSFB collected fees from both the sellers and buyers. The Schedule 14A filed with the SEC (Toys "R" Us 2005) notes the staple financing as follows (in the excerpt below, "Parent" refers to the PE sponsor group of Bain Capital, KKR, and Vornado Realty).

> Parent has obtained equity and debt financing commitments for the transactions contemplated by the merger agreement, which are subject to customary conditions. After giving effect to contemplated draws by the subsidiaries of the Company or Parent and its affiliates under the new debt commitments, Parent currently expects total existing and new debt outstanding at closing of the merger transaction will be approximately $6 billion. In connection with the execution and delivery of the merger agreement, Parent obtained commitments to provide approximately $6.2 billion in debt financing (not all of which is expected to be drawn at closing) consisting of (a) a $2.85 billion U.S. asset-based debt facility (the "Asset-Based Facility"), (b) a $2.0 billion bridge facility (the "U.S. Bridge Facility"), (c) a $1.0 billion European bridge facility (the "European Bridge Facility") and (d) a $350 million European working capital facility (the "European Working Capital Facility" and, together with the European Bridge Facility, the "European Facilities"). Parent expects to use these facilities and existing debt and may use alternative financing to finance the merger.

This transaction followed a typical protocol where the sponsors contribute approximately 15 to 20 percent of the enterprise value of the target in cash and borrow the remainder from the HYB market. As evident from the Schedule 14A filed with the SEC, LBOs are complex transactions. Bridge loans are usually prearranged to demonstrate that financing is in place should the selling shareholders approve the deal. For these transactions to be successful, the company must be able to service the annual interest payment on the new debt. Unable to generate enough income to service its interest payments and debt maturities, TOY ultimately filed for U.S. Chapter 11 bankruptcy protection on September 18, 2017. These two cases—TOY and Del Monte—demonstrate the risk and complexity that these transactions carry for all parties involved.

Bridge Loans

Historically, financial institutions would lend companies capital, thus bringing the financing risk onto their own balance sheets, and then work with the companies to issue replacement debt in the public market. Over time, regulations have forced financial institutions to more stringently manage their risk and remove these types of commitments from their balance sheets.

Instead of taking balance sheet risk on such financing transactions, investment banks issue and syndicate bridge loans providing a stopgap on risk when seeking replacement debt. Should the replacement bond issuance go awry, the institutional clients who bought the bridge loan would provide the issuing company capital in exchange for bonds or leveraged loans. Institutional clients receive a small fee for taking on this risk, typically 50 to 100 basis points (bps) of the deal size depending on sponsor credit profile, market conditions, and any potential risk of the market not favoring the replacement bond deal. Investment banks negotiate this fee with the institutional investors, who are ensuring they receive appropriate compensation for the risk, while looking to minimize their sponsor clients' transaction cost. Thus, bridge loans are a method for financial institutions to de-risk during this transition period of helping the company issue replacement bonds. With no bridge loan in place, if the market did not receive a bond well, the company's bank would subsequently need to provide the capital. With a bridge loan, the bank essentially transfers this risk to institutional investors that have agreed to bridge the loan to the company.

Leveraged Loans

Companies with high yield credit ratings issue leveraged loans. Leveraged loans have many names but the most commonly used colloquial term for them is "bank loans." Investment banks underwrite and subsequently syndicate loans to institutional investors to minimize risk and meet leverage ratio and liquidity requirements under the Basel III international regulatory regime, which was developed to remedy the deficiencies highlighted by the financial crisis of 2007–2008.

These loans have several unique characteristics and typically hold a senior position in the capital structure. First, the company's assets secure these loans. These loans typically offer floating rate interest payments (i.e., quarterly or semiannually) as defined by the prospectus and are quoted in the London Interbank Offered Rate (LIBOR) or Euro Interbank Offered Rate (EURIBOR) plus a spread. The spread is compensation for credit risk. The spread and credit quality are thus inversely correlated, so lower rated companies issuing bank loans provide a wider spread to compensate investors for the risk they are taking.

IG companies do not typically issue bank loans; instead, they issue highly rated *commercial paper*, a short-term debt instrument. As two former economists from the Federal Reserve Bank of St. Louis note (Stojanovic and Vaughan 1998, p. 1), "Large, creditworthy corporate borrowers have increasingly turned to commercial paper because the interest costs are lower than those on bank loans."

In an environment in which market participants expect interest rates to decline, companies prefer to issue term loans for their short-term capital needs, rather than bonds, because the loans are callable after their protection period. Calling the loan essentially allows them to refinance at a lower rate once the protection period expires. As the loan market has matured, Miller (2015, p. 184) notes that institutional "investors becoming the dominant capital providers, modest prepayment fees have become market-standard" and "issuers pay a one-percent penalty if they repay earlier than six to twelve months into the loan term." Companies also prefer to issue callable bonds because if interest rates decline, they can call the bonds and refinance with a lower coupon new issue. In contrast, investors prefer investing in term loans during a period of rising interest rates because higher interest payments compensate them when the floating tenor (e.g., LIBOR) resets with anticipated higher future rates. Investors also prefer non-callable bonds because such bonds protect them from needing to reinvest repaid principal at lower coupon rates.

Financial Industry Regulatory Agency

IG bonds are quoted on spread to a maturity matched Treasury. For example, the quote for hypothetical IG Bond Z is 20/15. Assuming Bond Z is a 10-year bond and the 10-year Treasury yield is 2.50 percent, this indicates the dealer is willing to buy and sell the bonds at 2.70 percent and 2.65 percent, respectively. Given the inverse relation between bond prices and yields, the 2.70 percent, the yield at which dealers are willing to buy the bonds, will have a lower price and vice versa.

Unlike equities, which trade on an exchange accessible to most market participants, bonds typically trade over-the-counter (OTC). Before 2002, all bond trades were private transactions between two parties, either between an investor and broker-dealer or between two dealers. In July 2002, the Financial Industry Regulatory Agency (FINRA) created the Trade Reporting and Compliance Engine (TRACE) to increase transparency in the U.S. fixed income corporate bond market. FINRA's mission is to provide "investor protection and market integrity through effective and efficient regulation of broker-dealers" (FINRA 2017a, p. 1).

FINRA originally created TRACE for corporate bonds, such as IGBs, HYBs, and convertible bonds, but not for U.S. Treasury bonds, which are the most liquid traded fixed income market instruments. Asset-backed, mortgage-backed, and mortgage-backed traded To-Be-Announced (TBA) securities are now part of the TRACE system (FINRA 2017b, p. 1). Although TRACE has brought transparency to the corporate bond market by reducing price volatility, it has harmed liquidity in the process, mainly for HYBs. Asquith, Covert, and Pathak (2013, p. 6), note the impact of TRACE:

> Trading activity decreases more for large issue size bonds, but that the reduction in price dispersion is uncorrelated with issue size. Credit ratings, however, matter for both trading activity and price dispersion. High Yield Bonds experience a large and significant reduction in trading activity, while the results are mixed for Investment Grade Bonds. High Yield Bonds also experience the largest decrease in price dispersion, but price dispersion significantly falls across all credit qualities. Therefore, the introduction of transparency in the corporate bond market has heterogeneous effects across sizes and rating classes.

Bond Liquidity and Trading

A bond's issue size is a unique characteristic that affects its trading liquidity. For example, T-Mobile, ticker "TMUS" on the New York Stock Exchange (NYSE), has one equity class share that investors buy and sell, while it has more than 10 actively traded bonds. Each bond has a unique identifier, a Committee on Uniform Security Identification Procedures (CUSIP) number, or an International Securities Identification Number (ISIN), which helps investors identify the security's coupon, maturity, call schedule, and/or any other unique feature such as secured or unsecured. TMUS bonds may have greater liquidity than those of a smaller company that only has one or two outstanding bonds. TMUS average bond size is about $1 billion. For comparison, American Apparel, a HY issuer that filed for its second bankruptcy protection in 2016, had one HYB issue of $250 million and was acquired by Gildan in January 2017 for $88 million (Li 2017). A direct correlation exists between the size of the bond issue and its liquidity and ability for a dealer to provide a bid/offer on the particular bond.

HYBs trade on price with a one "point" (i.e., 100 basis points) bid/ask spread, which is the general market convention including for bonds that have a larger issue size and multiple tranches. For example, if a dealer hypothetically quoted the TMUS 6 '23 bond (i.e., coupon 6.0 percent, maturity March 1, 2023) in Table 31.2 as 101/102, it would mean a 101 bid and 102 offer. When buying, sell-side banks always pay the lower price in the quote and the investors pay the higher price. In this case, the dealer is making a market in the bonds. If the dealer sells TMUS 6 '23 but does not own the TMUS 6 '23 bond and cannot source, or purchase, the issue, the dealer could buy TMUS 6.625 '23 as a hedge. TMUS 6 '23 and TMUS 6.625 '23 mature 30 days apart, and all else equal (i.e., bond call schedules and covenants), the bonds should trade close to each other based on yield, which would allow a dealer to hedge by going short one and long the other.

Most bonds trade with a minimum one point bid/ask spread, but there are many bonds where the dealer will not make a market because it does not want to risk owning or shorting an illiquid bond without finding another party to take the other side of the

Table 31.2 **T-Mobile Bonds Outstanding**

Ticker	*Coupon (%)*	*Maturity*	*Issue Date*	*Outstanding Amount (as of 12/17)*	*Currency*	*Moody's Rating*	*S&P Rating*
TMUS	6.125	1/15/2022	11/21/2013	$1,000.00	USD	Ba2	BB+
TMUS	4.000	4/15/2022	3/16/2017	500.00	USD	Ba2	BB+
TMUS	6.000	3/1/2023	9/5/2014	1,300.00	USD	Ba2	BB+
TMUS	6.625	4/1/2023	2/4/2014	1,744.00	USD	Ba2	BB+
TMUS	6.836	4/28/2023	10/16/2013	600.00	USD	Ba2	BB+
TMUS	6.500	1/15/2024	11/21/2013	1,000.00	USD	Ba2	BB+
TMUS	6.000	4/15/2024	4/1/2016	1,000.00	USD	Ba2	BB+
TMUS	6.375	3/1/2025	9/5/2014	1,700.00	USD	Ba2	BB+
TMUS	5.125	4/15/2025	3/16/2017	500.00	USD	Ba2	BB+
TMUS	6.500	1/15/2026	11/5/2015	2,000.00	USD	Ba2	BB+
TMUS	5.375	4/15/2027	3/16/2017	500.00	USD	Ba2	BB+

This table shows HYBs issued by T-Mobile, outstanding as of December 2017, and key data associated with these bonds. Fitch ratings are unavailable.

Source: Bloomberg.

trade. This situation is called an *agency trade* in which a dealer only works as an intermediary or riskless principal, brokering the trade and earning a modest spread (e.g., a ¼ point spread). For example, for a quote of 101.25/101.5, where one investor sells to the trader at 101.25 and the other investor buys from the trader at 101.5, the ¼ point in effect becomes the commission the dealer gets for brokering the trade. Table 31.2 shows HYBs issued by T-Mobile currently outstanding and the key data associated with these bonds.

Markit CDX Versus Credit Default Swap

Equity investors buy put options to hedge against a long equity position. Similarly, fixed income investors can buy an insurance-like credit default swap (CDS) to hedge a long bond position to protect against a credit event, such as a downgrade or bankruptcy. The investor, therefore, would buy a single name CDS that would pay out when such events occur, which is essentially a short credit risk position on the company (Markit 2008, p. 4). These single name CDS contracts are traded OTC and are very illiquid for HY companies.

Just as the S&P 500 index is a barometer for equity markets, Markit CDX North America High Yield (Markit HY CDX also known as HY CDX), tracks the HYB market performance. HY CDX is a basket of 100 single name CDS contracts. Portfolio managers can use CDX contracts as a proxy to either go long or short the HYB market. HY CDX is highly liquid, unlike the underlying single name CDS contracts.

Portfolio managers use CDX in a HYB portfolio for many reasons including hedging a long HYB portfolio, known as *buying protection*. Since the CDX represents 100 HYB issuers but more than 700 HYB active issuers exist, the HY CDX is more of a proxy hedge than a perfect hedge. Absent any credit events from any of the CDX constituents, the contract tends to track the HYB market closely, making it a powerful instrument to hedge a long portfolio. Because managers receive client cash inflows, which depending on the size of the flow could take weeks to redeploy, they may elect to use CDX to take quickly a long HYB proxy position, known as *selling protection*. By *selling protection*, the portfolio manager creates a synthetic long HY market position that the manager can unwind when spending new cash inflows to buy the actual HY bonds.

Exchange Traded Funds

An ETF is a marketable security that tracks commodity, equity, and bond indexes. ETFs typically trade in similar manner to common stock on equity exchanges in that they can be traded long or short and trade intraday. Analogous to how the SPDR S&P 500 ETF Trust, or SPY, provides S&P 500 index exposure to an equity investor, HYG and JNK are examples of ETFs that provide bond investors with high yield exposure. ETFs typically trade on the NYSE; the major difference between equity and bond ETFs is that the latter only owns a subset of the universe whereas the former holds the entire relevant universe. Recall that bonds are finite-lived and illiquid. So instead of owning small amounts of all the bonds issued by more than 700 high yield issuers, the ETF sponsors, such as Standard & Poor's, BlackRock, and Fidelity, create a list of securities that would be considered a good proxy for the high yield universe. The ETF authorized participant (AP) gauges market demand to ensure the ETF sponsors are appropriately providing ETF shares to the market by either creating or redeeming shares when necessary. Furthermore, the AP may notice a market arbitrage opportunity and decide to create or redeem shares to capture the available arbitrage profit.

Summary and Conclusions

HYBs have become an important component of the fixed income landscape since the 1980s. This chapter outlined the role played by HYBs in both providing the users and providers of capital with opportunities at the range of the credit spectrum below IG. Private equity firms commonly use HYBs to finance LBOs. Investors now view this asset class as a core component of well-diversified portfolios capable of generating superior risk-adjusted returns. Market participants can use Markit HY CDX to hedge long HY market exposure, express a negative view on the HY market, and serve as a long HY market proxy. Some restrictions exist on who can purchase HYBs; high yield ETFs can improve access to the HYB universe.

Discussion Questions

1. Discuss the characteristics of bond that is a HYB.
2. Describe the evolution of the HYB market including one positive and one negative aspect of this asset class from the issuer's perspective.
3. List the key parties involved in a HYB issue, define the term "lead left," and discuss some reasons for issuing HYBs.
4. Define the term covenants and describe the difference between "incurrence-based" and "maintenance-based" covenants.
5. Define "staple" financing and discuss why this type of financing is controversial.

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32

Distressed Debt

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Introduction

Distressed debt is an increasingly popular asset class, especially among hedge funds and private equity funds in the United States and abroad. Approximately 170 funds based in the United States and 25 funds based in Europe actively invest in distressed debt, collectively managing between $120 and $150 billion in private capital (Jain 2011). Given its enhanced risk and information asymmetry, distressed debt has a far greater return potential than investment-grade debt, with a risk-return profile and information-driven volatility more akin to that of equity securities.

The focus of this chapter is on corporate debt, with a view to present some of the game theoretic considerations involved when investing in distressed debt. That is, investors in distressed debt must consider how to restructure the terms of the loan agreement or the terms under which they will accept a distressed debt exchange. This task requires understanding the types of default and strategic behaviors arising from distressed situations.

The remainder of the chapter is organized as follows. The next section discusses the characteristics of distressed debt. The sections that follow offer a discussion of potential outcomes encountered when dealing with firms under financial distress and the various ways in which distressed debt issues can be restructured. Finally, the chapter concludes with a brief summary. Appendix A provides an alphabetized glossary of the key concepts and terms referenced throughout this chapter.

What Is Distressed Debt?

Distressed debt is characterized by the debtor's financial health. The borrowers in these loan agreements (i.e., the issuers of these fixed-income securities) are experiencing financial distress and may already be in default or operating under protection from applicable bankruptcy codes. The debtors include individuals, small businesses, corporations, and/or governments, with differing rules and procedures as to how restructuring may occur under various scenarios and the extent to which the debtors' other assets may be vulnerable under bankruptcy. Distressed loans and debt issues are

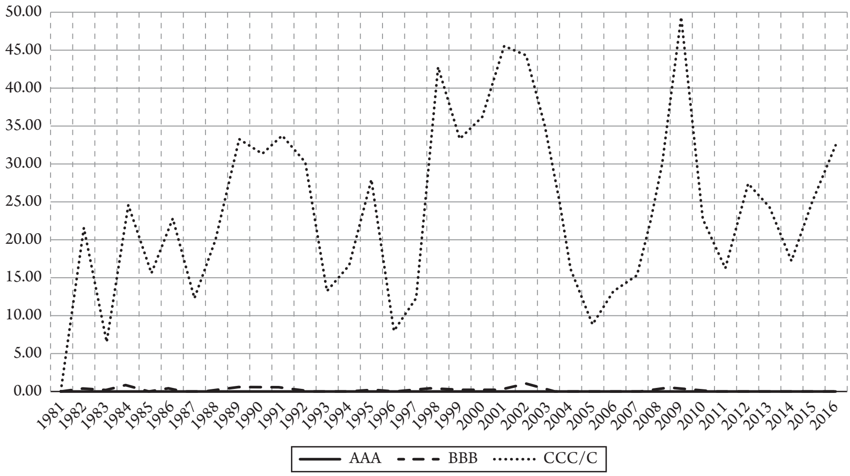

Figure 32.1 Global Percentage Default Rates over Time
This figure displays the annual percentage default rates, globally, for corporate bond issues rated AAA, BBB, and CCC/C between 1981 and 2016.
Source: S&P Global Ratings (2016).

oftentimes *underwater*, meaning the amount owed is greater than the value of the firm's underlying assets.

No definitive metric is available to quantify distressed debt, but common traits consist of particularly high yields and low credit ratings. Public distressed debt issues lie within a subset of high-yield (i.e., speculative or junk) bonds with credit ratings of CCC/Caa or below and valuations at a discount far below par. Figure 32.1 demonstrates that the risk of default is high in these issues with an annual global default rate of about 33 percent among CCC/C-rated corporate bond issues in 2016. In fact, less than 16 percent of these CCC/C-rated corporate bond issues recovered to a B rating or higher, with the vast majority remaining in distress or entering default.

Of the CCC/C-rated corporate bonds in 2016, 11.39 percent dropped out of the rating sample (i.e., were entered a rating of NR), 32.67 percent entered default (i.e., were entered a rating of D), 40.59 percent remained at a CCC/C rating, 14.36 percent transitioned to a B rating, and 0.99 percent transitioned to a BB rating (S&P Global Ratings 2016).

Another unifying theme across distressed debt is the equity-like profile these investments exhibit, with the actual equity shares of financially distressed debtors having little to no value in such situations. That is, since distressed debt trades far below par value, any uptick in the overall creditworthiness or value of the issuing firm results in close to a dollar-for-dollar increase in the value of the distressed debt issue depending on the seniority of the issue in question. Figure 32.2 provides a stylized graphical representation of the market values of debt versus equity plotted as a function of the value of the underlying assets or firm.

In general, corporate bond issues are far less liquid and less transparent with respect to their market values and depths than corresponding equity shares with minimum

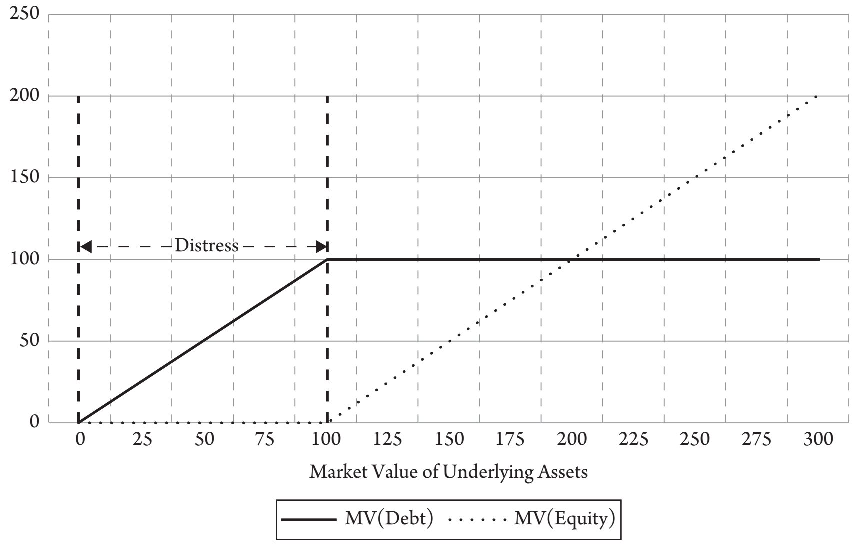

Figure 32.2 Debt and Equity as a Function of Underlying Firm Value
This figure displays a simplified representation of the market value of debt and market value of equity plotted against the total market value of underlying assets in the firm, based on total debt principal of $100.

block trades typically starting at $1 million. Distressed debt is illiquid and far more difficult to trade than investment-grade corporate bond issues. However, the illiquidity comes with some positive tradeoffs, such as greater negotiating power in debt restructuring and higher expected returns on investment.

Before delving into the various methods of restructuring distressed debt, understanding the possible behaviors and outcomes that may arise under distress is important. The following section discusses both the involuntary and strategic outcomes brought on by excess leverage.

Default and Other Potential Outcomes Arising Under Distress

Standard financial management principles in capital budgeting indicate rejecting negative net present value (NPV) projects and accepting all feasible positive NPV opportunities because positive NPV investments increase firm value after adjusting for the risk inherent in the venture. However, when a firm enters financial distress, distortions arise that cause rational deviations from this behavior, leading firms to strategically reject positive NPV projects (i.e., underinvestment) and yet strategically accept negative NPV projects (i.e., overinvestment). The purpose of this section is to outline not only the involuntary outcomes that eventually occur under financial distress, but also the deliberate outcomes designed to maximize one stakeholder's claims potentially at the expense of another.

Types of Default

Each loan agreement outlines the repayment terms, which generally encompass the principal balance owed, applicable interest rate, terms of repayment, and final maturity date of the loan. The loan agreement also details various covenants that the debtor must fulfill throughout the loan's life. Common financial covenants include limits on capital expenditures and dividend payouts as well as stipulations on various accounting-based financial ratios such as maintaining a minimum debt-service coverage ratio along with various liquidity ratios, and not exceeding a maximum leverage ratio (Nini, Smith, and Sufi 2009). Other common debt covenants include stipulations on maintaining the core line of business at the time of loan origination and providing relevant information in a timely manner. Debt covenants can differ vastly across agreements, with some even stipulating environmental or anti-terrorism clauses. Appendix B provides a sample excerpt of a set of debt covenants employed in a syndicated loan agreement for RPM Inc (RPM 2006).

Overall, two broad categories of default exist: (1) a default on debt services, which occurs when a borrower misses a contractual payment (i.e., either a scheduled interest payment or repayment of principal), and (2) a technical default, which occurs when the debtor has not defaulted on promised payments but has violated a covenant written in the bond indenture at the time of origination or since the last renegotiation of terms.

Default can occur involuntarily or strategically. That is, the likelihood of default is determined not only by the firm's financial ability to pay, but also by its willingness to pay despite financial incentives to renege on contracted payments. Strategic default occurs when a debtor is financially able to make its promised payments, but deliberately enters default based on a calculated assessment as to whether the implicitly embedded put option to default is worth more to exercise than to hold. The risk of strategic default increases as the loan becomes more deeply underwater because any gains to the underlying business accrue to the lender rather than to the borrower. The recent subprime mortgage crisis saw many instances of strategic defaults across the nation, with a marked clustering based on exposure to others who had strategically defaulted (Guiso, Sapienza, and Zingales 2013). A study of highly leveraged ski hotels also shows evidence of strategic defaulting, with marked improvements among the hotels, which underwent debt restructuring (Giroud, Mueller, Stomper, and Westerkamp 2011).

Even before a strategic or involuntary default, other (globally) inefficient outcomes may arise from the conflicts of interest between equity holders and debt holders of distressed firms, as outlined in the seminal works by Jensen and Meckling (1976) and Myers (1977). In particular, due to the limited liability feature inherent in the corporate structure, equity holders may be incentivized to overinvest or to take on more risk than they otherwise would in situations outside of financial distress. Conversely, equity holders of distressed firms may intentionally forgo investment opportunities if they are highly unlikely to reap the benefits. The following subsections outline the intuition for these potential outcomes.

The Overinvestment Problem

The *overinvestment problem,* also known as *asset substitution,* occurs when a firm strategically replaces or forgoes lower risk projects to invest in higher risk and possibly even

Table 32.1 **Example of Possible Payouts under Financial Distress**

	Bad State (50%)	***Good State (50%)***
Firm's total cash flow from assets	90	100
Cash flow to debt holders	~~100~~ 90	100
Cash flow to equity holders	0	0

This table illustrates the possible outcomes that can occur one year in the future based on $100 debt principal owed at the end of the year. Only two possible and equally likely states of the economy (good and bad) exist.

negative NPV projects (Green and Talmor 1986). That is, due to their limited liability, equity holders may be incentivized to invest in projects with a very small chance of success (i.e., the expected cash flows do not justify the inherent risks). This situation occurs because they cannot be asked to contribute more than they have already invested to make the debt holders whole.

To solidify the intuition, Table 32.1 shows a stylized example of a firm in financial distress, in which debt holders are due $100 at time $t = 1$. Suppose that based on the firm's current investments, cash flow from assets during the next period may be either $90 in a bad economic state with a probability of 50 percent or $100 in a good economic state with a probability of 50 percent.

Due to excessive leverage, the firm's equity holders are expected to receive nothing, even in the good economic state. However, consider a scenario as shown in Table 32.2 in which the equity holders have an opportunity to substitute the current investments with far riskier investments in which the cash flow from assets next period may be either $80 in a bad economic state with a probability of 50 percent or $110 in a good economic state with a probability of 50 percent. Despite the greater risk, the expected cash flow from investments at time $t = 1$ remains at $100.

Due to limited liability, equity holders are now definitely in a better position with the riskier asset substitution but debt holders are clearly in a worse position. That is, equity holders are no worse off in the bad state of the economy because their cash flows are bounded below at zero, irrespective of the extent to which cash flows fall short of

Table 32.2 **Example of Possible Payouts with Risky Asset Substitution**

	Bad State (50%)	***Good State (50%)***
Firm's total cash flow from assets	80	110
Cash flow to debt holders	~~100~~ 80	100
Cash flow to equity holders	0	10

This table illustrates two possible outcomes in one year based on the use of a risky asset substitution and $100 debt principal owed at the end of the year. Only two possible and equally likely states of the economy (good and bad) exist.

the loan balance due at time $t = 1$. Thus, equity holders may be incentivized to invest in riskier projects and may even undertake negative NPV investments for the chance to receive cash flows in the good economic state. Overall, both equity holders and bond holders in such situations would be better served with reduced leverage (Mauer and Sarker 2005).

The Underinvestment Problem

The *underinvestment problem*, also known as *debt overhang*, occurs when a firm deliberately rejects positive NPV investments because the benefits would accrue disproportionately, if not entirely, to the debt holders rather than to the equity holders and additional debt capital is unavailable to finance the positive NPV projects (Hennessy 2004). This problem is akin to the simple mental calculation undertaken by individual homeowners who find themselves with underwater mortgages. For instance, if a mortgagor/homeowner owes $1,000,000 on a property that is now worth only $800,000, the owner will avoid repairs that cost $10,000 even if these repairs are guaranteed to increase the value of the property by $20,000 because the benefits of increased property value accrue entirely to the lenders in this scenario.

To formalize this idea, consider the following stylized example of a firm in financial distress. As Table 32.3 shows, suppose that debt holders are due payments in the amounts of $20 and $100 at times $t = 1$ and $t = 2$, respectively. Based on its current investments, the firm's total expected cash flows from assets are expected to be $20 at each point in time, including time $t = 0$. For simplicity and without loss of generality, assume a discount rate of zero percent.

Based on this firm's total expected cash flows, the firm is expected to default by time $t = 2$. Overall, the total expected cash flows to debt holders amount to $40, and the total expected cash flows to equity holders, who are the residual claimants, amount to $20.

However, suppose the firm faces the following two investment opportunities, Opportunity A and Opportunity B. As Table 32.4 shows, both opportunities represent positive NPV investments and require upfront payments of $50 (at time $t = 0$) and $75 (at time $t = 1$), respectively. The total expected cash flows for each project amount to $100 and $25, respectively as shown in Table 32.4.

Table 32.3 **Another Example of Payouts under Financial Distress**

	t = 0	*t = 1*	*t = 2*	*Total*
Firm's total cash flow from assets	20	20	20	60
Cash flow to debt holders	—	20	~~100~~ 20	~~120~~ 40
Cash flow to equity holders	20	0	0	20

This table presents a two-period debt obligation one year and two years into the future for a hypothetical firm in financial distress. The first obligation due one year from now is $20, while the second obligation due two years from now is $100. Cash flows are divided into those distributed to debt holders and equity holders.

Table 32.4 **Payouts of Potential Investment Opportunities**

	t = *0*	*t* = *1*	*t* = *2*	*Total*
Possible investment opportunities				
Investment Opportunity A	–50	100	50	100

This table shows potential projects expected cash flows over a two year window. The first project requires an expenditure of $50 with two-year projected cash flows of $100 and $50, respectively. The second project requires a $75 outlay in year 1 with a projected cash flow one year from now of $100.

Table 32.5. **Payout to Stakeholders If the Firm Invests in Both Opportunities**

	t = *0*	*t* = *1*	*t* = *2*	*Total*
Firm's total cash flow from assets	–30	45	170	185
Cash flow to debt holders	—	20	100	120
Cash flow to equity holders	–30	25	70	65

This table illustrates potential firm cash flows that could be generated from two opportunities (A and B) under the assumption that debt obligations exist requiring payments of $20 one year from now and $100 two years from now.

Table 32.6 **Payout to Stakeholders If the Firm Only Invests in Opportunity A**

	t = *0*	*t* = *1*	*t* = *2*	*Total*
Firm's total cash flow from assets	–30	120	70	160
Cash flow to debt holders	—	20	~~100~~ 70	~~120~~ 90
Cash flow to equity holders	–30	100	0	70

This table illustrates the potential expected cash flows from an investment in only one opportunity (opportunity A) when the firm has a debt obligation to pay $20 one year from now and $100 two years from now.

If the firm invests in both projects, the equity holders and the debt holders benefit from the increase in expected cash flows. That is, as shown in Table 32.5, the total expected cash flows to debt holders would amount to the full $120 owed, and the total expected cash flows to equity holders would amount to $65.

Conversely, if the firm invests only in Opportunity A, the equity holders are even better off, with total expected cash flows amounting to $70. However, as illustrated in Table 32.6, the debt holders are worse off, with total expected cash flows amounting to less than the full $120 amount owed.

Thus, this additional gain to equity holders comes at a cost to debt holders, thereby resulting in an overall inefficient outcome. Simply put, the gain to equity holders from Opportunity B is not enough to merit the upfront costs because the equity holders bear the investment costs, but the upside predominantly benefits the debt holders. In contrast, under an all-equity capital structure or one with reduced leverage, the firm would invest in both positive NPV projects. Similarly, both projects would be undertaken if the firm could have accessed debt capital to finance the positive NPV projects.

With this insight in mind and as a segue into the next section on restructuring debt, alternatively consider what would happen if the debt holders had proposed an ex-ante debt restructuring at time $t = 0$, agreeing to a reduction in the outstanding principal balance to $95 at time $t = 2$ rather than the full $100. Under this restructured-debt scenario, Table 32.7 shows a cash-flow timeline that demonstrates the outcome if the firm invests in both Opportunity A and Opportunity B.

This debt restructuring is Pareto-improving. That is, under the restructured-debt scenario, all parties are better off and at the very least, no party is worse off. Ultimately the firm will invest in both positive NPV projects, as it should, and the total expected cash flows to debt holders amount to $115, and the total expected cash flows to equity holders amount to $70.

Restructuring Debt and Distressed Debt Exchanges

With respect to restructuring the debt service terms, the outstanding principal balance can be reduced (i.e., a principal write-down), the interest rate can be amended, or the loan maturity and terms of repayment can be renegotiated. Non-payment-related terms (i.e., financial covenants) in the debt agreement can also be renegotiated. A distressed debt exchange entails an exchange of the old debt for new debt under renegotiated terms. The exchange may also include other assets such as preferred stock or cash. For simplicity, both the restructuring of private and syndicated loans as well as distressed debt exchanges of public bonds can be referred to as "restructuring."

Restructuring may occur under the jurisdiction of the bankruptcy court, whereby a financially distressed firm can file under Chapter 11 of the U.S. Bankruptcy Code to seek protection during reorganization. In more extreme circumstances, the firm may file under Chapter 7, thereby relinquishing control to a court-appointed trustee to oversee the liquidation of assets and repayment of claims.

However, restructuring debt outside of court is typically the preferred route for investors in distressed debt, given that it is less costly and has the added benefits of proactively mitigating the likelihood of deliberate actions to take excessive risk or to

Table 32.7 **Payout to Stakeholders if the Firm Invests in Both Opportunities and Receives a Principal Write-Down on Its Debt**

	t = 0	*t = 1*	*t = 2*	*Total*
Firm's total cash flow from assets	–30	45	170	185
Cash flow to debt holders	—	20	95	115
Cash flow to equity holders	–30	25	75	70

This table illustrates potential cash flows that could be generated from two opportunities (A and B) under the assumption that debt obligations exist requiring a payment of $20 one year from now and a reduced payment of $95 (down from $100) two years from now.

forgo sound investments at the expense of debt holders. In fact, major terms of debt agreements are renegotiated out of court quite frequently, even outside of financial distress. For instance, in following a random sample of private debt agreements of publicly traded corporations, about 75 percent underwent a restructuring of the stated maturity, interest rate, and/or principal at some point throughout the life of the loan (Roberts and Sufi 2009). Empirical evidence suggests that debt covenants are also frequently renegotiated (Denis and Wang 2014).

In restructuring distressed debt, the terms of the debt agreement are renegotiated with the view to maximize the value of the debt claim, which entails assessing the borrower's ongoing ability to pay and whether the borrower may ultimately default despite the amended terms (i.e., whether early liquidation is feasible and preferable to restructuring the loan). The investor/lender must also assess the borrower's willingness to pay and consider what the natural cure rate might be. That is, the lender must assess the likelihood that a delinquent or financially distressed borrower may self-correct even in absence of restructuring the terms of the debt agreement.

Naturally, the terms of restructuring differ based on the predominant concerns surrounding the debtor's financial distress. That is, interest-rate reductions are more beneficial to distressed debt investors in circumstances where strategic default and the willingness to pay is not a concern, whereas principal write-downs are the more effective and value-enhancing mode of restructuring when willingness to pay rather than ability to pay is the predominant issue (Das and Kim 2014). Overall, the strategic actions of management and equity holders in distressed situations must be considered in implementing the optimal restructuring of the distressed debt investment to achieve a globally efficient outcome.

Summary and Conclusions

Distressed debt is a multi-faceted sub-asset class, with complexities that differentiate it from investment grade debt. This chapter has provided an overview of the basic terminology and issues to consider when vetting, investing in, and restructuring the bonds and loan agreements of financially distressed firms. The chapter helps to provide an understanding of the basic methods by which distressed debt may be restructured and the strategic opportunistic behaviors that must be anticipated during the debt restructuring.

Discussion Questions

1. Define distressed debt.
2. Define an underwater loan and describe the key factors driving the risk to investors in these loans.
3. Define a principal write-down and discuss the costs and benefits of this method of debt restructuring.
4. Describe other terms or focal points in restructuring debt besides reducing the principal balance.
5. Explain the risk of over- and under-investment that arises in distressed situations.

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Appendix A

Glossary of Key Concepts and Terms

This appendix provides an alphabetized list of key concepts and terms referenced throughout this chapter.

Ability to pay	*Ability to pay*, as distinct from *willingness to pay*, refers to the actual financial ability of a debtor to repay its debt obligations.
Asset substitution	*Asset substitution* (and/or overinvestment) occurs when an overleveraged debtor replaces or forgoes lower-risk investments to make higher-risk, possibly negative net present value (NPV) investments.
Chapter 7 bankruptcy	*Chapter 7* of the U.S. bankruptcy code specifies the process of liquidation for an individual or organization.
Chapter 11 bankruptcy	*Chapter 11* of the U.S. bankruptcy code specifies the process of reorganization for a financially distressed individual or organization. Note: The majority of private individuals seeking relief while under reorganization file for bankruptcy under Chapter 13 rather than under Chapter 11.
Cure rate	The *cure rate* refers to the rate at which previously delinquent loans are no longer in arrears. The *natural cure rate* refers to the cure rate in absence of loan modification or restructuring.
Debt covenant	A *debt covenant* is a formal agreement as to other conditions in addition to the terms of repayment that must be met on an ongoing basis throughout the life of the loan.
Debt overhang	*Debt overhang* and/or underinvestment occurs when an overleveraged debtor declines to make positive-NPV investments because it either: (1) cannot obtain additional debt capital, or (2) does not have the incentive to invest further equity capital due to excessive leverage.
Default	A *default* occurs when the debtor fails to make a promised payment as specified by the loan agreement. In the context of public bond issues, a bond in default is downgraded to a credit rating of D, and the bond is said to trade "flat" since accrued interest is no longer a consideration in pricing. See *technical default* for cases of default outside of failure to make promised payments.
Distressed debt	A loan or bond is considered *distressed* if the debtor is experiencing financial distress.

Distressed debt exchange	A *distressed debt exchange* is a negotiated restructuring of debt terms, thereby exchanging old debt for new debt under the renegotiated loan agreement. The exchange may also include other assets, such as additional debt at varying seniorities or maturities, preferred stock, or cash.
Pareto-improving	A *Pareto-improving* change occurs when at least one stakeholder's position is improved without harming any of the other stakeholders.
Principal write-down	A *principal write-down*, also known as a *principal reduction*, refers to a restructuring of debt terms to reduce the outstanding principal balance.
Strategic default	A *strategic default* occurs when the debtor deliberately enters default despite its financial ability to continue payments.
Technical default	A *technical default* occurs when the debtor violates non-payment-related terms of the loan agreement.
Underwater debt	A loan or bond is considered *underwater* if the debt principal exceeds the value of the underlying assets.
Willingness to pay	*Willingness to pay*, as distinct from *ability to pay*, refers to the actual willingness of a debtor to repay its debt obligations apart from rational considerations that may otherwise point to strategic default.

Appendix B

Sample Debt Covenants

Presented below is an excerpt from a public 8-K filing by RPM Inc. outlining the debt covenants for a syndicated loan agreement. The full document can be accessed from the SEC's EDGAR Company Search database at:

> https://www.sec.gov/Archives/edgar/data/110621/000095015207000037/l23911aexv10w1.htm

SECTION 9. COVENANTS. Each Borrower agrees that, so long as any of the Commitments are in effect and until payment in full of all Obligations, unless the Majority Lenders shall agree otherwise as contemplated by Section 13.05 hereof:

9.01 *Information*. The Company shall deliver to each of the Lenders:

(a) as soon as available and in any event within 90 days after the end of each fiscal year of the Company, consolidated statements of income, shareholders' equity and cash flows of the Company and its Subsidiaries for such year and the related consolidated balance sheet as at the end of such year, setting forth in each case in comparative form the corresponding figures for the preceding fiscal year, and accompanied by an opinion thereon of Ernst & Young LLP or other independent certified public accountants of recognized national standing, which opinion shall state that said consolidated financial statements fairly present in all material respects the consolidated financial condition and results of operations of the Company and its Subsidiaries as at the end of, and for, such fiscal year, provided that delivery of the Company's annual report on Form 10-K shall be deemed to satisfy the foregoing requirements;

(b) as soon as available and in any event within 45 days after the end of each fiscal quarter of the Company other than the last fiscal quarter in each fiscal year, consolidated statements of income, shareholders' equity and cash flows of the Company and its Subsidiaries for such fiscal quarter and for the portion of the fiscal year ended at the end of such fiscal quarter, and the related consolidated balance sheet as at the end of such fiscal quarter, accompanied, in each case, by a certificate of a Senior Officer, which certificate shall state that said consolidated financial statements fairly present in all material respects the consolidated financial condition and results of operations of the Company in accordance with GAAP (except for footnotes of the type required by the Securities and Exchange Commission to be included in quarterly reports on Form 10-Q), consistently applied, as at the end of, and for, such period (subject to normal year-end audit adjustments), provided that delivery of the Company's quarterly report on Form 10-Q shall be deemed to satisfy the foregoing requirements;

(c) promptly upon the mailing thereof to the shareholders of the Company generally, copies of all financial statements, reports, and proxy statements so mailed;

(d) promptly upon the filing thereof, copies of all registration statements (other than any registration statements on Form S-8 or its equivalent) and any reports which the Company shall have filed with the Securities and Exchange Commission;

(e) if and when the Company or any member of the Controlled Group (i) gives or is required to give notice to the PBGC of any "reportable event" (as defined in Section 4043 of ERISA) with respect to any Plan which might constitute grounds for a termination of such Plan under Title IV of ERISA, or knows that the plan administrator of any Plan has given or is required to give notice of any such reportable event, a copy of the notice of such reportable event given or required to be given to the PBGC, (ii) receives notice of complete or partial withdrawal liability under Title IV of ERISA or notice that any Multiemployer Plan is in reorganization, is insolvent, or has been terminated, a copy of such notice; (iii) receives notice from the PBGC under Title IV of ERISA of an intent to terminate or appoint a trustee to administer any Plan, a copy of such notice; (iv) applies for a waiver of the minimum funding standard under Section 412 of the Code, a copy of such application; (v) gives notice of intent to terminate any Plan under Section 4041(c) of ERISA, a copy of such notice and other information filed with the PBGC; (vi) gives notice of withdrawal from any Plan pursuant to Section 4063 of ERISA, a copy of such notice; or (vii) fails to make any payment or contribution to any Plan or Multiemployer Plan or makes any amendment to any Plan which has resulted or could result in the imposition of a Lien or the posting of a bond or other security, a certificate of a Senior Officer setting forth details as to such occurrence and action, if any, which the Company or member of the Controlled Group is required or proposes to take;

(f) promptly (and in any event within 3 Business Days) after a Senior Officer of the Company knows that any Default or Event of Default has occurred and is continuing, a notice of such Default or Event of Default, describing the same in reasonable detail;

(g) promptly after a Senior Officer of the Company knows of a change in the Fitch Rating, S&P Rating, and/or Moody's Rating of the Company, a notice of such change in the Fitch Rating, S&P Rating and/or Moody's Rating of the Company; and

(h) from time to time such other information regarding the financial condition, operations, prospects or business of the Company or any Borrower as the Administrative Agent or any Lender through the Administrative Agent may reasonably request.

The Company will furnish to each Lender, at the time it furnishes each set of financial statements pursuant to paragraph (a) or (b) above, a certificate of the Company executed by a Senior Officer (i) to the effect that, to the best of his knowledge after due inquiry, no Default or Event of Default has occurred and is continuing (or, if any Default or Event of Default has occurred and is continuing, describing the same in reasonable detail) and (ii) setting forth in reasonable detail the computations necessary to determine whether it was in compliance with Sections 9.08 to 9.12, inclusive, and 9.16 hereof as of the end of the respective fiscal quarter or fiscal year.

9.02 *Taxes and Claims*. The Company will pay and discharge, and will cause each of its Subsidiaries to pay and discharge, all material taxes, assessments, and governmental charges or levies imposed upon it or upon its income or profits, or upon any property belonging to it, prior to the date on which penalties attach thereto, and all material lawful claims which, if unpaid, might become a Lien upon the property of the Company or such Subsidiary, provided that neither the Company nor such Subsidiary shall be required to pay any such tax, assessment, charge, levy, or claim the payment of which is being contested in good faith and by proper proceedings if it maintains adequate reserves with respect thereto and if such contest, proceedings, and reserves have been described in a certificate of a Senior Officer delivered to the Lenders.

9.03 *Insurance*. The Company will maintain, and will cause each of its Subsidiaries to maintain, insurance with responsible companies in such amounts and against such risks as is usually carried by companies of established repute engaged in the same or similar businesses, owning similar properties, and located in the same general areas as the Company and its Subsidiaries.

9.04 *Maintenance of Existence; Conduct of Business*. The Company will preserve and maintain, and will cause each of its Subsidiaries to preserve and maintain, its corporate, partnership or limited liability company existence, as applicable, and all of its rights, privileges, and franchises necessary or desirable in the normal conduct of its business, and will conduct its business in a regular manner; provided that nothing herein shall prevent (i) the consolidation or merger (and resulting dissolution) of any Subsidiary of the Company into the Company so long as the Company is the surviving corporation, (ii) the consolidation or merger of any Subsidiary of the Company into any other

Subsidiary of the Company so long as, in the case of such mergers or consolidations involving one or more Foreign Borrowers, either (A) a Foreign Borrower is the surviving entity, or (B) to the extent a Foreign Borrower is not the surviving corporation, such Foreign Borrower has been released in accordance with Section 2.09(d) hereof, (iii) the sale of any Subsidiary of the Company which is not a Significant Subsidiary so long as, in the case of any Foreign Borrower, such Foreign Borrower has been released in accordance with Section 2.09(d) hereof, (iv) the termination of corporate, partnership or limited liability company existence, dissolution or abandonment by the Company of any Subsidiary which is not a Significant Subsidiary so long as, in the case of any Foreign Borrower, such Foreign Borrower has been released in accordance with Section 2.09(d) hereof, and (v) any sale, lease, or transfer of assets not prohibited by Section 9.10 hereof.

9.05 *Maintenance of and Access to Properties*. The Company will keep, and will cause each of its Subsidiaries to keep, all of its properties necessary in its business in good working order and condition (having regard to the condition of such properties at the time such properties were acquired by the Company or such Subsidiary), ordinary wear and tear excepted, and proper books of record and account in which full, true, and correct entries in conformity with GAAP shall be made of all dealings and transactions in relation to its business activities, and will permit representatives of the Lenders to inspect such properties and, upon reasonable notice and at reasonable times, to examine and make extracts and copies from the books and records of the Company and any such Subsidiary.

9.06 *Compliance with Applicable Laws*. The Company will comply, and will cause each of its Subsidiaries to comply, with the requirements of all applicable laws, rules, regulations, and orders of any governmental body or regulatory authority (including, without limitation, all Environmental Laws), a breach of which would have a Material Adverse Effect, except where contested in good faith and by proper proceedings.

9.07 *Litigation*. The Company will promptly give to the Administrative Agent (which shall promptly notify each Lender) notice in writing of all litigation and of all proceedings of which it is aware before any courts, arbitrators, or governmental or regulatory agencies affecting the Company or any of its Subsidiaries which could reasonably be expected to have a Material Adverse Effect.

9.08 *Leverage Ratio*.

(a) The Company will not permit Indebtedness of the Company and its Subsidiaries, determined on a consolidated basis, on any date to exceed 65 percent of the sum of such Indebtedness and consolidated shareholders' equity of the Company and its Subsidiaries on such date.

(b) The Company will not permit Indebtedness of its Domestic Subsidiaries, determined on a combined basis exclusive of Indebtedness to the Company and Indebtedness pursuant to receivables securitizations incurred in accordance with the terms and conditions of this Agreement, on any date to exceed 15 percent of consolidated shareholders' equity of the Company and its Subsidiaries on such date.

9.09 *Interest Coverage Ratio*. The Company will not permit the ratio, calculated as at the end of each fiscal quarter ending after the Closing Date for the four fiscal quarters then ended, of EBITDA for such period to Interest Expense for such period to be less than 3.5:1.

9.10 *Mergers, Asset Dispositions, Etc.* No Borrower will (i) consolidate or merge with or into any other Person or (ii) sell, lease, or otherwise transfer, directly or indirectly, in one transaction or a series of related transactions, all or substantially all of its business or assets; provided that (1) any Borrower may consolidate or merge with another Person if (A) such Borrower is the entity surviving such merger and (B) immediately after giving effect to such consolidation or merger, no Default or Event of Default shall have occurred and be continuing, (2) any Borrower other than the Company may sell, lease, or transfer all or substantially all of its business or assets to the Company or any other Borrower, and (3) nothing herein shall prevent any of the transactions or events permitted under clauses (i)–(v) of Section 9.04.

9.11 *Liens*. The Company will not, and will not permit any of its Subsidiaries to, create or suffer to exist any Lien upon any property or assets, now owned or hereafter acquired, securing any Indebtedness or other obligation, except:

(i) Liens existing on the Closing Date and securing Indebtedness in an aggregate principal amount not exceeding $10,000,000;
(ii) Liens existing on other assets at the date of acquisition thereof or which attach to such assets concurrently with or within 90 days after the acquisition thereof, securing Indebtedness incurred to finance the acquisition thereof in an aggregate principal amount at any time outstanding not exceeding $35,000,000;
(iii) any Lien existing on any asset of any corporation at the time such corporation becomes a Subsidiary of the Company or is merged or consolidated with or into the Company or one of its Subsidiaries and not created in contemplation of such event;
(iv) any Lien arising out of the refinancing, extension, renewal or refunding of any Indebtedness secured by any Lien permitted by any of the foregoing clauses of this Section 9.11, provided that such Indebtedness is not increased and is not secured by any additional assets;
(v) other Liens arising in the ordinary course of the business of the Company or such Subsidiary which are not incurred in connection with the borrowing of money or the obtaining of advances or credit, do not secure any obligation in an amount exceeding $25,000,000, and do not materially detract from the value of its property or assets or materially impair the use thereof in the operation of its business;
(vi) Liens not otherwise permitted by the foregoing clauses of this Section 9.11 securing Indebtedness in an aggregate principal or face amount at any date not to exceed $40,000,000; and
(vii) Liens incurred pursuant to receivables securitizations and related assignments and sales of any income or revenues (including Receivables), including Liens on the assets of any Receivables Subsidiary created pursuant to any receivables securitization and Liens granted by the Company and its other Subsidiaries on Receivables in connection with the transfer thereof, or to secure obligations owing by them, in respect of any such receivables securitization; provided that (x) the amounts received by the Company and its other Subsidiaries from such Receivables Subsidiary in connection with the sale or other transfer of such Receivables would not under GAAP be accounted for as liabilities on a consolidated balance sheet of the Company, and (y) the aggregate principal amount of the investments and

> claims held at any time by all purchasers, assignees, or other transferees of (or of interests in) Receivables from any Receivables Subsidiary, and other rights to payment held by such Persons, in all receivables securitizations shall not exceed $250,000,000.

9.12 *Investments*. The Company will not, and will not permit any of its Subsidiaries to, make or permit to remain outstanding any advances, loans, or other extensions of credit or capital contributions (other than prepaid expenses in the ordinary course of business) to (by means of transfers of property or assets or otherwise), or purchase or own any stocks, bonds, notes, debentures, or other securities of, any Person (all such transactions being herein called "*Investments*"), except: (i) operating deposit accounts; (ii) Liquid Investments; (iii) subject to Section 9.13 hereof, Investments in accounts and notes receivable acquired in the ordinary course of business as presently conducted; (iv) Investments existing on the Closing Date in Subsidiaries or joint ventures, and Investments after the Closing Date by the Captive Insurance Companies in the ordinary course of its business; (v) Investments not otherwise permitted by the foregoing clauses of this Section 9.12 in Subsidiaries (other than the Receivables Subsidiary) of the Company and in Persons which become Subsidiaries of the Company as the result of such Investments; (vi) Investments not otherwise permitted by the foregoing clauses of this Section 9.12 in joint ventures in an aggregate amount not to exceed $75,000,000; (vii) Investments comprised of capital contributions, loans, or deferred purchase price (whether in the form of cash, a note, or other assets) to any Receivables Subsidiary or of residual interests in any trust formed to facilitate any related receivables securitization; and (viii) Investments not otherwise permitted by the foregoing clauses of this Section 9.12 in an aggregate amount not to exceed $20,000,000.

9.13 *Transactions with Affiliates*. Except as expressly permitted by this Agreement the Company will not, and will not permit any of its Subsidiaries to, directly or indirectly: (i) make any Investment in an Affiliate of the Company (other than a Subsidiary of the Company); (ii) transfer, sell, lease, assign, or otherwise dispose of any assets to an Affiliate of the Company (other than a Subsidiary of the Company); (iii) merge into or consolidate with or purchase or acquire assets from an Affiliate of the Company (other than a Subsidiary of the Company); or (iv) enter into any other transaction directly or indirectly with or for the benefit of an Affiliate of the Company (other than a Subsidiary of the Company) (including, without limitation, Guaranties and assumptions of obligations of an Affiliate of the Company [other than a Subsidiary of the Company]); provided that (a) any Affiliate of the Company who is an individual may serve as a director, officer, or employee of the Company and receive reasonable compensation or indemnification in connection with his or her services in such capacity; and (b) any transaction entered into by the Company or a Subsidiary of the Company with an Affiliate of the Company which is not a Subsidiary of the Company providing for the leasing of property, the rendering or receipt of services, or the purchase or sale of inventory and other assets in the ordinary course of business must be for a monetary or business consideration which would be substantially as advantageous to the Company or such Subsidiary as the monetary or business consideration which would obtain in a comparable arm's length transaction with a Person not an Affiliate of the Company.

9.14 *Lines of Business*. The Company and its Subsidiaries, taken as a whole, shall not engage to any substantial extent in any line or lines of business activity other than present or related product lines.

9.15 *Environmental Matters*. The Company will promptly give to the Lenders notice in writing of any complaint, order, citation, notice, or other written communication from any Person with respect to, or if the Company becomes aware after due inquiry of, (i) the existence or alleged existence of a violation of any applicable Environmental Law or Environmental Liability at, upon, under, or within any property now or previously owned, leased, operated, or used by the Company or any of its Subsidiaries or any part thereof, or due to the operations or activities of the Company, any Subsidiary on or in connection with such property or any part thereof (including receipt by the Company or any Subsidiary of any notice of the happening of any event involving the Release of a reportable quantity under any applicable Environmental Law or cleanup of any Hazardous Substance), (ii) any Release on such property or any part thereof in a quantity that is reportable under any applicable Environmental Law, (iii) the commencement of any cleanup pursuant to or in accordance with any applicable Environmental Law of any Hazardous Substances on or about such property or any part thereof and (iv) any pending or threatened proceeding for the termination, suspension, or non-renewal of any permit required under any applicable Environmental Law, in each case which individually or in the aggregate could reasonably be expected to have a Material Adverse Effect.

9.16 *Lease Payments*. Neither the Company nor any of its Subsidiaries has incurred or assumed or will incur or assume (whether pursuant to a Guaranty or otherwise) any liability for rental payments under a lease with a lease term (as defined in Financial Accounting Standards No. 13 of the Financial Accounting Standards Board, as in effect on the date hereof) if (i) such lease is of an asset previously owned by the Company or any of its Subsidiaries and (ii) after giving effect thereto, the aggregate amount of minimum lease payments that the Company and its Subsidiaries have so incurred or assumed will exceed, on a consolidated basis, $50,000,000 for any calendar year under all such leases.

9.17 *Anti-Terrorism Laws*. Neither the Company nor any of its Subsidiaries shall be in violation of any law or regulation or appear on any list of any government agency (including, without limitation, the U.S. Office of Foreign Asset Control list, Executive Order No. 13224 or the USA Patriot Act) that prohibits or limits the conduct of business with or the receiving of funds, goods, or services to or for the benefit of certain Persons specified therein or that prohibits or limits any Lender or LC Issuer from making any advance or extension of credit to any Borrower.

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Microstructure of Fixed Income Trading

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Introduction

Corporations, banks, and governments are like trees with roots extending deep into the foundations of financial markets. Just as trees cannot grow taller without sufficient soil, so too economies do not develop without the financial depth provided by borrowing and the associated fixed income markets (Schumpeter 1934). This asset class provides stability to the global markets, enabling public and private organizations, including governments, to take risks and innovate in new ways.

Extending this analogy, when observing a forest "getting lost in the trees" is more common than "getting lost in the soil." An investor may seek to analyze the financial position of a company without understanding the fixed income marketplace that supports it. However, such an analysis runs the risk of myopia when the ground starts shaking and economies begin to crumble. Just as the movement of tectonic plates shapes the geographic boundaries dividing nations, so too does trading in the bond markets shape national economies and create invisible fault lines particularly given the increasing interdependence among markets.

This chapter maintains that understanding the microstructure of fixed income trading may enable predicting these market "earthquakes" before they occur. It describes the microstructure of fixed income trading starting with how these markets formed, how they function, and how they may evolve in the future. The chapter does not provide an exhaustive overview of the fixed income markets but instead focuses on three classes of bonds: Treasuries, corporate bonds, and municipal securities. Other scholars have completed considerable work on the microstructure of other asset classes, such as mortgage-backed securities, agency bonds, interest rate products, and derivatives. This chapter excludes these asset classes and focuses on U.S. markets as the largest and most liquid fixed income markets globally. It concludes by generalizing the findings and predicting the impact for global fixed income markets.

Regulation and Automation

The two primary forces responsible for recent changes in the structure of fixed income trading are the regulation of banking activities and the automation of trading with electronic platforms. Historically, market-makers have enabled price discovery and improved efficiency within markets that are otherwise opaque, infrequently traded or illiquid. However, this business model and the ability to assume risk depend on other variables such as regulation. The bond markets have historically depended on market makers to provide liquidity, but these recent changes question this assumption going forward.

With the collapse of Lehman Brothers and the financial crisis of 2007–2008, regulators have placed strict controls on banking procedures, specifically in the structured credit and derivative markets (Guynn 2010). This chapter contends that these controls have created an environment that disincentivizes risk-taking for broker-dealers. The second macro force affecting fixed income markets is the launch of electronic trading platforms. Technology is reducing the cost of trading and drastically accelerating the pace of these markets. This shift is perhaps best exemplified in the proliferation of high frequency trading, an evolution that may have occurred, in part, due to the supply gap created by regulators. Although the intended result of regulation and automation may be faster, fairer markets, complexity can exacerbate risk. This chapter contends that more frequent periods of sudden, unexpected, and historic volatility are likely to occur.

Key Topics in Fixed Income Markets

The fundamental structure of fixed income markets differs from the equity markets. Therefore, understanding the "language" of fixed income markets is important to better comprehend how these markets evolve. Accordingly, this section explains several key terms involving fixed income markets.

Over the Counter

The *over-the-counter (OTC) market* refers to a financial market that is organized through informal dealer networks. Because these markets do not operate on central exchanges, they tend to be more opaque and less liquid than exchange-traded markets.

Market Maker

OTC markets historically rely on broker-dealers to provide order flow and liquidity. Although some dealers may only participate occasionally, a *market maker* is a dealer who commits to buy and sell securities at all times. Market makers have historically played a key role in the development of OTC markets by providing liquidity to investors and facilitating trading activity.

Liquidity

In theory, a *liquid market* is one in which trades can be executed at no cost (O'Hara 2012). In practice, markets are described as *liquid* when trading costs are low and *illiquid* when such costs are high. However, determining the costs of a trade is not always simple because they may vary depending on the size, timing, and motivations of the counterparty (Fleming and Remolona 1999). This chapter provides an analysis on liquidity and its measurement across different markets.

Price Formation and Discovery

Price formation refers to the mechanism through which market prices impound new information. *Price discovery* is the distribution of those prices to potential investors. The specifics of these topics tend to vary across asset classes because they largely depend on the structure of these markets.

U.S. Treasury Market

The U.S. Treasury market is the deepest and most liquid debt market in the world (Joint Staff 2015). Such liquidity benefits U.S. taxpayers by reducing the cost of borrowing for the federal government. Because the U.S. government guarantees the payment of obligations for Treasuries securities, these securities are deemed to be "risk free" and serve as the benchmark rate for a wide range of global debt instruments (Massa and Simonov 2003).

The history of U.S. Treasury securities can be traced to 1917 when Congress required funding to finance the Allied cause in World War I (Garbade 2008). Although the United States had previously relied on taxation to finance its war efforts, the staggering cost of the World War I generated a national debate on the benefits of debt financing. Advocates of this new financing method argued that a national war bond program could improve the standard of living for Americans by extending the payback timeline to future generations, and by enabling domestic institutions and foreign powers to participate in the war funding. The debate concluded with Congress passing the Emergency Loan Act in 1917, which authorized the issuance of $1.9 billion in Liberty Bonds, which paid 3.5 percent interest for 30 years (Garbade 2008).

The Birth of the Auction System

Although the first series of Liberty Bonds was eventually placed, the market response to this issuance was at first unenthusiastic, with many bonds trading well below par value (Mizrach and Neely 2007). The Board of Governors of the New York Stock Exchange (NYSE) initially tried to coerce bond traders into raising their prices. At one point, it conducted an investigation to identify whether "pro-German influences" had bribed "unpatriotic" traders to sell under par. However, the board eventually concluded that the market was soft as the bonds were not effectively being marketed to small investors (Markham 2002).

In the short term, the Treasury "closed the gap" between its funding needs and market demands with increased interest rates and extensive wartime marketing. By the 1920s, the consensus was that borrowing funds was expensive. The Treasury continually struggled to match supply with demand, with bonds chronically over-subscribed, suggesting that the government was offering too much interest on its debt. For these reasons, the U.S. Treasury turned to an auction system in 1929 in which Treasury bills were sold to the highest bidder, laying the groundwork for the modern structure of the government bond market (Garbade 2008).

Market Size and Overview

As of 2017, more than $19 trillion in U.S. government debt was outstanding of which foreign investors held $2.6 trillion (Treasury 2017). According to the Securities Industry and Financial Markets Association (SIFMA 2017a), the average daily trading volume of these securities was $455 billion, making these assets the most liquid on the market.

Auction Process

The auction process begins with the Treasury making a public announcement, which is typically carried by major newspapers and media channels. These announcements state the types of securities to be auctioned, CUSIP number, offering date, issue, and auction date. The Treasury accepts bids up to 30 days in advance through an electronic system called the *Treasury Automated Auction Processing System* (TAAPS) and also accepts bids by mail. The Treasury keeps specific bid amounts confidential and sealed until auction date (TreasuryDirect 2017).

The Treasury accepts competitive and noncompetitive bids. Larger investors, such as institutions and foreign governments, submit competitive bids, which are filled in a typical auction format with the highest bidder winning each round. In contrast, smaller investors submit noncompetitive tenders. The Treasury guarantees to fill such bids generally up to $5 million per security.

Although the specific process of Treasury auctions has evolved over time, the current sealed-bid, single-price format started in 1998. The Treasury ostensibly adopted this updated process due to rules violations in 1991 (Mercer, Moore, Whitby, and Winters 2013). The effect of the change was to transfer more value to the Treasury during the auction process. Sealed-bid auctions prevent buyers from incorporating estimates of their competitors' reservation prices and single-price formats tend to increase "buyer's remorse" (Milgrom 1989).

Secondary Markets

Although retail investors can buy directly from the Treasury during the auction process, these noncompetitive bids generally represent less than 5 percent of the auction volume (Foley, Cebula, and Houmes 2012). The remaining Treasuries flow through primary dealers after auction, and these dealers continue to act as market-makers in the secondary markets thereafter.

The secondary markets for U.S. Treasuries are multiple dealers, OTC markets, with the main trading centers are in New York, London, and Tokyo. Although trading can occur 24 hours per day, more than 90 percent of trading volume occurs during New York hours (7:00 am to 5:30 pm Eastern Standard Time) as the Federal Reserve (Fed) is the largest trader of government securities (Mizrach and Fleming 2008).

When-Issued Trading

Mercer et al. (2013) contend that when-issued trading cures the “winner’s curse.” *When-issued trading* refers to the practice of trading in the forward market ahead of Treasury auctions. The authors maintain that when-issued trading provides a price discovery mechanism through which primary dealers can infer the “correct” yield of the Treasuries that are scheduled to go to auction.

When-issued trading has a clearly defined timeline, with trading on the 13-week Treasury-bill beginning with the auction announcement and ending with the delivery of new bills. Mercer et al. (2013) show that while the auction price is somehow discovered in the when-issued market, this information is not linked to order flow as it is thought to be in the equity markets. The exact mechanism through which forward price converges with the ultimate auction price is left open as a topic for future research.

On-the-Run and Off-the-Run

As Treasuries are auctioned and their prices are made public, this information is added to the “yield curve” that plots the current interest rates on U.S. government securities. This curve measures the rates demanded by the market for risk-free loans of various tenors and is historically used to calculate the risk-free rate that forms the basis of many fixed income valuations.

The nominal yield curve is constructed by mapping current interest rates on the most-recently-issued government securities. Although several outstanding contracts typically exist at a given tenor, the most recent auctions tend to provide the best indication of the government’s current cost of capital. These securities are referred to as “on-the-run,” and usually trade at a premium to older securities (“off-the-run”), which are generally less liquid (Chincarini 2012).

Demand is often high for on-the-run securities when they are initially issued, as traders sell their old bonds (now off-the-run) and “roll” their contracts to ensure a constant maturity. This activity can generate substantial market volatility, and some investors try to time their trading to take advantage of the anticipated trading volume. This strategy is known as *convergence trading* (Chincarini 2012).

Institutional Agents

The U.S. Treasury issues bonds too frequently to efficiently interact with all potential security purchasers. Rather, a system has developed over time incorporating primary dealers to trade directly with the Federal Reserve in the primary market and inter-broker dealers for trading in the secondary market.

Primary Dealers

The U.S. Treasury created its auction system to overcome the need to accurately match its pricing against market demand. Toward that end, the Fed created a system in 1960 that permitted 18 dealers to trade directly with the government and to act as market makers for its securities. As Table 33.1 shows, 23 dealers now trade directly with the Fed. These primary dealers assist the Fed in implementing monetary policy. The Fed requires them to submit bids at open market operations, to provide market insight (e.g., answer survey questions about expectations for the economy, monetary policy, and financial market developments) to the Fed's trading desk, and to actively participate in the auction process (New York Federal Reserve Board 2017).

Interdealer Brokers

The core of the secondary market for U.S. Treasuries is the interdealer broker (IDB) market, which traditionally accounts for the majority of interdealer trading. Because Treasuries are not traded on an exchange, dealers must identify counterparties for each buy/sell order. IDBs are pure intermediaries that liaise between potential counterparties to establish a price and volume for each transaction. They provide value to dealers by enabling price discovery, providing liquidity, and offering anonymity.

The Treasury estimates that IDBs initiated about 40 percent of transactions in the secondary markets between 2015 and 2017 (New York Federal Reserve Board 2017). Dealers traditionally executed these trades over voice brokerage. Since the early 2000s, however, trading has increasingly migrated to digital platforms called *electronic communication networks* (ECNs). The two major platforms in this market are BrokerTec, which ICAP owns, and eSpeed, which Nasdaq OMX acquired in 2013 but was originally part of BGC Partners (Mizrach and Fleming 2008).

These digital platforms automate trading by matching buyers to sellers without human intervention. By speeding up the trading process and reducing the cost of trading, ECNs have consolidated the IDB market (Risk.net 2016). A study by the New York Federal Reserve shows that BrokerTec trading activity accounted for about 60 percent

Table 33.1 **List of Primary Dealers**

Bank of Nova Scotia, New York Agency	J.P. Morgan Securities LLC
BMO Capital Markets Corp	Merrill Lynch, Pierce, Fenner & Smith Inc.
BNP Paribas Securities Corp	Mizuho Securities USA LLC
Barclays Capital Inc.	Morgan Stanley & Co LLC
Cantor Fitzgerald & Co	Nomura Securities International, Inc.
Citigroup Global Markets Inc.	RBC Capital Markets, LLC
Credit Suisse Securities (USA) LLC	RBS Securities Inc.
Daiwa Capital Markets America Inc.	Societe Generale, New York Branch
Deutsche Bank Securities Inc.	TD Securities (USA) LLC
Goldman Sachs & Co LLC	UBS Securities LLC
HSBC Securities (USA) Inc.	Wells Fargo Securities, LLC
Jefferies LLC	

The table lists the primary dealers authorized to trade Treasury securities.

Source: New York Federal Reserve Board (2017).

of all electronic interdealer trading in the on-the-run two-, five-, and 10-year notes and slightly above 50 percent for the 30-year bonds (Dungey, Henry, and Mckenzie 2013).

Although certain firms such as ICAP seem to have benefited from the electronification of the U.S. Treasury market, others have been forced to consolidate under increased market competition and reduced bid-ask spreads (*Economist* 2012). Today, five firms represent the overwhelming majority of IDB market volume in U.S. Treasuries: ICAP, Tullett Prebon, Tradition, BGC Partners, and GFI Group (Stafford 2013).

High Frequency Traders

The wide availability of digital communication and the electronification of trading functions have invited high frequency traders (HFTs) to enter the U.S. Treasury market. These agents use highly sophisticated algorithms and computer tools to rapidly trade securities in an automated fashion, which enables HFTs to trade at higher speed with tighter spreads than traditional brokers (Rijper, Sprenkeler, and Kip 2010).

As these firms generally hold positions over a very short time horizon, which is often for less than a second and almost always less than a trading day, HFTs increase the overall volume of U.S. Treasury trading. This pattern of rapid two-way trading results in the continuous posting of bid-ask quotes, enabling price discovery to other market participants. By adding liquidity and reducing bid-ask spreads, HFTs lower transaction costs for other market participants (Rijper et al. 2010).

Although a limited set of public data is available on the specific level of HFT participation in the Treasury markets, a leaked client list from BrokerTec indicates that eight of the top 10 firms on their platform were HFTs (Risk.net 2016). This finding suggests that HFTs may have initiated the majority of trades conducted in the secondary market for U.S. Treasuries in 2015.

HFTs deploy strategies that take advantage of intraday price fluctuations and market microstructure features. Although this activity often does not affect long-term investors, it can introduce short-term volatility. One example of the potential for high frequency trading to influence market prices was the "Flash Crash" on October 15, 2014, when U.S. Treasury cash and futures markets experienced substantial volatility amidst record trading volumes, including a rapid round-trip in prices that occurred with no new exogenous information (Joint Staff 2015). In the six minutes from 9:33 am to 9:39 am EST, the 10-year Treasury yield decreased by 16 basis points, then abruptly reversed course and retraced its steps over the next six minutes, with no apparent cause. Although the event did not markedly alter long-term Treasury prices, the Flash Crash demonstrates the extent to which the U.S. Treasury market has become dependent on HFTs to provide liquidity.

Foreign Governments

Although the value of outstanding U.S. debt has increased fivefold between 1990 and 2016, foreign governments and institutions have increasingly funded these loans. Whereas foreign governments represented 19 percent of the U.S. debt market in 1990, they have increasingly provided capital to the U.S. government, and now represent a plurality of ownership, at roughly 44 percent of total debt outstanding (Federal Reserve Bank of St. Louis 2017). The People's Republic of China is currently the largest owner of U.S. Treasuries with total holdings of roughly $1.2 trillion as of 2017, and Japan is the next largest owner of U.S. debt, at $1.1 trillion in value (Treasury 2017).

Economic reasons help to explain why a foreign government would want to own U.S. debt. First, holding Treasuries can improve the lender's creditworthiness. The securities offer deep liquidity and are backed by U.S. dollars, a globally accepted currency that is pegged by 27 other countries. Overall, the U.S. dollar offers clear safety and security benefits for a sovereign government looking to invest its reserves.

Trading with the United States can generate further demand for its currency. Friedman (2009) contends that globalization forces an economic dependency between trading partners. He notes that U.S. manufacturing partners in China and India receive constant payment streams in dollars that must be converted to local currency. This activity increases demand for local currency, reducing supply and increasing domestic interest rates. The central bank often offsets this imbalance by buying excess U.S. dollars and selling its own currency. When replicated across the globe, with multiple trading partners, this behavior generates substantial demand for U.S. Treasuries (Friedman 2009).

Foreign governments may also buy Treasuries for political reasons. Friedman (2009) cites the "Golden Arches Theory of Conflict Prevention" to explain how economic interdependence leads to a political "lock-in." According to this theory, no two countries that have McDonald's franchises have ever gone to war. Although this theory is not literally true, and Friedman later revised it to the "Dell Theory of Conflict Prevention," the concept remains the same: countries with bonded economies are unlikely to go to war. This theory suggests that buying U.S. Treasuries can be an effective diplomatic strategy.

A final reason that countries may purchase U.S. debt is to indirectly stimulate their own economies. The monthly trade deficit between the U.S. and China stands at $30 billion (United States Census Bureau 2018). When the Chinese government lends money to the United States, some of these funds naturally flow back to China's suppliers. This strategy of export-led growth has helped propel China's economy toward high growth rates, and may well have led to currency devaluation, were it not for the nation's tight, central control on its domestic economy.

Pricing and Liquidity

The infrequent trading of fixed income instruments creates challenges in measuring liquidity and determining prices. The relative depth of the U.S. Treasury market provides an opportunity to study price discovery and market efficiency.

Liquidity Measurement

Several measurements can be used to evaluate the liquidity of the Treasury market. The most common measures are the *bid-ask spread*, which is the difference between the bid or ask price and the average price, which is the midpoint between the average bid and ask. However, a drawback of this method is that these prices are only valid for limited quantities over a narrow time period. Therefore, the spread only measures the cost of executing a single trade of a limited size (Fleming and Remolona 1999).

Alternative measurements may look at market depth, such as *quote size*, which is the posted number of contracts that the buyer/seller is advertising, or *trade size*, which is the actual volume of securities exchanged. Both metrics may underestimate market depth because dealers may not reveal the full quantities they are willing to transact at a given price or may choose not to transact at the full volume available (Fleming and Remolona 1999).

Although the above measurements are applicable to all OTC securities, other measurements are unique to the Treasury market. For instance, the *liquidity spread* tracks the difference between yields on on-the-run and off-the-run Treasuries with similar financial characteristics. As the most recently issued Treasuries tend to be the most liquid, this spread represents the premium that traders are willing to pay for liquidity. This measurement is still a proxy for liquidity because other factors may affect the relative value of an on-the-run security, such as its "specialness" in the repo market (Duffie 1996). This potential lending income should be accounted for when evaluating Treasuries with the liquidity spread method.

Price Discovery

The market for U.S. Treasuries provides an excellent context to analyze *price discovery*, the mechanism through which new information is impounded into market prices, as it receives a steady flow of information that can be analyzed against tick-by-tick price changes. The two streams of research in this domain involve how public information affects Treasury prices and how trading activity reveals private information (Mizrach and Neely 2007).

The activity of trading in any OTC market reveals information not only about the security but also about the trade. In their microstructure analysis of the Treasury market, Massa and Simonov (2003) identify a "reputation" factor that influenced the level of impact that a certain trader's activity may have on market pricing. This factor is arguably less relevant in the Treasury market, whose liquidity and depth are theoretically less affected by the motivations of a single counterparty. Therefore, the following section focuses on how public information affects Treasury prices. A discussion of the topic of private information occurs in greater detail later in the chapter.

Public Information

Since Treasury yields indicate the U.S. government's ability to borrow in U.S. dollars, they are particularly sensitive to changes in monetary policy, which often takes place around scheduled announcements. These events are useful for high frequency analysis on the effect of public information on the Treasury markets, as government agencies typically impose strict "lock up" conditions in advance of a public announcement to prevent early dissemination of information into the markets.

Fleming and Remolona (1999) identify two stages of market adjustment in the Treasury markets to a release of new public information. The first stage, which often begins a minute ahead of the scheduled release, is marked by a dramatic widening in the bid-ask spread as dealers seek to predict how this new information may affect the market. Although this price change causes a spike in volatility, it is often accompanied by a lull in trading volume. This first stage shows how information can influence the markets before it becomes public and demonstrates how market-makers can influence pricing by withdrawing inventory.

The second stage of price formation occurs over the next few minutes as the market internalizes the new information. This stage is characterized by a surge in volume, high volatility, and moderately wide bid-ask spreads, suggesting that market participants may initially disagree on the meaning of a given event. However, Treasury spreads quickly narrow over the next few minutes as the correct interpretation becomes apparent. For the next 90 minutes, price and volatility fluctuate at higher levels than normal, as market participants scramble to trade on the new information.

Information Efficiency

The above analysis suggests that the Treasury market may be defined as having historically weak form information efficiency. Although Treasury prices quickly impound public information, an opportunity remains for some participants to profit from trading on public information before their competitors. This opportunity window is likely to continue to shrink as digital networks, sophisticated algorithms, and high frequency trading accelerate the processing of new information. This trend may continue until the incremental cost of processing new information faster exceeds the benefits that may be derived from such a strategy.

Corporate Bonds

Historically, dealers directly sold corporate bonds to small investors. Large investors typically bought prime new issues and smaller investors bought individual bonds (Homer 1975). As a result, underwriting spreads were large enough to incentivize dealers to engage in widespread distribution regardless of the transaction size. Small transactions, while still less profitable than larger transactions, were worth pursuing due to the prevailing wide spreads at the time; this is no longer true today. Before the 1970s, only investment grade corporations could issue public bonds. In the 1980s, corporations first issued bonds with a credit rating below investment grade.

During the 1920s, institutions typically traded bonds in lots of 100 ($1 million), which were inefficient to trade on exchanges. Bond trading firms accumulated inventories of this size because a seasoned round lot was more valuable and could be sold at a higher premium than an odd lot number of bonds at any particular time. This situation gave institutions an incentive to wait for new issues when transacting in the bond markets. Once institutions accumulated the required number bonds, they were aggregated and resold in the OTC markets.

Growth of OTC Trading

During the depression of the 1930s, exchanges lost business to OTC markets as private investors stopped using exchanges (Homer 1975). Institutions absorbed the majority of the remaining small supply of new and seasoned issues, which were being sold at depressed prices. This situation led to the small lot business drying up and the large lot business dominating the market. This evolution is how the bond market became a market that trades mainly through the OTC marketplace.

Institutions generally transact in large quantities and their venue of choice for these transactions remains the OTC market. The advantage of the OTC markets, as opposed to exchange trading, is the ease and efficiency in negotiating a price for a round lot. Historically, buying odd lots at a specific price was inefficient so institutions preferred to negotiate directly with a dealer. This trend in the bond market persisted until the early 1970s.

Structure of the Corporate Bond Market

As of 2016, the value of the corporate bond market was $2 trillion, a substantial decline from its 10-year high of $3 trillion in 2006 (SIFMA 2017b). TRACE (2018) lists more than 7,700 corporate issues today of which 70 percent are investment grade. The average daily volume in this market is $30 billion, representing about a 1 percent turnover on a daily basis (SIFMA 2017b).

Corporate bond markets are heterogeneous because an issuer can have many different securities outstanding. Financial institutions and other large buyers typically hold bond assets until maturity or trade in large quantities. This situation leads to a market that trades infrequently and consists of large orders, which in turn reduces the likelihood of matching buyers to sellers at any given time. This characteristic largely explains why bond markets, especially for corporate debt, mainly rely on market-makers such as banks or security firms.

Market-makers fulfill client orders by using agency trading and principal trading (Committee on the Global Financial System 1999). *Agency trading* is the practice of matching a buyer with a seller. In the event no buyer or seller is found, the market-maker can step in as the counterparty to complete the transaction. This approach is considered *principal trading,* which is the act of the market-maker using its own balance sheet to facilitate the trade. This act of readiness to absorb a trade supports market liquidity and price discovery. In general, these agents have two revenue models: facilitation revenues and inventory revenues.

Facilitation revenues are generated from the bid-ask spread. These spreads are inherently tied to the cost and risk associated with carrying assets in the dealer's inventory. Inventory revenues are derived from the change in value of assets held within the dealer's inventory, including accrued interest as well as funding and hedging costs. The regulatory environment also has an indirect effect on this revenue category.

A strict regulatory environment can reduce a market-maker's incentive to take risk in less liquid markets. Bid-ask spreads narrow when market-makers believe they can accommodate trades quickly and cheaply or if funding and hedging costs are low. Spreads widen if the opposite of this situation is true—the security is illiquid and the market maker believes offering liquidity in this market segment is riskier and costlier.

Financial institutions may reduce market-making activities if they believe profitability is waning in a given sector. If volatility rises in a particular segment of the market, and a market-maker believes its inventory is riskier to carry, this could prompt the market-maker to deplete its current holdings of a particular asset. This loss of liquidity can in turn cause bid-ask spreads to widen, which often leads to further volatility and greater instability. In order for markets to function properly, especially in less liquid markets, market-makers must be willing and incentivized to take risks and build positions in different segments of the market (Fender and Lewrick 2015).

Liquidity and Price Discovery

Liquidity and price discovery are important aspects of corporate bond trading. This section briefly discusses each.

Liquidity Measurement

Different markets often use different measurements of liquidity making comparisons across asset classes difficult. Liquidity can be measured by the ability of an investor to sell assets with little delay, at low cost, and at a price that is close to the asset's actual market price. Factors contributing to an asset's liquidity are the market structure and the nature of the security being traded. Examine how the asset trades during normal conditions and at times of heightened volatility, which is typically considered to be during times of large imbalances in trade flows, are also necessary (Fender and Lewrick 2015). Further, the bond market's heterogeneity creates de facto thinly traded securities.

Factors Affecting Liquidity

The corporate bond market is traditionally bifurcated by credit rating into investment-grade and high-yield or junk bonds. Data from the corporate bond market suggest that liquidity is concentrated in the investment-grade market, with considerably less liquidity for high yield bonds (Fender and Lewrick 2015).

Another factor affecting the liquidity of corporate bonds is trade size. In general, larger trades are more difficult and expensive to complete in OTC markets. Block orders (i.e., large-size trades) of investment grade corporate bonds have been decreasing over time. In recent years, liquidity within the corporate bond markets focuses more across just a few issues relative to the size of the overall corporate bond market. As Fender and Lewrick (2015) show, between 2007 and 2014, the share of securities whose 12-month trading volume equals at least half of the number of securities outstanding fell from 20 percent to 5 percent. This observation indicates a condition within the corporate bond market that may be becoming more prominent.

Price Discovery

The corporate bond market still relies heavily on phone-based quoting, which essentially places quotations in the hands of sales people negotiating prices with other sales people (Chien and Rhode 2013). Despite advancements in pricing mechanics for micro ($100,000 or under) and odd lot ($100,000 to $1 million) trades with the rise of single-dealer platforms, these platforms are part of an electronification initiative that is ongoing within the fixed income marketplace. For larger trades such as round-lot ($1 million to $5 million) and block trades (at least $5 million) the potential for high spreads with the current legacy systems in place has still seen little to no advancement.

Due to the lack of transparency and the asymmetric nature of information flow within a dealer-driven marketplace, information flow greatly influences price discovery. As corporate bond trading becomes increasingly automated, the process of price discovery is likely to evolve. This effect is evident based on the role of short interest within the corporate bond markets.

Griffin and Hong (2012) examine the role of *short interest* within the corporate bond marketplace, which refers to short positions that have not yet been covered or closed out. Short interest is also a market-sentiment indicator that conveys information about returns for a particular investment. The authors find that short interest has a statistically significant effect in terms of an annualized excess return of 384 basis points on corporate bond pricing. The explanatory power of a large or small short interest statistic far outweighs the impact short interest has on the equity markets with respect to price setting. These findings support Diamond and Verrecchia (1987) whose study suggests that if short selling reflects nonpublic adverse information, then it should subsequently promote accurate pricing of securities to reflect that information.

Due to a bondholder's fundamental interest in fixed claims on company assets, the role of short interest has a major impact on price setting within the corporate bond market. Short selling is an indicator of downside risk, and therefore if short interest positions increase, a bondholder should view this movement as more important than shareholders would (Griffin and Hong 2012). For example, if default risk increases, unlike shareholders who can liquidate and leave the firm to its creditors, a bondholder's source of income is based on the terminal value of the company nearing default (Hayn 1995; Fischer and Verrecchia 1997; Griffin and Hong 2012). This finding is evidence for the increasingly negative relation between bond returns and short interest as default risk increases.

Bond holders have fundamentally greater economic interests in the downside risk of their securities relative to the upside. Because corporate bonds trade in less transparent markets than other types of securities, the informational role of short interest is only exacerbated. Griffin and Hong (2012) show periods of significantly negative excess returns following periods of high short interest. With a high level of short interest present, traders of speculative grade bonds are more sensitive to adverse changes than traders of investment grade bonds. Significantly negative excess returns follow high short interest positions for speculative grade bonds whereas insignificantly negative excess returns follow periods of high short interest for investment grade bonds. The high levels of short interest may potentially convey signals to market participants that influence price discovery.

Griffin and Hong (2012) examine short interest information during the earnings announcement period. They report a negative relation between the abnormal short interest levels pre-earnings announcement and bond returns in the following announcement period. The negative relation was even stronger when examining abnormal short interest levels during the announcement period relative to the post-announcement bond returns. The effect of earnings announcements, with respect to abnormal short interest, and bond returns further demonstrate how short traders promote price discovery. This evidence further supports the theory that short interest plays a large role in setting bond prices.

Impact of Automation

Electronic trading encompasses several different areas of market functions: trades conducted in systems, electronic quote requests, electronic communication networks, various proprietary dealer platforms, alternative electronic platforms, quotation of prices, and dissemination of trade requests electronically, electronic settlement, and electronic reporting. The proliferation of electronic trading has also spurred on the development of automated trading (i.e., algorithmic and high frequency) within both the fixed income futures and parts of the cash bond markets (Bank for International Settlements 2016).

Modernization is occurring in the venues where fixed income securities trade and the procedures through which trades are negotiated. Advances in technology have started to impact the structure of the fixed income market, price discovery process, and liquidity. This shift in the trading landscape of the bond market landscape differs among segments. Due to heterogeneity and complexity, advancements in trading within specific segments of the fixed income market are lagging behind other markets. The corporate bond market is an example of a marketplace that continues to process the majority of transactions through legacy systems (Bank for International Settlements 2016).

The effect of electronic trading on market quality tends to be beneficial. The advantages of having a highly efficient market that fully uses current technology include lower transaction costs for investors (particularly for relatively small trades sizes), increasing competition for liquid assets, broadening market access, and reducing the dependence on market-makers. Studies suggest that automation also results in faster price discovery (Bank for International Settlements 2016). Electronic trading platforms are not an appropriate solution for illiquid securities due to the high risk for information leakage. The less liquid the marketplace, the greater is the dependence on bilateral dealer-client relationships.

Two notable characteristics present in the corporate bond market limit the rise of electronic trading within this segment. Heterogeneity and low frequency trading are not characteristics of a marketplace that is well suited for automation. This fact has not stopped financial institutions from expending resources into developing sophisticated platforms to automate the marketplace. Goldman Sachs, among other firms, has been experimenting with an automated bond trading platform (Wigglesworth and Rennison 2017). For now, the scope of these platforms is mainly limited to relatively small odd lot transaction sizes ($1 million or less). The primary purpose of these early trading platforms is to alleviate traders from resource intensive trades. Nevertheless, the recent innovations observed in the credit markets have led to many of these new platforms being created and facilitating corporate bond intermediation.

The recent innovations in this marketplace have been spurred by the growing liquidity concerns. One innovation observed in the corporate bond markets is electronic all-to-all trading platforms, which now account for approximately 5 percent of all electronically traded investment grade and high yield bond trades (Bank for International Settlements 2016). The rise in electronic trading has in turn led buy-side participants to develop infrastructure to respond to trade inquiries. Asset managers, who are required to seek out best execution, have also noted this gradual shift in the dynamics of trading within the corporate bond markets. Other innovations allow for the matching of two participants with offsetting interests at a given price. Despite these recent innovations, the bulk of corporate bond trading is still conducted via traditional methods (Bank for International Settlements 2016).

Municipal Bonds

The origin of municipal bonds traces back to the Renaissance when Italian city-states began borrowing from wealthy families in the banking community. As these city-states invested to expand their influence, municipal leaders borrowed from wealthy individuals as an alternative to increasing taxes. The idea of borrowing from local taxpayers to fund public infrastructure is the genesis of the municipal bond market (Goetzmann and Rouwenhorst 2005). The first recorded municipal bond in the United States was sold in 1812. In 1945, the total amount of municipal debt outstanding was less than $20 billion and today exceeds $3.7 trillion (Securities and Exchange Commission 2012).

Investors often buy municipal bonds for their tax-exempt status. A municipal bond is exempt from taxation at the federal, state, and local level. Therefore, a municipal bond can potentially be tax-free at all three levels depending on the entity issuing the security (Daniels and Ejara 2009). Municipal bond debt consists of general obligation (GO), and revenue bonds. *GO bonds* are taxed-backed securities secured by the full faith and credit of the issuer. *Revenue bonds* are debt instruments secured by the revenues derived from the project funded by the bonds such as airports, bridges, and toll roads.

Structure of the Municipal Bond Market

Municipal issuers such as states, cities, and counties have the ability to issue bonds to finance their public infrastructure. Municipal securities can vary widely by state, as each jurisdiction maintains its own process for issuing the securities. This heterogeneity in process leads to increased transaction costs, as each bond can have slightly different terms and conventions.

According to the Municipal Securities Rulesmaking Board (MSRB), the issuance process for municipal securities begins with the municipal advisor, who is brought onboard as a fiduciary for the issue. The advisor's responsibility is to oversee all the assets and costs involved with the project. The advisor coordinates with bond counsel, a lawyer who handles the legal details of the issue, and collaboratively selects an underwriter whose duty is to distribute the issue. Afterward, the underwriter uses multiple brokers to distribute the issue, connecting the buy and sell sides in the distribution process (MSRB 2016).

Underwriters connect municipal bond issuers with potential buyers and in so doing, must also determine the offering price of these bonds (MSRB 2016). Underwriters typically bear the risk associated with failing to distribute the issue they manage. As a result, underwriters play a critical role in deciding the yield and time frame of maturities for a particular issue. Accurate price discovery is essential for any underwriter or underwriting syndicate responsible for distributing these bonds. If the underwriter prices the bonds inappropriately, they face the risks associated with holding mispriced bonds in their inventory (MSRB 2016).

The sale of municipal bonds is a largely manual process. The bonds are distributed in the OTC markets by a network of dealers. The majority of bond issues trade infrequently but in large quantities when they do trade. According to the Anthony, Haines, and Aydogdu (2004), 70 percent of municipal issuers had no trades in their securities between 1999 and 2000. Less than 1 percent of securities accounted for half of the overall muni-market transaction history for the period. The municipal bonds that did trade turned over, on average, 1.5 times per year.

Municipal bond illiquidity also affects other products that retail investors purchase such as mutual funds and exchange-traded funds (ETFs). When investors make large withdrawals from these funds, which are essentially a portfolio or index that follows an investment strategy, the underlying municipal bonds that make up these securities must be sold to cover the outflows. If a fund needs cash quickly, it may have to resort to selling securities at an unfavorable price. This situation may be further exacerbated with municipal bonds because they are particularly illiquid assets.

Issuers of municipal bonds vary, as do the legality and capability of their tax advantages. In a higher-tax environment, municipal bonds perform better, and for wealthy individuals, the benefit of cash flows being tax-free may be greater. The higher the tax rate, the less interest a municipal bond needs to pay in order to generate the effective yield of a similar corporate bond. The most active issues municipal bonds tend to be larger, newer issues. These issues enjoy greater liquidity due to more availability. Traders are therefore more likely to hold them in inventory given the demand for these issues.

Pricing and Liquidity

As with other fixed income instruments, municipal bonds are subject to pricing sensitivities based on availability. However, as municipal bonds have considerable variability across issues and issuers, their prices are often harder to discover than for corporate bonds, or for government bonds, which trade more frequently. This section discusses the process of price discovery in the municipal bond market, as well as the impact of liquidity on municipal bond spreads over the benchmark curve.

Components of Municipal Bond Spread

Three important factors to consider when examining the yield spread on a municipal bond are credit, liquidity, and tax premiums. Ang, Bhansali, and Xing (2014) examine these factors to evaluate their contribution to the municipal bond's spread. The study isolates each component of the credit spread to see how much of a given factor contributed to the premium. The results show that although the first two components—credit and liquidity—widen municipal bond spreads, the tax component narrows spreads. The effect of each component can be illustrated by observing yields before and after the financial crisis of 2007–2008. The credit component increased from 0.40 percent to 0.57 percent, tax from –2.09 percent to 1.84 percent, and liquidity rising from 0.82 percent to 2.14 percent (all averages) between 2008 and 2013. The majority of the variation lies within the liquidity component. The implications of the increase from the liquidity component indicate that the compensation investors seek to bear liquidity risk increased greatly after 2008. Thus, liquidity plays a large part in determining the cost of municipal bonds.

Liquidity Measurement

More than 2,700 municipal securities broker-dealers are registered with the MSRB (Joffe 2015). Dealers are required to report all their trades to the MSRB, which provides online data services to investors looking for trade information by security name.

Overall, municipal bonds trade infrequently. Despite having more than a million different outstanding municipal securities across about 60,000 issuers, few of these securities trade with any regularity in the secondary market. In contrast to the equity markets, municipal bond transaction costs decrease with trade size and are not related to trade frequency. The average issuance costs range from 2.71 percent for issues under 10 million to 1.23 percent for issues more than 10 million. This situation further illustrates that transaction costs vary greatly with the size of the issue being traded (Joffe 2015).

Factors Affecting Liquidity

The cost of municipal bond liquidity can be attributed to the market's lack of price and quote transparency. According to Venditti (2015), bond trading costs decrease with credit quality improvements but increase with financial instrument complexity. The least expensive bonds to trade are the simplest structure (i.e., bonds without call features, credit enhancements, and sinking funds).

Unlike the equity markets where larger trades have a higher transaction cost, increased transaction size leads to reduced costs for large investors in the municipal bond market. This situation occurs because institutions have a better understanding of the market and therefore the value of the municipal bonds being traded (Cuny 2018). The fact that municipal bonds mainly trade in the OTC market with negotiated prices leaves smaller retail investors at a clear disadvantage.

Informational Asymmetry

Two theoretical reasons help to explain the observed uneven bargaining power of large institutions over small investors in the municipal bond market (Biais and Green 2007). The first explanation is the cost to acquire information. More sophisticated investors have greater access to price-relevant information and can therefore ascertain a bond's true value and negotiate a better price. The second theory relates to counterparty search costs. Investors with access to more trading counterparties can negotiate better prices because they have a greater ability to solicit price quotes. These two factors limit the bargaining power of retail investors and help to explain why small investors often pay a larger trading fee than institutions.

Informational asymmetry, a leading cause of the higher costs incurred by small municipal bond buyers, dissipates to a degree when fundamental information is widely dispersed and available (Daniels and Ejara 2009). Although all investors have access to information from financial media, issuer websites, and electronic municipal market access (EMMA), retail bond sellers often neither have the capacity nor expertise to analyze this information. The result is that bond sellers often do not negotiate better prices even when more data are available.

Informational asymmetry also explains why a municipal bond's funding source can influence the required yield. Whereas the full faith and taxing power of the local government backs GO bonds, revenue bonds are only financed by the projects they are supporting. These projects, which include toll roads, utilities, and airports, often have limited disclosures and information available on their financial success. For this reason, revenue bond holders typically require higher payments and a greater yield spread than GO bonds (Daniels and Ejara 2009). When a high degree of information asymmetry exists, dealers increase the spread on a security to protect against dealing with informed traders. A positive correlation between the spread and the degree of information asymmetry emerges when trading in this environment. This argument is consistent with the observation that GO bonds have higher average credit ratings and explain the convexity of revenue bonds, which decrease in value faster than GO bonds for a given change in credit quality.

Summary and Conclusions

This chapter discussed U.S. Treasuries, corporate bonds, and municipal securities, and their respective microstructures. Whereas U.S. Treasuries have been largely automated by HFTs, and investment grade corporate bonds are perhaps moving in this direction, the municipal bond market still remains manually oriented and expensive to trade. If history is any indicator, this market is likely to follow suit and begin to consolidate.

Broker-dealers provide a valuable service in the OTC markets, enabling price discovery and reducing trading costs. However, their business model has become increasingly more difficult in the past few decades. Technology has enabled HTFs to build businesses on minor price discrepancies and to offer some additional liquidity. However, the brief holding period of HTFs does not provide much long-term value and can amplify major intraday trading movements.

Electronic trading has reduced the cost of trading by automating the dissemination of price and liquidity information. Although this trend has arguably made markets fairer by reducing bid-ask spreads, it has also enabled the rise of HFTs. These technologies operate at a speed much faster than human comprehension and their continued growth may introduce additional, unexpected volatility into the markets.

Regulation has disincentivized banks from carrying inventory, reducing their willingness to take risk and "make markets" for investors. The result is that when long-term holders want to sell, fewer buyers are now available. This situation may amplify the volatility of market events, as in the Treasury market Flash Crash in 2014, when broker-dealers left the market, and government yields dropped 8 percent in less than six minutes. Although automation and regulation may lead to faster, fairer markets, these tools can also backfire during periods of high stress.

Discussion Questions

1. Explain why a foreign government would buy U.S. debt.
2. Discuss why short interest is a signal for bond prices.
3. Describe the relation between a municipal bond's spread and risk premium.
4. Discuss the potential benefits and risks of automation in the fixed income market.

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PART VIII

STRATEGIES, PORTFOLIO MANAGEMENT, AND FUTURE OUTLOOK

34

Debt Investment Strategies

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Introduction

Investors often choose to allocate capital to bonds, bond funds, and other debt-based instruments because they are expected to provide modest but reliable returns over time. Such investments help to reduce some risks faced by investors by complementing other assets in a portfolio such as equities, which offer higher expected returns but are less predictable. The debt market provides a diverse set of investment opportunities with a wide variety of time horizons, risk exposures, and repayment terms. Like the broader investment universe, investors can mix and match debt-based products to achieve specific return objectives. A reasonable investment strategy for bonds and other investments provides guidelines for when and how to invest (or divest) in these securities in a way that maximizes their potential benefits in a portfolio.

A strategy is usually associated with one or more objectives that an investor wants to achieve. For example, if an investor wants to maintain a portfolio that is relatively insensitive to fluctuations in interest rates, then a "passive" or "insulating" strategy is appropriate. Such a strategy suggests a mix of investments that is likely to grow, albeit slowly, regardless of the direction of interest rates. Passive strategies may need to be recalibrated periodically as prevailing market conditions change. If an investor's objective is to achieve returns that outperform some index, then an "active" or "speculative" strategy is appropriate. Market indices, forecasts, and other economics predictions may suggest to the investor that specific adjustments to the portfolio allocation across sectors or terms would have short-term advantages over the indexed portfolio. For example, if investors speculate that interest rates are likely to rise soon, then they may want to liquidate some of the bond holdings in their portfolios, especially those with a longer term, due to an expected decline in bond prices. As the market outlook changes, other adjustments may be warranted. Both strategy types require diligent observation of market conditions.

Certainly, active strategies require more attention and rely on more reliable forecast data than do passive strategies. The description of a strategy often includes a "trigger event," such as a rate hike by the Federal Reserve (Fed) or an increase in inflation expectations, which describes the conditions under which the recommended course of action should be put implemented. For example, if investors want the portfolio of bond holdings to maintain the same overall duration as some indexed portfolio, they may expect the two to differ somewhat over time. These investors will not need to implement a strategy to realign their investments until the trigger event in which they observe that the difference is greater than some pre-determined threshold. A strategy that takes advantage of an increase in interest rates would not be implemented until market conditions, such as those regarding changes in the yield curve, information regarding inflation, and Fed policy decisions, would indicate that such a rise is soon to be expected.

The overall process for developing, implementing, and maintaining an investment strategy can be described in a manner consistent with Fabozzi (2007) and Maginn, Tuttle, McLeavey, and Pinto (2007).

- *Objective and Policy.* The investor's objectives, preferences, and constraints are identified and, if possible, formalized into a policy statement covering some time horizon. Such a statement would be essential for, say, a mutual fund that pools investments from the public and is accountable to regulators. For an individual investor, a clear policy would allow for effective communication with a financial advisor to meet fiduciary responsibilities. Ideally, a policy would include descriptions for how progress toward an objective is measured, such as in terms of the duration of the portfolio or expected asset returns. These portfolio metrics are referred to as "benchmarks." The policy may also include a set of desired "qualities" for the portfolio, which cannot be directly measured. These qualities might include considerations such as simplicity or convenience or the liquidity of the holdings.
- *Strategy Development.* Based on the objectives identified and the prevailing economic conditions that are expected during the horizon, a strategy is developed. For a passive strategy, this strategy would reflect the recommended characteristics regarding the mix of investments that should be maintained in the portfolio. For more active strategies, it would include a sequence of suggested purchases and/or shorts and/or redemptions of securities or options to make when some trigger event is observed. The strategy is developed with careful consideration of portfolio goals and benchmarks, as well as its potential impacts to the portfolio qualities. A *decision-support model* may be developed, which is a mathematical representation of the benchmarks in a strategy. It may be used to describe or justify a strategy or to help portfolio managers determine the parameter values (e.g., the number of securities to buy or sell) appropriate to a specific situation. Such models would be critical to any computer-based system for strategy development.
- *Observation.* As time passes, market conditions, portfolio asset values, and investor circumstances are likely to change. The levels of the benchmarks are also likely to change. An investment manager must decide whether such changes are within the confines of the investment policy, whether a passive strategy needs to be adjusted, or if some active strategy has been triggered. A common example of this activity is

when the manager of a passive fund monitors the portfolio characteristics to make sure that its risk or return benchmarks stay within some acceptable range around its target.
- *Portfolio Adjustment.* When deemed necessary, the investment manager determines the tactics for implementing a strategy, which includes identifying the specific number of securities to buy and/or sell to achieve the desired portfolio metrics and qualities.

Various investment strategies are available to meet the different market conditions that might arise. For example, a person seeking a comfortable retirement is likely to have different goals than a mutual fund or pension fund manager who is likely accountable to a larger and more diverse group of stakeholders. The objectives relevant to an investor at one time may be inappropriate in another. Some investors might even have multiple or even contradictory objectives at any given time.

The debt market offers numerous investment products, each providing different terms, maturities, interest rates, and credit ratings, such that it would be reasonable to expect that several investment strategies can be developed for a given objective. Investment strategies would likely be developed first through some consideration of the quantitative factors involved to achieve an objective such as the prices of the available securities, prevailing interest rates, and forecast values. A proposed strategy could then be evaluated based on collective experiences of actual investors or through a computer-based simulation or back-testing experiments. Computer-based decision support systems may be employed to make sure that a strategy is mathematically feasible and can achieve desired goals in a cost-effective manner. They can also help refine a strategy and determine the circumstances under which it would be most beneficial. Such tools are especially necessary to develop and evaluate strategies for rare or hypothetical situations for which practical investor experience is limited.

This chapter focuses on the first steps of the process involving the articulation of objectives and development of appropriate strategies. Different debt-investment strategies are introduced that could be considered based on an investor's identity, objectives, responsibilities, risk tolerance, and financial position. The objectives and policy activity performed for a given situation dictates the benchmarks to measure and the qualities to observe. When appropriate, decision-support models used during the strategy development and follow-on activities should be described. Listing the trigger events or conditions under which a strategy may be particularly effective is helpful. Given that new investment strategies are continually being developed and refined, competent investors and fund managers should be aware of as many relevant strategies as possible and to know when, where, and how to apply them for the assets they manage. Finally, the chapter ends with a summary.

Strategies for Individual Investors

An *individual investor* is a person or a small group of people, such as a family, that takes on the primary decision-making roles regarding the investment of some portion of their wealth. Unlike institutional investors, who pool assets from multiple sources and hence must consider the collective needs of different stakeholders and regulating agencies, individual investors can focus on their own specific circumstances when formulating their objectives and developing their strategies. Individuals may seek advice from a friend, a professional, or even a computer, but they bear all the risk associated with the investment decisions under their control. Not surprisingly, the investment options for individual investors who manage their own assets tend to be simpler than those for institutions. Individuals are advised to avoid overly aggressive or sophisticated strategies involving derivatives, variable rate notes, perpetual maturity bonds, foreign debt, or non-bond debt. Such strategies would be better suited in the portion of the portfolio that an individual cedes to a professional financial planner or to a professionally managed fund. Most of the relevant strategies developed for the portions controlled by individuals involve making reliable investment gains, managing cash flows, and protecting wealth against the negative impacts of inflation and taxation.

Investing for Growth

Consider the example of Jane H., who just graduated from college. She has a new job that pays enough to cover her living expenses and allows her to contribute monthly to a tax-deferred individual retirement plan to save for the future. She has been advised to invest most of this money into the stock market because of its high risk-adjusted returns. During the 50 years between 1966 and 2015, the stocks in the S&P 500 index have returned an average of about 9.7 percent, reflecting a 5.4 percent premium over inflation, although some time periods have been much worse than others (Barker 2016). Since Jane has a long investment horizon, she should not worry about the occasional market downturns. She is savvy in finance and knows her investments should be diversified to mitigate the risks from large movements in any one asset class. A modest percentage of her tax-deferred savings is dedicated to fixed income securities such as bonds or a bond fund because the yields are higher than government securities.

Jane's primary goal is to grow her retirement account at a reasonable rate and so the best way to measure her progress is to observe the total value at the end of the planning horizon, say 10 years. The benchmark used for bond-based investments is the value of the coupon returns during the planning horizon that were not reinvested plus the (present) value of the bond holdings calculated at the end of the horizon. An appropriate strategy for Jane to increase the value of the bond allotment is to invest predominantly in securities that provide high yields. This strategy would likely be achieved through a portfolio with long-term corporate or municipal bonds and some lower-rated bonds or foreign bonds promising higher interest rates. Having a mix of these different bond types provides an added level of investment diversity within the fixed income asset class.

Jane is willing to accept the risks inherent in this strategy realizing that some of the bonds may default and that the value of her investments may fluctuate as prevailing interest rates change over time. Next, she wants to learn whether her objectives can be better met through a strategy of purchasing individual bonds or through the selection of a bond mutual fund with an equivalent risk/return profile.

Loosely speaking, the returns from these two options would be about the same, although the value of the bond fund is likely to exhibit greater sensitivity to fluctuations in market conditions. Before maturity, a bond's realized return depends predominantly on the value of its coupons during the planning horizon and the prevailing interest rates at the time of the liquidation. The return on the bond fund, which is composed of a sequence of bond purchases and redemptions, is also influenced by the values of the interest rates over the horizon.

The advantage of owning individual bonds is that investors can create customized portfolios based on their unique preferences and tax status. The investor can avoid the volatility in a fund due to other investors redeeming bonds when prices are low, which may affect the individual's pro-rata share of the fund. With an individual bond or a separately managed account, individual ownership of the underlying securities is a benefit with the customization.

Despite these benefits, qualitative factors exist that make the bond fund a better strategy for Jane. For example, because a bond fund is liquid, it can usually accommodate sizeable contributions. This characteristic is better suited to Jane's schedule of periodic small payments. Bond fund distributions are automatically reinvested, so Jane need not manage the inflows from redemptions and periodic coupon payments. The fund is likely to be managed by individuals with expertise in debt markets. So, despite its higher fees, the fund is likely to invest in superior bond offerings than a layperson. The fund manager's job is to monitor the markets for good opportunities when they arise, a task that would be extremely inconvenient or impossible for a nonprofessional. Because the fund pools money from a wide set of participants, it has a large, diverse set of holdings with a mix of different maturities and embedded options and is better insulated against the default of any one bond. With a mutual fund structure, Jane can avoid costly and difficult credit analysis. Finally, when Jane wants to liquidate her holdings, the fund provides a cheaper and easier option. These factors would likely compensate Jane for lack of personalization and direct control over the cash flows generated from any individual bonds she selects and their tax implications, if any. In sum, the benefits of professional and dedicated management are likely to offset the fees and potential missed opportunities or mismanagement of capital. Better yet, a combination of both individual bonds and mutual funds may be the best diversification tool because it provides the benefits of liquidity and diversification, as well as customization.

By the end of the planning horizon, Jane's financial objectives will likely evolve. Over time, her wealth grows and she may want to start a family and/or buy a house. As she saves for her children's education, she may become more cognizant of the investment risks she initially adopted. In essence, Jane has evolved and now requires a modified set of investment strategies. She may decide to enlist the services of a financial advisor with knowledge of additional investment options. This advisor will periodically reevaluate her original investment decisions for attractive investment opportunities based on her potentially evolving financial goals.

Capital Preservation

Jane's mother Mary has very different objectives for her bond investment holdings. Mary is preparing for retirement and is less interested in taking on extra financial risk for possible higher investment returns. Instead, she is more interested in keeping safe the wealth she has accumulated, so she can enjoy a comfortable retirement. Over the last 30 years, Mary and her recently deceased husband paid for their children's college educations, paid off their home mortgage, and built a modest investment portfolio. Their allocation to bond investments has increased over time and now represents a considerable proportion of Mary's current holdings. The portfolio includes numerous individual bond issues with different terms. The long-term bonds they bought years ago will mature soon, while the more recent purchases are several years from maturing.

Mary's current objectives for her investments are to provide a reliable periodic income that lasts as long as she lives and to make sure that inflation does not degrade the buying power of her accumulated wealth, while maintaining her current lifestyle. These objectives can be labeled as "minimize longevity risk," "minimize inflation risk," and "minimize austerity risk," respectively. Bond holdings and other fixed-rate investments are particularly vulnerable to unexpected increases in inflation. The risk is more pronounced for the holdings with longer durations. The best way to hedge against this risk is to include assets, such as variable rate bonds or Treasury inflation-protected securities (TIPS), in the portfolio whose value or return increases with inflation. Longevity risk and austerity risk are complementary. Both are based on the uncertainty around a single individual's life expectancy. If Mary spends down her wealth too quickly, she has a greater likelihood of running out of money during her lifetime. If she decides to be too conservative, she risks unnecessarily foregoing a comfortable lifestyle in retirement. The values calculated for these risks would be different for every individual, depending on qualitative factors such as current physical health, family history, availability of family or social services if needed, definition of "adequate" income, and extent to which leaving an estate for Jane and her siblings is important.

If she were wealthy, Mary could avoid these risks by simply "living off the interest" from her bonds, which would generate a regular income through their periodic coupon payments. When one of the bonds matures, Mary could reinvest its proceeds into new bonds. With a "bond ladder" strategy, the mix of bonds in the portfolio is maintained to have a wide diversity of maturity dates (Leibowitz, Bova, and Kogelman 2015). Longer-term bonds tend to yield greater returns. Mixing in short-term bonds has the effect of moderating the portfolio's overall duration, making its value less sensitive to inflation and rising interest rates, which is one of Mary's primary concerns.

For an individual investor seeking retirement income, a distribution of maturities associated with a bond ladder has benefits over a portfolio with an equivalent duration that employs a "bullet" strategy, in which bond holdings are concentrated around a single maturity. For example, at any point during the planning horizon, some bonds will be nearing maturity. The ladder allows for a liquid source of funds whenever they are needed. It could be designed to control the portfolio duration throughout the planning horizon. For example, if the portfolio has about 1/30th of its value allocated to bonds with each of the next 30 years of maturity, then after every year, Mary could reinvest the proceeds from the maturing issues into a new 30-year bond, which would keep the overall duration relatively constant, assuming a stable interest rate environment.

Variations on the bond-ladder strategy involve maintaining a mix of bond holdings with a more creative combination of maturities. These can be developed for individuals who want to better achieve their specific objectives or who have their own expectations regarding future interest rates and other market conditions. For example, if interest rates are expected to soon rise, a *barbell strategy*, a concentration in holdings with shorter-term and longer-term maturities, would be beneficial because it provides more immediate opportunities to reinvest maturing holdings to take advantage of the higher return rates.

A savvy investor can track the overall portfolio duration or some other benchmark for risk or return to make sure it follows some desired "glide path" (Idzorek 2008). A *glide path* represents the pattern of some portfolio metric with respect to time. For example, a bond portfolio's allocation to different maturities can be adjusted over time so that the value of the overall duration is observed to follow some desired pattern. An investor with limited wealth might want the glide path of portfolio duration to follow a decreasing curve. Toward the end of retirement, the investor would be most concerned that increases in the inflation rate would degrade the buying power of a dwindling portfolio, requiring a greater proportion of shorter-term bonds. These bonds would also mature sooner, corresponding to when the funds would be needed. For a wealthier retiree, the rate of descent in the duration glide path would be slower and more linear. A different glide path, that tracks the mean rate of return for the assets in the entire portfolio, including equity and commodity holdings, may have a positive slope in later years, as more of the portfolio is dedicated to investment strategies for the estate and the younger, more risk-accepting heirs that will inherit it (Pfau and Kitces 2014).

In Mary's case, the bond holdings have been built up over time, so she already enjoys some of the benefits of a bond ladder. Since she and her husband had increased their bond allocation over time, Mary's mix has a larger percentage of holdings in longer-term bonds. Mary wonders how to best invest her planned contributions to rebalance the bond ladder, if necessary, to help meet her retirement objectives.

Mary needs to consider several factors when developing an investment strategy using bonds to provide for her retirement income, instead of, say, purchasing an annuity. Mary is not wealthy, so with limited funds, the objectives of creating a generous income stream and guaranteeing that it will last her entire lifetime conflict with one another. She cannot rely solely on investment returns and bond coupons. She will also have to liquidate the holdings over the course of her retirement, with the hope that her portfolio will not be completely depleted in her lifetime. Mary will likely purchase the bonds at a premium, to generate larger coupon payments during their terms, but they will not be as valuable when they mature. She may occasionally have to buy some shorter-term bonds to control the portfolio duration and to add liquidity, but these bonds may not generate as much income as longer-term bonds. Any decision-support model to help Mary would need to focus on the distribution of the bond holdings over the different maturities, such as a ladder, bullet, or a barbell, rather than just the overall duration.

Broadly speaking, a bond portfolio that depletes principal over time can only support a limited time frame. That amount of time depends on factors such as inflation, the investment returns from the holdings in the portfolio, and the rate at which the principal is drawn down. In a common strategy called the "4 percent rule," Mary would draw about 4 percent of her starting portfolio value each year, with an annual inflation adjustment. Table 34.1 shows how much the average yearly yield above inflation would be required to reach the desired horizon before exhausting the portfolio based on different draw-down rates.

Table 34.1 **Average Growth Rate above Inflation Required for Drawdown Rate to Last Desired Time Frame**

	Time Frame (Years)							
Draw–down Rate		**20**	**25**	**30**	**35**	**40**	**45**	**50**
	3%	<–5.00	–2.10	0.00	0.27	0.92	1.38	1.72
	4%	–2.04	0.00	1.22	2.00	2.52	2.89	3.15
	5%	0.00	1.80	2.84	3.50	3.93	4.22	4.43
	6%	1.80	3.40	4.31	4.86	5.21	5.45	5.61
	7%	3.44	4.87	5.66	6.13	6.42	6.61	6.73

This table demonstrates that a portfolio would need a return rate 1.22 percentage points above inflation for the 4 percent rule to be sustained for 30 years. The table provides the return required for different values of the time frame or the draw-down rate.

According to Table 34.1, if Mary's investments were to keep pace with inflation, then the 4 percent rule would provide income for about 25 years. She would need to draw a smaller income or seek higher returns if she wants the income stream to last longer. Based on historical Treasury bond yields, a strategy having both a generous draw-down rate and a longer time frame would be very difficult to achieve. An integrated strategy that considers both bond and higher yielding equity holdings would be necessary.

As Mary progresses through her retirement, her objectives and circumstances are likely to evolve. Each year, better information about her individual life expectancy will become apparent, so she can adjust her decisions about the trade-offs between a generous income and a longer time horizon. If enough wealth is available to meet both objectives, she is likely to create new or more detailed investment strategies regarding how to fund her estate. Like her daughter, Mary is likely to benefit from the help of a professional financial advisor to establish and maintain the mix of strategies guiding her investments and divestments.

Tax Implications

Individual investors, such as Jane and Mary, are much more focused on their pre- and post-retirement tax liabilities throughout their working career and into retirement than institutional investors. Pension funds, some insurance companies, and foundations/endowments often qualify for tax exemptions, so lowering their tax burden via tax-free debt instruments, such as municipal bonds, may not be as important. Individual investors may want to lower their pre-retirement income tax liability via tax-free debt rather than investment with taxable returns such as corporate debt.

For individuals living in states with high tax rates, investors rely more often on tax-free municipal debt to reduce the tax burden. For example, an individual with a marginal tax rate of 35 percent would need to buy a taxable bond with a 5 percent yield, or a tax-free equivalent bond with only a 3.25 percent yield to receive the same income. As individuals move from lower into higher tax brackets, the benefits are even clearer.

Increasingly, institutional investors who do not necessarily benefit from the tax exemption have started buying tax-free municipal debt when yields are attractive on a relative basis. As recently as 2008, central banks embarked on quantitative easing (QE), in which they introduced new money into the money supply by purchasing government securities to lower rates and spur lending, borrowing, and growth. As QE pushed sovereign yields down to record lows, foreign buyers and tax-exempt buyers started to enter the muni market to take advantage of the relatively higher yields. This relation is best demonstrated from the municipal-to-Treasury yield ratio, which states that the higher the ratio, the more attractive municipal yields are relative to their taxable counterparts, even before the tax exemption is considered. Figure 34.1 shows a 10-year tax-free municipal yield as a percent of the 10-year Treasury yield. The ratio has fallen back down to the low 80 percent since the European Central Bank (ECB) began QE in 2015.

When the municipal bond yield is higher than the Treasury bond yield, municipals are attractive relative to their Treasury counterparts. When the ratio is more than 100 percent, a popular debt investment strategy is for "crossover buyers" to enter the market. *Crossover buyers* are institutional market players that do not benefit from tax exemption. When global interest-rates are very low or, in some case, negative foreign investors invest in the U.S. municipal market for the relatively attractive yields. The Fed tracks this activity on a quarterly basis in its "Federal Flows of Funds Report." Table 34.2 shows an increase in institutional buyers over the years that quantitative easing was deployed in the United States and overseas, as of December 2017.

Figure 34.1 10-Year AAA Municipal Yield as a Percentage of a 10-Year Treasury Yield
This figure shows the 10-year tax-free municipal yield as a percent of the 10-year Treasury yield on the y-axis. When the ratio is above 100 percent, municipals yield more than their Treasury counterparts. The ratio has decreased to about 80 percent as institutions bought increasingly more municipal debt to take advantage of the relatively higher yields.
Source: Authors based on Bloomberg data.

Table 34.2 **Holders of Municipal Securities (in Billions of USD)**

Holders	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017 (Q1–Q3)*
Non-financial corporate business	22.3	22.9	21.8	13.1	22.3	44.9	61.4
U.S.-chartered depository institutions	297.3	365.0	418.9	451.5	498.9	549.2	560.3
Property-casualty insurance companies	331.0	328.1	326.4	321.7	345.8	338.5	342.4
Life insurance companies	121.8	131.5	141.6	147.8	171.2	179.0	187.9
Rest of the world	72.4	71.8	76.1	80.4	87.0	94.3	103.9

This table shows an increase in institutional buyers between 2011 and 2017. As the Federal Reserve was buying Treasuries and pushing down yields, institutions that previously were not major buyers of municipal debt started to become bigger holders of the debt to take advantage of the relatively more attractive yields. Amounts outstanding are shown at the end of period and are not seasonally adjusted.

Source: Federal Reserve. Available at https://www.federalreserve.gov/releases/z1/current/z1.pdf (p. 135) and https://www.federalreserve.gov/releases/z1/20151210/z1.pdf (p. 131).

Liquidity

Historically, individual investors often have difficulty buying individual bonds because they typically trade in large blocks, which makes them very expensive to purchase and difficult to sell. Buying in smaller increments increases costs in terms of a broker's commission. An alternative is to buy smaller blocks from issuers in a less liquid market. This option might be appropriate if the investor plans to hold the securities until they mature.

Over time, wealth managers have improved mechanisms to buy individual bonds for retail investors. The cost of individual investors buying bonds has decreased dramatically. Liquidity risk has been reduced for retail investors because they can now buy individual bonds at more cost-effective rates such as through separately-managed accounts with lower minimum investments. This framework allows them to implement strategies such as a bond ladder or a barbell in a cost-effective manner.

General Modeling Considerations

Given that the nature of the investment decisions faced by an individual are no less complex than those required of a manager of a large fund, sophisticated decision-support models for bond investments would need to be developed that financial planners or computer programs called robo-advisors can use to provide advice to individual investors. Similar to other investors, such models would require relevant data about current and expected yields, maturities, embedded options, and the credit-ratings of potential borrowers. Models for an individual are usually also reflective of personal factors such as financial goals, expected income and account deposits, tax obligations, and risk tolerance. Because individuals have finite life spans and financial needs and objectives that change from one period to the next, investment strategies for individuals need to be more fluid than for institutions. In the current example, Jane and Mary are both likely to focus on a few different objectives during various stages of their lives.

For individuals with limited wealth, the decisions about bond investments cannot easily be separated from the decisions about other asset classes in their portfolios including their homes. In the early stages of retirement, an individual's investment portfolio is likely to contain a substantial proportion of equity holdings that are also used to meet income and growth objectives. Thus, for individuals the bond strategies are usually developed along-side the equity strategies and the integrated strategies that exploit the correlation between asset classes. In this case, the primary benchmarks for investment risk would be inflation, rather than interest rates, and the standard deviation of expected returns, rather than the duration of the bond holdings.

Strategies for Institutional Investors

Institutional investors such as bond funds, foundations, pension plans, insurance companies, and family offices have different risk-reward profiles and operating constraints than individual investors. An institution by definition has many stakeholders and considerably larger asset base. As a result, investment managers are much more accountable to the participants and possibly government regulating bodies. For many institutions, the planning time horizon is essentially infinite as they are expected to maintain a set of policies over long time-periods. Many institutions have low operating expenses relative to their assets, as is the case with foundation and endowments, and surpluses of assets over liabilities, as may be the case with pension funds, which may allow them to take on more risk. Institutional investors often use the fixed income portion of their asset allocation for capital preservation, to reduce the overall volatility in the portfolio and engage in asset-liability investing to hedge liabilities.

One passive, fixed-income strategy that is common to pension plans is liability-driven investing (LDI), (Stockton, Donaldson, and Shtekhman 2008). In an LDI strategy, the process involves matching the duration of assets with the duration of liabilities and having the ability to reinvest those assets in long-duration fixed income. When bond prices are low (i.e., yields are high), institutional investors reinvest income from bonds that mature in a higher price/lower yield environment. When interest rates start to rise, LDI strategies may be more beneficial because institutional investors can reinvest income from matured debt in lower bond prices/higher yields.

Michael Moran, chief pension strategist at Goldman Sachs Asset Management, recently discussed the evolution of LDI (Moran 2016). Although Moran's analysis focuses on corporate defined benefit plans, the concept of LDI also works for public defined benefit plans. In the report, Moran notes many pension plans are looking for opportunities to de-risk, including adding fixed income and extending duration. This very basic strategy does not require much customization. Once pension plans implement these basic de-risking strategies, such as increasing the allocation to fixed income and extending duration, additional techniques are available that are customizable. These techniques involve a completion or an anchor manager to help improve the efficacy of the liability hedge. The *completion manager* is someone who analyzes both the liabilities and benchmarks used in LDI investing and then develops a portfolio that fills in the gaps of the hedge, working with the plan over time to achieve a targeted solution. Such solutions may include using derivatives to allow the pension plan to add certain risk factors such as duration, yield curve, credit, and inflation risk.

Other institutional investors such as insurance companies face different objectives and constraints than pension plans. For example, insurance companies typically need to hold assets that are more liquid because their payouts are less predictable than a pension fund. In a year with multiple natural disasters such as wildfires, hurricanes, and earthquakes, insurance claims are much higher than in previous years. The insurance company needs sufficient liquidity quickly to pay out such claims. A property and casualty insurance company may have a much larger fixed income portfolio than other institutional investors whose annual liquidity needs are more predictable.

According to report from the National Association of Insurance Commissioners (NAIC) and The Center for Insurance Policy and Research (National Association of Insurance Commissioners for Insurance Policy and Research 2016), the largest portion of insurer assets at year-end 2016 is still bonds, with 67 percent of the industry's total cash and invested assets. The NAIC report compiled data from 4,500 insurance companies across the five major insurer types. After bonds, the second largest holding was stock investments accounting for only 12 percent of assets. Within fixed income, corporate bonds made up about 54 percent, followed by municipal bonds at 14 percent. For the portfolio manager that oversees a property and casualty insurance company, corporate and municipal bonds provide relatively attractive yields, capital preservation, and high liquidity if needed. The capital markets report from the NAIC indicates that credit quality for insurance companies also remained relatively concentrated in high-grade bonds. Although those bonds offer lower yields, the lower volatility and higher liquidity are suitable for an insurance company that does not know its exact liabilities in a given year. More than 94 percent of bonds carried investment-grade designations as of the end of 2016.

Institutional investors such as pension funds and insurance companies benefit from a rising-rate environment. Rising rates deflate liabilities by applying a higher discount rate to those liabilities and give institutional investors the opportunity to de-risk their portfolio by selling their current holdings, such as equities, in exchange for long-duration fixed income assets with attractive rates. For institutional investors such as underfunded pension funds (i.e., liabilities exceed assets), a rising-rate environment can be helpful because it deflates their liabilities and the institutional investors have higher yields to buy going forward.

Rising Rate Strategies

In early 2018, interest rates were expected to rise after a 30-year bull market in bonds. Managing debt investment strategies in a rising interest rate environment is more challenging than when rates are falling. The first problem in actively managing fixed income strategies in a rising rate environment is that it requires forecasting rates into the future. The first objective is to develop a view on the direction and speed of interest rates changes. One problem facing fixed income portfolio managers is the uncertainty in the interest-rate environment. In the late 2000s, the debate over when rates would rise was a major topic. In late 2008 and early 2009, the Fed was effectively printing money with QE policies, inflation was expected to rise, and investors expected long-term rates to rise based on conventional wisdom. However, inflation and increases in rates did not materialize. Figure 34.2 shows bond yields on two-, 10-, and 30-year Treasuries were lower in 2017 than a decade earlier.

If a portfolio manager believes an increasing interest-rate environment is likely, the best (active) debt investment strategy may be a *total return strategy*, which is a strategy that includes a price change component plus the coupon payment. In such a strategy, the portfolio manager seeks to shorten the duration of fixed income securities based on the belief of rising interest rates. An investor may, for instance, sell a 4 percent coupon bond and replace it with a shorter-duration, 1.5 percent coupon bond. The coupon is lower but so is the associated price volatility. A continual trade-off exists between income and price volatility.

In the decade after the financial crisis of 2007–2008, savers and older individuals who had relied on income-oriented strategies and could not afford price depreciation held many of their investments in short-term paper, and subsequently earn close to 0 percent. To compensate for lower income, investors can also seek higher yields by moving to securities with lower credit quality. This relation reflects another trade-off: as investors desire higher yield, they must be compensated for taking credit risk. Savers and income-oriented investors have had a very challenging time since the financial crisis

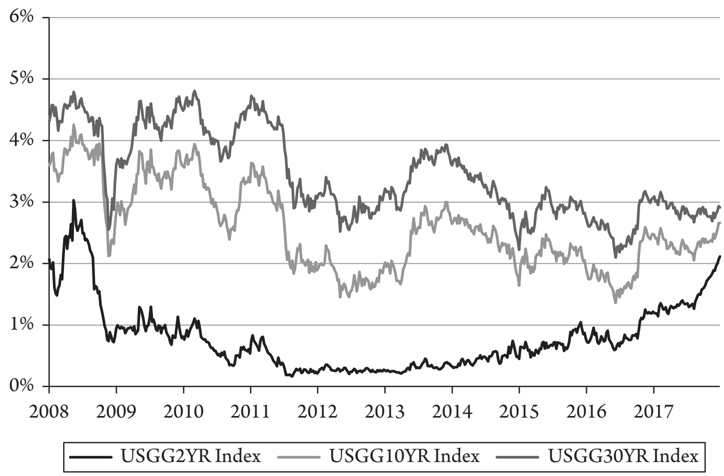

Figure 34.2 Two-Year, 10-Year, and 30-Year Treasury Yields

This figure shows falling interest rates in 10-year and 30-year Treasuries, despite many fixed income investors' beliefs that inflation and long-term growth prospects would lead to higher interest rates after the Federal Reserve started printing money in 2008.

Source: Authors based on Bloomberg data.

and may be looking forward to a rising interest-rate environment anticipating higher yields and wider spreads.

Duration can be a drag on returns creating a challenge in a rising interest-rate environment because long-duration bond prices fall more in rising rates than short-term bond prices. In a declining interest-rate environment, fixed income strategies benefit from rising prices as well as some income potential. When rates rise, duration works against the strategy as rates start to move higher on the long end of the yield curve, which drives prices down. Besides taking on additional credit risk to compensate for lower duration and therefore lower yields, investors may also look at taking on country risk, currency risk, and liquidity risk.

Many high-yield bonds outperform investment-grade bonds in a rising rate environment because of spread compression, which offsets the rise in rates. If rates are rising, the economy is improving, which results in improving fundamentals for specific bond issuers. For corporate bonds, a company is likely to have more cash flow available to bond holders if it is collecting more revenue and higher profits in an expanding economy. For municipal bonds, state and local governments are collecting higher tax receipts and have more money available for bond holders. Investors may also have more willingness to take risk and buy risky credits in an improving economy, further leading to spread compression. In this scenario, adding credit risk from buying bonds with credit spreads that can tighten from improving fundamentals is likely to be more beneficial than extending duration and taking on interest-rate risk. Since the late 2000s, high-yield debt has outperformed U.S. Treasuries as investors have moved to lower rated bonds and sought out higher-yielding debt to compensate for low Treasury yields. Figure 34.3 shows the Bloomberg Barclays Global High Yield Total Return Index outperforming the U.S. Treasury Index.

Still, with credit spreads very tight, taking on additional credit risk may not be the best way to capture extra yield. Spreads may be unable to tighten much further, and investors will be unable to benefit from further spread compression. Figure 34.4 shows the spread compression between the U.S. 10-year Treasury and 10-year BBB-rated U.S. corporate debt. The yield difference between a 10-year Treasury and 10-year BBB-rated U.S. corporate bond is now only 123 basis points. This spread is the narrowest since 2007.

Another strategy to increase yield is to invest in sovereign bonds. This strategy can also hedge against rising interest rates in the domestic market. Global QE where central banks become large buyers of their own sovereign debt and subsequently pushing yields lower has taken considerable value out of fixed income assets in developed markets. Investors may need to expand their search for fixed-income assets in emerging markets to find higher yielding bonds. The economic cycles in foreign markets may not coincide with the domestic economy, which helps with hedging different business cycles. When rates are rising in the United States, they may be falling in emerging markets. For example, in 2015, many emerging markets were in a recession, while the United States was in a recovery. The yields in the emerging markets were higher, which was a good way for investors to increase income and diversity. Currency risk is also an additional diversification tool. More sophisticated investors can get higher yields for international debt if they are willing to receive foreign currency coupons. For example, Brazil can issue 10-year debt at 4 percent denominated in U.S. dollars. Alternatively, Brazil may

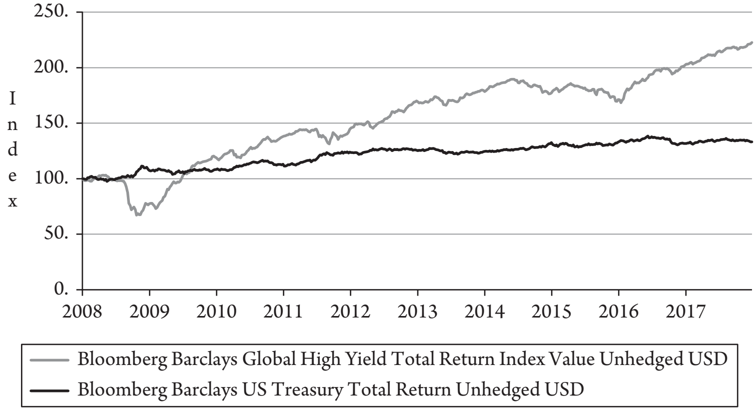

Figure 34.3 Global High Yield Total Return Index versus U.S. Treasury Total Return Index

This figure shows high-yield bonds outperforming Treasuries as more investors moved down in credit quality in search for higher-yielding debt. The Bloomberg Barclays Global High Yield Total Return Index outperformed the Bloomberg Barclays U.S. Treasury Total Return Index on a normalized basis starting in 2008.Y-axis shows the current value of the index starting from a normalized basis in 2008. (So this is index value not % or basis points. Normalized starting at 100 index value).

Source: Authors based on Bloomberg data.

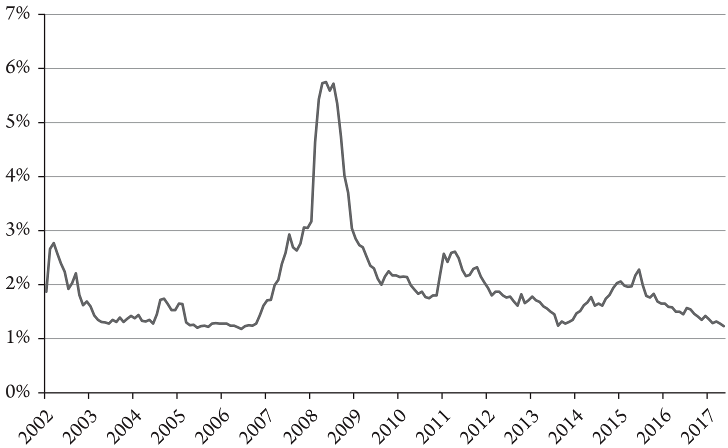

Figure 34.4 Spread between 10-Year BBB U.S. Corporate Yields and 10-Year Treasury Yields

This figure shows the spread compression between the U.S. 10-year Treasury and 10-year BBB rated U.S. corporate debt. Spreads tightened as investors moved down in credit quality in search for higher-yielding debt.

Source: Authors based on Bloomberg data.

issue 10-year debt denominated in the Brazilian real and pay 10 percent. If the investor buys the debt in Brazilian real, and the dollar weakens against the Brazilian Real, the dollar-denominated investor receives additional units of their home currency from the appreciation of the real. If the investor buys the debt in Brazilian real and the dollar strengthens versus the real, the investor is likely to lose some, if not all, of the benefit of the extra income from the 10 percent coupon.

Falling Rate Strategies

In falling interest-rate environments, fixed income investors face different challenges. The good news is that investors receive the benefit of price appreciation as rates fall. To exploit the price moves, investors may want to be long duration, so when yields fall, prices move higher than prices on the short end of the yield curve. If investors are extending duration on the yield curve to gain income, they may be able to seek out higher credit quality bonds. This strategy helps them take advantage of falling rates and a flattening yield curve. Falling rates generally mean that economic growth is slowing and higher quality bonds may outperform high-yield bonds.

The good news in a falling rate environment is that investors can capture price appreciation in addition to the income from the coupon. Such a strategy is a stark contrast from investors who are trying to manage price declines in a rising-rate environment ensuring any income from the coupon more than offsets the decrease in price.

Fixed-income investors need to be aware of other risks that emerge in a falling rate environment, such as call risk and reinvestment risk. When rates fall, issuers are more likely to call their bonds (i.e., compel the investor to redeem and refinance the debt at lower rates). When bonds are called, investors must give up the higher rate of return and accept a lower return from the market. They also face reinvestment risk in falling-rate environment. As the bond matures and investors receive their principal, they would have to reinvest their cash in a new, lower-yielding bond. Although investors can benefit from price appreciation, the income they receive is likely to be lower as rates fall and the bonds mature or are called away.

Along with the strategies already discussed that are available to investors such as managing yield curve risk, buying international and emerging-market debt, buying debt in different currencies and managing call/reinvestment risk. Fixed income investors can also implement strategies that take advantage of differing coupon structures.

Coupons

Bonds with higher coupon rates are less sensitive to changing interest rates than low coupon bonds, all else equal. Therefore, bonds with higher coupon rates are more defensive against rising rates because bond prices fall less than bond prices with lower coupons. Because investors receive more of the promised cash flows earlier in the term, bonds with higher coupons are less sensitive to price fluctuations in the market. A *premium bond* is a bond selling above par. For investors to be compensated for a lower coupon and lower income, bonds are usually sold at a discount. A *discount bond* is a bond that trades at a price less than its par value.

Investors typically demand higher-coupon bonds when they are interested in generating, or are more dependent on, an income stream. They are often willing to pay a premium for the higher coupon—say $103 per $100 par bond—even though they will only receive par at maturity since the income received during the bond's life offsets the drop in price. Investors using bonds as a vehicle for savings would purchase lower-coupon or zero-coupon instruments, which are often sold at a discount, say $97 per $100 par. This strategy allows for price appreciation during the bond's life, especially in an environment with stable interest rates.

Bonds with both high coupons and discounts to par would likely only be available in the junk-bond market, in which the credit worthiness of the issuers is low. In March 2014, Puerto Rico issued the largest junk-rated debt in the history of municipal finance up to that point. Investors demanded an 8 percent coupon and a discount to par with a price of $93 per $100 bond to yield 8.73 percent. By comparison, Puerto Rico previously issued AA rated bonds at par in 2012 with only a 5 percent coupon.

Summary and Conclusions

This chapter has discussed several common debt strategies designed to meet various investor objectives for both individuals and institutions. External factors that influence a strategy's design include economic conditions and government policies, the set of investment opportunities available, the creditworthiness of various debtor classes, and the expectation of short- and long-term interest rates. Because these factors fluctuate, portfolio managers must continually adjust a strategy's parameters. For individual investors, managing longevity risk as well as using the bond portfolio to lower volatility and preserve capital are usually key objectives. Institutional investors, with their indefinite time horizons, can use their bond portfolio to asset-liability match and maintain high liquidity to deal with unexpected adverse events. Both individual and institutional investors can generally manage falling interest rates by extending duration and moving up in credit quality. In a rising interest rate environment, investors can typically shorten duration and move lower on the credit scale. Taking advantage of premium and discount bonds to manage price volatility, as well as hedging currency risks in emerging markets, can also enhance returns.

The debt market has numerous investment options available. The complexity of the problems faced by investors wanting to meet some objectives and the diligence required to keep the strategies effective over time lead many individual investors to seek professional help.

Discussion Questions

1. Explain why adding short-term bonds to a portfolio can reduce the portfolio's vulnerability to inflation.

2. Describe any differences in terms of risk, return, and liquidity between (a) owning two bonds with the same maturity and (b) owning one bond with a longer maturity and one bond with a shorter maturity, in which the pair has the same present value and the same overall duration.
3. Describe a situation in which a strategy developed for an institutional investor cannot be implemented by an individual.
4. Explain how a portfolio manager can use an active bond strategy using country, currency, and credit risk based on the manager's views on interest rates.
5. Describe which types of institutional investors are best suited to use LDI strategies and the main benefits of doing so.

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Debt Portfolio Management

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Introduction

The global and U.S. bond markets exceed their stock market counterparts in both size and trading volume. As of year-end 2016, the global and U.S. bond markets' outstanding debt totaled $92.2 trillion and $39.4 trillion, respectively (Securities Industry and Financial Markets Association 2017). By contrast, the global and U.S. equity market capitalizations were $64.9 trillion and $27.4 trillion, respectively (World Bank Group 2017). For comparison, the average daily trading volume of the U.S. bond market in 2016 was $771.1 billion (including $514.2 billion in Treasury securities), as opposed to $272.9 billion for the U.S. equity market. In terms of U.S. corporate issuance, U.S. corporate debt issuance totaled $1,987.1 billion in 2016, whereas equity issuance totaled $197.5 billion (Securities Industry and Financial Markets Association 2017). Although bonds do not seem to attract nearly as much attention as stocks, the relative size of the bond market demonstrates the vital role it plays in security investment and portfolio construction.

Bonds are largely regarded as a key component of investment portfolios held by both individuals and institutions. Individual investors often appreciate the steady stream of income that bonds provide. Frequently, investors will hold many bond classes for capital preservation due to their perceived lower risks or will widely use bonds to hedge against equity risk. Table 35.1 presents the correlation between the yields on major bond indices and the return on the S&P 500 Composite Index between 2007 and 2016. As highlighted in the last row of the table, significant negative correlation exists between each bond index and the S&P 500 Composite Index.

Although it is widely accepted that bonds are an integral component of a balanced portfolio, modern portfolio theory (MPT) has been applied more widely to equity management. It has historically been considered more straightforward to value bonds than stocks due to their promised stream of cash flows and their certain maturity. However, debt portfolio management has recently received increased attention and recognition of the related, unique set of challenges that do not extend to the equity market. For

Table 35.1 **Inter-Year Average Yield of Major Bond Indices and the S&P 500 Composite Index Correlations, 2007–2016**

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*
1	1.00																			
2	0.99	1.00																		
3	0.96	0.91	1.00																	
4	0.97	0.94	0.94	1.00																
5	0.88	0.89	0.78	0.94	1.00															
6	0.85	0.86	0.76	0.94	0.98	1.00														
7	0.85	0.86	0.77	0.94	0.98	1.00	1.00													
8	0.93	0.87	0.99	0.94	0.78	0.78	0.79	1.00												
9	0.98	0.97	0.92	0.99	0.94	0.93	0.93	0.90	1.00											
10	0.94	0.92	0.91	1.00	0.96	0.96	0.96	0.92	0.97	1.00										
11	0.96	0.93	0.95	1.00	0.92	0.92	0.92	0.96	0.98	0.99	1.00									
12	0.96	0.95	0.93	0.85	0.73	0.68	0.68	0.86	0.88	0.81	0.84	1.00								
13	0.93	0.93	0.90	0.81	0.69	0.63	0.63	0.83	0.85	0.76	0.80	1.00	1.00							
14	0.95	0.97	0.86	0.86	0.80	0.76	0.75	0.80	0.92	0.83	0.84	0.95	0.94	1.00						
15	0.68	0.57	0.85	0.66	0.40	0.39	0.40	0.87	0.59	0.62	0.70	0.68	0.66	0.52	1.00					
16	0.69	0.58	0.86	0.69	0.44	0.44	0.46	0.89	0.62	0.66	0.74	0.68	0.65	0.52	1.00	1.00				
17	0.66	0.56	0.81	0.57	0.30	0.27	0.28	0.80	0.53	0.52	0.61	0.73	0.73	0.56	0.96	0.94	1.00			
18	0.77	0.77	0.68	0.78	0.74	0.79	0.79	0.67	0.82	0.77	0.77	0.68	0.65	0.72	0.34	0.39	0.24	1.00		
19	0.79	0.70	0.92	0.80	0.58	0.58	0.59	0.95	0.74	0.77	0.84	0.75	0.72	0.64	0.97	0.98	0.91	0.47	1.00	
20	−0.48	−0.43	−0.49	−0.49	−0.38	−0.46	−0.47	−0.49	−0.50	−0.48	−0.51	−0.42	−0.39	−0.39	−0.36	−0.41	−0.24	−0.83	−0.43	1.00

1—Global Aggregate	11—U.S. Universal
2—Global Treasury	12—Pan-European Aggregate
3—Global Aggregate Credit	13—Euro Aggregate
4—U.S. Aggregate	14—Asian Pacific Aggregate
5—U.S. Treasury	15—Global High Yield
6—U.S. Government-Related	16—U.S. High Yield
7—U.S. Agencies	17—Pan-European High Yield
8—U.S. Corporate	18—US Treasury Inflation Notes
9—U.S. MBS	19—EM USD Aggregate
10—U.S. Government/Credit	20—S&P 500

This table presents the correlation between the yields on major bond indices and the return on the S&P 500 Composite Index between 2007 and 2016.

Source: Bloomberg. Data as of August 25, 2017.

example, with the innovation of new types of instruments, such as bonds with complex options, cash flows of a bond become more difficult to determine. Perhaps the most important and unique feature of bonds relates to their direct exposure to interest rate risk. Bond prices are inversely related to changes in interest rates. This cardinal rule of bond pricing makes it crucial to understand the price sensitivity of a bond to changes in the yield curve, as valuation becomes more difficult within a backdrop of heightened interest rate volatility.

Effective bond portfolio management requires correctly identifying relevant risk exposures, defining an investment objective, and selecting the proper investment techniques to apply. In keeping with these goals, this chapter consists of two sections. The first section discusses the major sources of risk facing debt portfolio managers and the second section examines methods to respond to these risks. The portfolio strategies discussed here include both passive strategies, which require no forecast of changes in the risk factors, and active strategies, in which expected market changes must be formed and rebalancing of the portfolio is required. Some techniques discussed in this chapter are aimed to ensure the funding of liabilities while others are designed to maximize total return. Certain portfolio strategies are technical and computationally intensive while others are based on more fundamental analysis. Within active debt portfolio strategies, this chapter also reviews the application of MPT.

Risk Factors

This chapter discusses the key risk factors associated with debt portfolios, explains the causes of each type of risk, and examines the major measures and indicators of each risk factor. Understanding these risk factors is the foundation of forming efficient debt portfolio strategies.

Interest Rate Risk: Changes in the Yield Curve

A coupon-bearing bond generates two types of cash flows: a coupon and principal payments. A bond's total return is composed of the income provided by its coupon and any capital gains or losses caused by a change in the bond's price. In contrast to the fixed nature of a bond's coupon, uncertainty around changes in a bond's value creates a major source of risk when investing in fixed income securities.

A bond's price is valued by discounting the future coupon payments that the bondholder can claim at the appropriate discount rate (i.e., the market interest rate) and the bond's par value at maturity. As a result, changes in a bond's price have both anticipated and unanticipated components. The anticipated component results from the passage of time, as the proportion of a bond's total value represented by the instrument's future cash flows continuously decreases. The unanticipated component can be caused by a change in the expectations of future interest rates or a shift in the yield curve. Several macroeconomic factors may cause changes in the yield curve, including fluctuations in current or expected monetary policy, liquidity, and expectations around future inflation (Duffie and Kan 1996; Haubrich and Dombrosky 1996). Quantifying a bond's sensitivity to unanticipated changes in the yield curve is critical to debt portfolio investment.

Numerous approaches are available to measure bonds' risk exposure to the yield curve (Litterman and Scheinkman 1991; Ho 1992; Klaffky, Ma, and Nozari 1996; Willner 1996; Golub and Tilman 1997). This section introduces two measures of this sensitivity: duration and convexity. It then introduces fixed income portfolio management strategies that operate within the framework of these two variables.

Duration

Duration measures the sensitivity of a bond's price to changes in interest rates. The appropriate measure of duration depends on a set of assumptions regarding the shape and hypothetical shift of the yield curve (Macaulay 1938; Samuelson 1945; Fisher and Weil 1971; Hopewell and Kaufman 1973; Ingersoll, Skelton, and Weil 1978; Leibowitz and Weinberger 1981; Bierwag, Kaufman, and Toevs 1983). The most commonly used measure of duration is derived based on the following assumptions: (1) the yield curve is flat and (2) a one-time parallel shift occurs in the yield curve. In this scenario, duration can be expressed as shown in Equation 35.1:

$$R_u = -D\Delta i \tag{35.1}$$

where $R_u =$ the unanticipated return of a bond due to a change in interest rates, or $R_u = \frac{dP}{P}$, where P is the bond's price; D = bond duration; i = interest rate; and Δi = the proportional change in one plus the interest rate.

For a pure discount bond, duration is approximately equal to its maturity, or $D \approx T$. The implication of this relation is that the price sensitivity of a pure discount bond to changes in the interest rate is proportional to its maturity. For example, when the proportional change in one plus the interest rate is 1 percent, or $\Delta i = 1$ percent, the price of a one-year pure discount bond should change by 1 percent and the price of a 10-year pure discount bond should change by 10 percent. Table 35.2 presents the price changes of pure discount bonds with various maturities when interest rates change from 5 percent to 6 percent (i.e. $\Delta i = 1$ percent). The duration of a pure discount bond approximates its maturity and can be discerned from the values in the table.

For coupon-paying bonds, duration is calculated as shown in Equation 35.2:

$$D = \frac{\sum_{t=1}^{T} \frac{C(t)}{(1+i)^t}(t)}{P_0} \tag{35.2}$$

Table 35.3 presents the duration of bonds with various coupon rates and maturities, when $i = 5$ percent and when $i = 10$ percent.

For coupon-paying bonds, duration must be shorter than its maturity. Three other observations can be made from Table 35.3: (1) duration decreases with the coupon rate, (2) duration increases with maturity, and (3) duration decreases with the interest rate.

Table 35.2 **Pure Discount Bond Price Sensitivity and Macaulay Duration**

Maturity (Year)	*Price*		*Duration*	*Percentage Change in Price (R_u) Based on Equation 35.1*	*Actual % Change in Price*
	i = 5%	*i = 6.05%*			
1	\$952.38	\$942.95	1.00	–1.00	–0.99
2	\$907.03	\$889.16	2.00	–2.00	–1.97
3	\$863.84	\$838.43	3.00	–3.00	–2.94
4	\$822.70	\$790.60	4.00	–4.00	–3.90
5	\$783.53	\$745.50	5.00	–5.00	–4.85
6	\$746.22	\$702.97	6.00	–6.00	–5.80
7	\$710.68	\$662.87	7.00	–7.00	–6.73

This table presents the price changes of pure discount bonds with various maturities, calculated based on Equation 35.1 and their actual price changes, when interest rate changes from 5 percent to 6 percent.

Table 35.3 **Duration of Bonds with Different Coupon Rates under Different Discount Rates**

i = 5%			
Coupon Rate (%)	*Maturity*		
	2	***5***	***10***
3	1.97	4.70	8.66
4	1.96	4.62	8.36
5	1.95	4.55	8.11
6	1.94	4.48	7.89
7	1.94	4.41	7.71
i = 10%			
Coupon Rate (%)	*Maturity*		
	2	***5***	***10***
3	1.97	4.66	8.29
4	1.96	4.57	7.95
5	1.95	4.49	7.66
6	1.94	4.41	7.42

This table presents the Macaulay duration of bonds with various coupon rates and maturities, when $i =$ 5 percent, and i = 10 percent.

Equation 35.2 illustrates the calculation of the most widely known measure of duration, Macaulay duration. In practice, many other versions of duration exist. Some examples include modified duration, which measures price sensitivity to changes in a bond's yield, the Fisher-Weil duration, which refines the Macaulay duration by accounting for the term-structure of interest rates, and key rate duration, which measures the price sensitivity of bonds to shifts of different parts of the yield curve (Fisher and Weil 1971; Bierwag 1977).

In practice, for very small changes in interest rates, duration almost measures the exact sensitivity of a bond's price. However, for large changes in the interest rate, duration only provides an approximation, which becomes increasingly inaccurate as the changes in interest rates become larger. The following section introduces a measure that is more suitable for large shifts in the yield curve.

Convexity

For large shifts in the yield curve, duration becomes a less accurate measure of the sensitivity of bond values to changes in interest rates. To overcome this limitation, a correction term must be added to Equation 35.1 to calculate the unanticipated price change of a bond due to a shift in the yield curve. This correction term is called *convexity* (Christensen and Sorensen 1994; Chance and Jordan 1996; Elton, Gruber, Brown, and Goetzmann 2013). Although duration assumes a linear relation between the percentage change in a bond's price and the percentage change of one plus the interest rate, convexity recognizes that the relation between the percentage change in bond prices and the percentage change in one plus the interest rate is a convex function. In Equation 35.3, let C be the bond's convexity. The bond's unanticipated return due to a shift in the interest rate is given by Equation 35.3:

$$R_u = -D\Delta i + C(\Delta i)^2 \tag{35.3}$$

The bond's convexity is calculated as shown in Equation 35.4:

$$C = \left(\frac{1}{2}\right)\frac{\sum_{t=1}^{T}\frac{t(t+1)C(t)}{(1+i)^t}}{P_0} \tag{35.4}$$

To illustrate the difference between duration and convexity, Table 35.2 is reproduced, with the interest rate changing from 5 percent to 10.25 percent (Δi = 5 percent). The Macaulay duration and convexity of a set of pure discount bonds that pay $1,000 at maturity are calculated in Table 35.4. Furthermore, Table 34.4 also presents the actual and predicted price changes of the bonds, as detailed in Equations 35.1 and 35.3, based on changes in the interest rate.

Table 35.4 illustrates that when shifts in yield are relatively large, duration does not provide a very good approximation of the change in a bond's value due to a change in interest rates. Accounting for convexity in this calculation substantially improves the accuracy of the estimation. For example, for a five-year pure discount bond, when the

Table 35.4 **Duration and Convexity**

Maturity (year)	*Price*		*Duration*	*Convexity*	*Percentage Change in Price (R_u) Based on Equation 35.1 (%)*	*Percentage Change in Price (R_u) Based on Equation 35.3 (%)*	*Actual Percentage Change in Price (%)*
	i = 5%	*i = 10.25%*					
1	$952.38	$907.03	1.00	1.00	–5	–4.75	–4.76
2	$907.03	$822.70	2.00	3.00	–10	–9.25	–9.30
3	$863.84	$746.22	3.00	6.00	–15	–13.50	–13.62
4	$822.70	$676.84	4.00	10.00	–20	–17.50	–17.73
5	$783.53	$613.91	5.00	15.00	–25	–21.25	–21.65
6	$746.22	$556.84	6.00	21.00	–30	–24.75	–25.38
7	$710.68	$505.07	7.00	28.00	–35	–28.00	–28.93
8	$676.84	$458.11	8.00	36.00	–40	–31.00	–32.32

This table presents the Macaulay duration and convexity of a set of pure discount bonds that pay $1,000 at maturity, the percentage price changes calculated based on Equations 35.1, 35.3, and the actual percentage price changes, when interest rate changes from 5 percent to 10.25 percent.

interest rate increases from 5 percent to 10.25 percent, if an unanticipated change in the bond's value is estimated using duration alone, the result is a 5 percent decrease in bond price. Conversely, if the unanticipated change in the bond's value is estimated using both duration and convexity, the forecast is a 21 percent price decrease, a result much more in line with the bond's actual price decrease of 22 percent.

Credit Risk

A bond's credit or default risk is a more relevant concept for corporate and municipal bonds than it is for sovereign government bonds. *Credit risk* refers to the risk that cash flows are not received as promised. When a security's credit risk is high, expected returns may be lower than promised returns because the possibility exists that the issuer may not make its promised payments. To compensate for this potential loss, investors usually demand a higher expected return for bonds with higher credit risk.

A bond rating is among the most commonly cited measures of a bond's credit risk. The majority of U.S. corporate bonds are rated by one (or more) of the top three rating agencies in the United States: Moody's, Standard & Poor's, and Fitch. Ratings provided by these agencies may differ. Moody's and Standard & Poor's use similar algorithms in generating their rating classifications. Bonds are classified on the basis of the probability of a missed, delayed, or partial payment, and the size of the loss incurred if any of these scenarios occur (Elton et al. 2013). Bonds are considered investment grade if their rating is Baa or higher by Moody's or BBB or higher by Standard & Poor's. Bonds with ratings below this threshold are considered to be speculative bonds, or "junk bonds." Some institutions and funds restrict their investments to bonds that receive at least a minimum credit rating (Baker and Mansi 2002; Calio 2005; Eisinger 2005; Elton et al. 2013). Whether this investment practice can cause segmentation of the bond market is debatable. No clear consensus exists within empirical research (Kisgen and Strahan 2010; Bongaerts, Cremers, and Goatzmann 2012; Chen, Lookman, Schurhoff, and Seppi 2014).

Several firm characteristics are identified as variables that influence bond ratings issued by Moody's or Standard & Poor's, including earnings relative to interest payments, debt ratio, earnings volatility, and level of working capital. The best combination of these variables can be found using mathematical techniques that attempt to duplicate the bond rating process conducted by the rating agencies. Empirical evidence shows that the right combination of these variables is useful in duplicating 70 to 80 percent of published ratings (Elton et al. 2013). This relation enables analysts to assess the likelihood of a loss on a potential loan and allows banks and insurance companies to evaluate the creditworthiness of these small- or medium-sized borrowers.

The measurement of credit risk has evolved considerably over the last few decades. These advances have incorporated large trends in the global credit market, including an increased number of bankruptcies, growth in off-balance sheet financing, and a decline in real asset values (Altman and Saunders 1997). Aside from a bond's credit rating, many other measures of credit risk are universally recognized. The first category is accounting-based scoring systems, which combine and weight a borrower's key accounting ratios. Accounting-based scores are favored by many financial institutions (Altman, Haldeman, and Narayanan 1977; Smith and Lawrence 1995; Altman and Narayanan 1997). Additionally, several bankruptcy-based models predict the probability of bankruptcy and credit risk using a firm's level of debt and the value and volatility of its assets within an option pricing framework (Wilcox 1973; Santomero and Vinso 1977; Scott 1981). Capital market-based, mortality-default risk models also are available that derive actuarial-type default risk that utilizes historical data regarding bond ratings and maturities (Altman 1989; Asquith, Mullins, and Wolff 1989).

Altman and Kuehne (2014) provide historical data on the default rate of high-yield straight corporate bonds in the United States, Canada, and Mexico between 1971 and 2013. The weighted average annual default rate during this period was 3.61 percent (with weights based on outstanding par values). By comparison, the arithmetic mean during the same period was 3.14 percent. However, the time-series variance is considerable, with peaks observed in 1990, 1991, 2002, and 2009 (Altman and Kuehne 2014). The data excludes default issues. Default includes the events of bankruptcy, missing interest payments beyond the grace period, or the completion of a distressed exchange.

Liquidity Risk

Liquidity risk concerns transaction costs and the uncertainty associated with selling assets in a timely fashion without loss of value. Because investors need to be compensated appropriately for liquidity risk, illiquid bonds should exhibit wider spreads relative to a benchmark than liquid bonds. In bond investments, liquidity is usually measured by the bid-ask spread. In a bond quote, the *bid* is the highest price that the dealer is willing to pay for a bond, and the *ask* is the lowest price for which the dealer is willing to sell a bond. For example, suppose a corporate bond quote lists a security with a bid price of $992.50 and an ask price of $995.00. The bid-ask spread is $2.50 in this case. Most major bond dealers will sometimes provide "indicative two-sided" quotes for opaque bonds. For example, a quote on a five-year corporate bond might be "82-80, 5-by-10," indicating the dealer is willing to buy $5 million worth of the bonds at a spread of 82 basis points above the yield of the five-year Treasury bond, and sell $10 million worth of the bond at a 80 basis points spread (Crabbe and Fabozzi 2006).

The institutional dynamics of the bond market help provide an understanding of how liquidity risk arises. Trading costs arise from both coordination and information imperfections of the market. Because buy and sell orders are not received simultaneously, dealers must hold an inventory of bonds in reserve in order to facilitate transactions. Given that inventory needs to be financed, holding inventory creates a financing cost for dealers. The bid-ask spread is therefore designed to compensate dealers for this holding cost and the uncertainty about the length of time needed to hold the inventory. Similarly, when a bond is more opaque with a complex structure, it is inherently more complex to analyze. In other words, when information asymmetry is severe, dealers expect to hold the inventory for a longer period, causing bid-ask spreads to widen accordingly. Several market factors may also affect the bid-ask spread. Spreads generally increase with market volatility and a flattening yield curve. Since dealers usually finance their inventories in the money market, a flatter curve increases the cost of short-term financing (Crabbe and Fabozzi 2006).

Although bond liquidity is based on uncertain trading costs, several liquidity-based patterns appear from the bond market. First, opaque bonds with complex structures are less liquid than plain vanilla or simpler structured bonds. For example, corporate bonds are less liquid than Treasury bonds, and collateralized mortgage obligations (CMOs) generally have higher spreads than those of planned amortization class (PAC) bonds. Second, liquidity decreases with the size of the transaction. Selling $1 million par value of bonds without a large concession on the bid price is typically easier than selling $50 million par value of bonds. Third, bonds issued by large companies with high credit ratings are generally more liquid than their lower-rated counterparts issued by smaller companies. Fourth, considerable industry variation occurs with respect to bond liquidity (Crabbe and Fabozzi 2006). However, although some general patterns can be observed, bond market liquidity changes over time. In a highly volatile bear market, the bid-ask spread can widen to the point where completing large transactions is almost impossible.

Debt Portfolio Management Strategies

Once investors develop a clear picture of their risks, they can customize portfolio strategies to either take advantage of or mitigate these risk factors. This section introduces several commonly used portfolio management techniques. These techniques can be categorized based on investment styles/objectives. In a passive strategy, the investor's only decision relates to the formation of the initial portfolio, whereas in an active strategy, the investor needs to frequently restructure and rebalance the portfolio. Investors use some of the strategies discussed to insulate against many of the risks previously detailed in order to generate total returns.

Passive Debt Portfolio Management

This section introduces three passive techniques: (1) immunization, (2) dedication, and (3) indexation. Both immunization and dedication are designed to protect portfolios against shifts in the yield curve. Investors and portfolio managers generally use these methods to ensure that the cash flows needed to fund a given liability will be realized. By contrast, the purpose of indexation is performance replication.

Immunization

Investors and portfolio managers often use immunization to insulate against shifts in the yield curve or to fund a given liability. The foundation of immunization is to eliminate a portfolio's sensitivity to changes in the term structure by matching the duration of the asset used to fund the liability to the duration of the liability itself. By matching durations, the values of the assets and liabilities rise or fall by the same amount for any given change in the interest rate. In essence, using beta as an analogy to bond duration, combining an asset and a liability with the same beta results in a zero beta portfolio whose returns do not fluctuate with the market.

To illustrate this strategy, consider a liability of $2,000 due in five years. An investor can fund this liability by buying a bond that generates cash flows with a total value of $2,000 at the end of the fifth year. If the purchased bond has a maturity of five years, the investor knows with certainty the value of the coupon payments and/or the bond's face value to be received each year. However, because the future interest rate is unknown, the investor is uncertain about the rate at which the coupon payments can be reinvested, resulting in uncertainty around the total value of the cash flows at the fifth year. Specifically, when interest rates rise, investors can reinvest the coupon payments at a higher than expected rate, resulting in a surplus after meeting the liability owed in the fifth year.

In contrast, if interest rates fall, investors would face a scenario of reinvesting the coupon payments at a less-than-favorable rate, which may result in not reaching the required $2,000 to meet the obligation in the fifth year. Alternatively, while investors can buy a bond with a maturity longer than five years, the bond's value in the fifth year still depends on the unknown future spot interest rate. With a rising interest rate, an investor can reinvest the coupon payments from years one through four at a higher rate, but the bond's value in year five will still decline. If the future interest rate falls, an investor will reinvest the coupon payments at a lower rate, but the bond's value in the fifth year will rise. Given that the value of the coupon reinvestment and the bond's value during the fifth year move in opposite directions with both rising and falling interest rates, selecting a bond for which these changes in value exactly offset each other might be possible. This action would result in a constant total value of the cash flows during the fifth year.

Immunization involves holding an asset whose duration matches the duration of the liability. In the previous example, to immunize the $2,000 liability in five years, an investor should buy a bond with a duration of five years. Consider a seven-year bond with a coupon rate of 14 percent. Assume the current interest rate is 8 percent. Table 35.5 shows the cash flows generated by the bond, and the value of those cash flows at year five under various interest rates: 7, 8, and 9 percent. Compared to the base scenario of an interest rate of 8 percent, when the interest rate falls to 7 percent, the value of the cash flows from year one to four, valued at year 5, decreases, while the value of cash flows from year 6 to 7, valued at year 5, increases. Although the value of each cash flow at year 5 changes, the positive and negative changes offset each other. Consequently, the bond's value at year five stays stable around $1,928, when the interest rate changes from 8 percent to 7 percent. When the interest rate increases from 8 percent to 9 percent, the bond value at year five appears similar. The reason that the bond value stays relatively stable in year five is because this bond has a duration of 5 years, at which point the bond's value is insensitive to changes in the interest rate. Therefore, holding this bond ensures the receipt of a certain cash inflow to repay the $2,000 liability when it comes due. Investors and portfolio managers can use immunization to fund liabilities of various sizes. For example, a liability of $20,000 at year five can be met with eleven of the seven-year bonds with a coupon rate of 14 percent and duration of five years (i.e., $20,000/$1,928 equals about 11 bonds).

Although immunization using duration is considered a passive approach to debt portfolio management, it actually requires active restructuring of portfolio assets. This situation occurs because duration is calculated for a particular yield curve. When the yield curve changes, the asset's duration also changes. Moreover, a bond's duration changes simply from the passage of time. Therefore, immunization requires constant

Table 35.5 **Bond Value at Year 5**

Year	*Cash Flow*	*Interest Rate*		
		7%	8%	9%
1	140	$183.51	$190.47	$197.62
2	140	171.51	176.36	181.30
3	140	160.29	163.30	166.33
4	140	149.80	151.20	152.60
5	140	140.00	140.00	140.00
6	140	130.84	129.63	128.44
7	1140	995.72	977.37	959.52
Value at Year 5		**1931.66**	**1928.32**	**1925.82**

This table shows the cash flows generated by a seven-year bond with a coupon rate of 14 percent, and the value of these cash flows at year 5 under the interest rates of 7 percent, 8 percent, and 9 percent.

monitoring and rebalancing of a portfolio to ensure the exact matching between the durations of the asset and liability.

When large shifts in the yield curve occur, duration becomes an inaccurate measure of the sensitivity of bond value to the yield curve, in which case, using convexity provides a remedy. In practice, some portfolio managers immunize their debt portfolios by matching both duration and convexity. However, portfolios immunized by matching both duration and convexity are costly to construct and relatively rare, and thus are more likely to be found within the framework of high cost portfolios.

The associated debt management literature discusses the effectiveness of different immunization strategies (Fisher and Weil 1971; Bierwag 1977; Bierwag and Kaufman 1977; Chulsoon 1979; Cox, Ingersoll, and Ross 1979; Fong and Vasicek 1984). This discussion highlights two different techniques: a barbell strategy and a focused strategy (Elton et al. 2013). To illustrate, suppose a liability needs to be funded in 10 years. With a barbell strategy, a portfolio is constructed with bonds of very different durations so that the weighted average duration of the portfolio is 10 years. For example, the portfolio can be evenly split between five-year and fifteen-year duration bonds. With a focused strategy, the durations of all the bonds in the portfolio are around 10 years (e.g., 9 to 11 years). Some contend that the focused strategy is more effective because duration is an approximation of the sensitivity of bond value to shifts in the yield curve and is subject to measurement error. With a focused strategy, all bonds in the portfolio have similar durations, limiting the magnitude of the error. However, a barbell strategy uses bonds with more disparate durations, which can result in substantial measurement error.

Dedication

Dedication is another liability funding strategy. The principle is to construct a portfolio that produces the same cash flows at the maturity of a liability. Suppose a pension liability requires the following payments: $800 in year 1, $1,500 in year 2, and $2,500 in year 3. One way to construct a dedication portfolio to fund this liability is to select bonds with the coupon and/or principal payments that are exactly $800 in year 1, $1,500 in year 2, and $2,500 in year 3. In practice, some bond managers prefer a cash flow surplus in early periods. This surplus is usually invested to fund part of the cash flows in later periods. For example, a bond manager can construct a portfolio that produces the following cash flows: $1,000 in year 1, $1,800 in year 2, and $1,900 in year 3. The $200 and $300 surplus from years one and two respectively, can be invested so that, in year three, funding the additional $600 needed will be sufficient.

The dedication strategy is considered a purely passive strategy because no restructuring is needed once the bonds are selected. Because the timing of the cash flows generated by the debt portfolio exactly matches the timing of the liability, investors need not be concerned about shifts in the yield curve. However, given that this strategy assumes timely bond payments, it is subject to the issuer's credit risk. Moreover, the dedication strategy is exposed to reinvestment risk. Specifically, in the previous example, if the bond manager invests the cash flow surplus from the first two years to fund the liability incurred during year three, a minimum rate of return on the reinvestment is required to ensure sufficient funding.

Indexation

Indexation is another passive strategy that seeks to replicate performance of the index. Although indexation is very common in equity portfolio management, its application is quite different in the bond market. Since a large number of corporate bonds are not actively traded, forming a portfolio in proportion to the composition of a major index is impractical. Instead, indexation in debt portfolios is undertaken by delineating important bond characteristics and holding bonds in each category in proportion to the index. Bonds are commonly delineated based on their issuers, coupon rates, credit ratings and durations. For example, the bond manager calculates the percentage of BBB-rated corporate bonds with a coupon rate between 6 percent to 7 percent and a duration between five and six years in a particular index. All possible combinations of bond characteristics are considered in this process and the corresponding percentages are calculated. A stratified portfolio is then constructed based on these percentages. With indexation, once the bonds in the portfolio and their weights are selected, further rebalancing is rare. Historically, very few active funds have outperformed major indices. Although the process of constructing a replicated portfolio involves extensive quantitative analysis, the indexation strategy is usually successful in replicating index performance (Elton et al. 2013).

Active Debt Portfolio Management

Active strategies in debt portfolio management have both experienced their own unique development and have adopted the Modern Portfolio Theory (MPT) found in equity portfolio management. This section introduces two active strategies that are unique to bond management followed by a discussion of the applications of MPT to debt portfolios.

Market Timing

In debt portfolio management, market timing can be performed on two key variables: (1) the interest rate and (2) bond price. As previously discussed, bonds with longer durations are more sensitive to interest rate movements. Because of the inverse relation between bond values and interest rates, when interest rates fall, long-duration bonds increase more in value than short-duration bonds. Similarly, when interest rates rise, long-duration bonds lose more value than short-duration bonds. One strategy used by bond managers is to shorten duration when interest rates are expected to rise, and thus limit the loss, or extend the duration when interest rates are expected to fall, and thus increase the gain. Successful timing of interest rate movements requires not only a good forecast of future interest rates, but also a view that differs from the general consensus of market participants. Another limitation of this timing strategy is that it requires a liquid bond market so that transactions can be completed quickly. Because the most liquid securities in the bond market are usually government bonds, this timing strategy is not widely applicable to many corporate bonds.

Another type of market timing involves trading mispriced bonds. One strategy to detect mispricing involves calculating the difference between actual market price and the theoretical price. A bond's theoretical price is the sum of the risk-adjusted present value of its future cash flows and the value of any embedded options. A bond can be mispriced due to the misclassification of its credit rating, which is more commonly observed among speculative bonds. Bond managers can examine the issuer and bond characteristics and invest in the bonds with lower default risks than indicated by their ratings.

Sector Rotation and Selection

Asset allocation accounts for a substantial portion of portfolio return variability. In MPT, *asset allocation* refers to the weights assigned to each asset class within a portfolio. The imperfect correlations between the returns of different asset classes improves the investment efficient frontier (Elton et al. 2013). However, for fixed income portfolios, the different macroeconomic and microeconomic sectors are exposed to the aforementioned risks but to different degrees. This situation can potentially make sector allocation beneficial to investors.

Sector rotation and selection in bond management can also be based on a manager's belief of a sector-wide mispricing. *Sector rotation* involves switching investments from a sector believed to be overvalued to one viewed as undervalued. For example, relative to AAA-rated corporate bonds, the yields of junk bonds with the same maturity are usually higher, due to the inclusion of a default risk premium. In a given period, if the market believes the default risk of junk bonds relative to that of AAA-rated bonds will increase, the spread in yields between these two classes of bonds will widen. However, if a bond manager believes the market is overestimating the default probabilities of junk bonds, the manager may rotate investments to junk bonds. Sectors do not have to be defined by industry in this context and can be classified more broadly. For instance, a sector can be defined by a particular rating, issuer identity, coupon rates, duration, or embedded option features. Similarly, sector selection is motivated by the belief that a particular sector will outperform the market in the long run. For example, if a bond manager believes the current default premium on junk bonds is higher than the premium presently justified by the default probability, the manager may permanently hold a junk bond portfolio with the hope that, in the long run, this portfolio will outperform other sectors.

Another factor that justifies sector allocation is the potentially different option adjusted spread (OAS) values calculated by dealers and vendors. *OAS* is a spread added to the yield curve or interest rate tree to discount a bond's cash flows to equate the value of the model's cash flows with the bond's market price. This process can be applied to any bond with embedded options, including mortgage-backed securities (MBSs) and callable bonds (Brazil 1988; Kalotay, Yang, and Fabozzi 2004; Levine and Davidson 2005). Unlike duration or convexity, a standardized calculation of OAS does not exist, mainly due to the plethora of available interest rate and prepayment models. As dealers develop their own models of the yield curve and prepayment schedules, considerable variation in OAS may exist. Therefore, OAS can help investors identify market mispricing. After accounting for interest and prepayment risks, theoretical and observed prices should converge, holding other factors constant. If a systematic relation exists between these two prices within a particular sector, an arbitrage opportunity may exist (Obazee 2006).

Applying MPT to Bond Portfolio Management

Applying MPT to debt portfolio management involves estimating a bond's expected return. This section discusses three approaches to this estimation: (1) pure expectations theory, (2) the single-index model, and (3) the multi-index model. The first approach is built upon *pure expectations theory*, which states that over the long term, a bond's return must equal the total return of successive reinvestments over all short-term sub-periods. Therefore, this theory predicts that the expected return of the next period is the spot rate in one period, and long-term interest rates are simply the weighted average of current and future short-term rates.

To illustrate how to apply the pure expectations theory to the estimation of expected bond returns and bond prices, consider a five-year bond with a coupon rate of 8 percent, face value of \$1,000, and current price of \$1,040. The current one-period forward rate from year one to year five are 5 percent, 6 percent, 7 percent, 8 percent, and 9 percent, respectively. The expected spot rate in one period from year two to year five are 6 percent, 7 percent, 8 percent, and 9 percent, respectively.

When assuming pure expectations theory is correct in forecasting future interest rates, the current one-period forward rate and expected spot rate in one period are the same starting in period 2. Using the discounted cash flow method, the bond's price today is calculated as:

$$P_0 = \frac{\$80}{(1.05)} + \frac{\$80}{(1.05)(1.06)} + \frac{\$80}{(1.05)(1.06)(1.07)} + \frac{\$80}{(1.05)(1.06)(1.07)(1.08)} + \frac{\$1,080}{(1.05)(1.06)(1.07)(1.08)(1.09)} = \$1,047.81$$

Similarly, the bond's price in one year is:

$$P_1 = \frac{\$80}{(1.06)} + \frac{\$80}{(1.06)(1.07)} + \frac{\$80}{(1.06)(1.07)(1.08)} + \frac{\$1,080}{(1.06\%)(1.07)(1.08)(1.09)} = \$1,020.20$$

If the bond is correctly priced, the total return of period one consists of two parts: the \$80 coupon payment and the capital loss of \$27.61, or (\$80 – \$27.61)/\$1,047.81, which equals 5 percent, exactly the spot rate in the first period. However, because the bond is currently mispriced at \$1,040, the bond's total return in period 1 should consist of three parts: \$80 coupon payment, or \$80/\$1,040 = 7.69 percent; \$27.61 capital loss that results from the change in equilibrium price, or (\$1,020.20 – \$1,047.81)/\$1,047.81 = –2.64 percent; and \$7.81 of mispricing, or (\$1,047.81 – \$1,040.00)/\$1,040.00 = 0.75 percent. Therefore, the total expected return of period 1 based on the pure expectations theory is 7.69 percent – 2.64 percent + 0.75 percent = 5.81 percent.

Expected bond returns can also be estimated using two other approaches: single- and multi-index models in MPT. This section presents both index models, each analogous to their equity market counterparts. The single-index model asserts that a bond's return consists of the expected return assuming pure expectations theory holds and the return due to an unanticipated shift in the yield curve. Equation 35.14 shows the bond return:

$$R_i = \overline{R_i} + \frac{D_i}{D_m}(R_m - R_i) + e_i \quad \textbf{(35.14)}$$

where R_i = the return on bond *i*; $\overline{R_i}$ = the expected return on bond i; R_m = the return on the bond index; D_i = the duration of bond *i*; D_m = the duration of the bond index; and e_i = the random influence with a mean of zero and a variance of σ^2_{ei}.

Equation 35.14 is analogous to the single-index model in the equity market, which is expressed as Equation 35.15:

$$R_j = \alpha_j + \beta_j R_{ms} + \varepsilon_i \quad \textbf{(35.15)}$$

where R_j = the return on stock *j*; α_j = the component of security *j*'s return that is independent of the market performance; R_{ms} = the return on the market index; and β_j = a constant that measures the expected change in R_j given a change in R_{ms}, calculated as the covariance between R_j and R_{ms}, divided by the variance of R_{ms}.

To see the similarity between Equation 35.14 and Equation 35.15, we define β_i as $\frac{D_i}{D_m}$. In other words, β_i is the ratio of the covariance between the bond *i*'s return and the return on the bond index, divided by the variance of the return on the bond index. One important characteristic of the single-index model for bond pricing is that β_i no longer needs to be estimated from historical return data as in equity portfolio management. Instead, β_i can be directly calculated as the ratio of the bond's duration to the duration of the bond index.

One limitation of the single-index model is that it assumes a shift in the yield curve is the only factor driving bond returns. Consequently, the single-index model ignores many other prominent sources of influence, including tax effects, liquidity, default premium, and embedded options, such as callable features. A multi-index model addresses this concern by including multiple influences. This model requires estimating the sensitivity of bond returns to each factor. Each sensitivity parameter can be viewed as analogous to β_i in the single-index model. Thus, instead of having a single β_i, the multi-index model has a $\beta_{i,n}$ for each of the *n* factors. Empirical studies document that at least two factors are necessary to adequately capture the changes in the term structure (Brennan and Schwartz 1977, Elton, Gruber, and Michaely 1990).

Summary and Conclusions

Due to a unique set of risk exposures, debt portfolio management has received increasing attention from both academics and practitioners. Because bond returns are subject to a greater variety of macroeconomic factors than returns on common equity, debt portfolio management encapsulates strategies that are both unique to fixed income securities and based upon MPT. This chapter builds a framework of debt portfolio management by discussing the common risk factors in bond investment and a set of debt portfolio management strategies targeted at these factors. These strategies generally can be applied to serve two purposes: liability funding and total return seeking. The active strategies usually require continuous restructuring and rebalancing of the portfolio, whereas in passive strategies, actions are only required at the initial construction of the portfolio. No single strategy can consistently guarantee a winning portfolio. Techniques introduced in this chapter do not have to be applied in isolation. Before choosing a strategy, investors should correctly assess their tolerance for and exposure to risk and form a well-defined investment objective. Successful debt portfolio management requires implementing the proper strategy targeted at insulating the specific risk factors and achieving predefined investment objectives.

Discussion Questions

1. Explain the key principle behind an immunization strategy and how it compares to using beta in an equity investment.
2. Explain the dedication strategy and the risks associated with this strategy.
3. Consider a four-year bond with a coupon rate of 7 percent and face value of $1,000. Further assume the yield curve is flat, with a 9 percent yield to maturity. Assuming the yield curve remains flat, calculate the bond's duration and convexity today and in two years.
4. Consider a five-year bond with a coupon rate of 12 percent and a face value of $1,000. Given the following hypothetical interest rates and assuming the pure expectations theory is correct, calculate the bond's expected price in two years.

Period	**Current One-Period Forward Rate (%)**
1	5
2	6
3	7
4	8
5	9

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Debt Trends and Future Outlook

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Introduction

The United States has the largest economy in the world. At the end of 2017, the U.S. gross domestic product (GDP) was $19.739 trillion. Coupled with the massive economy is a staggering amount of debt. The United States had $47 trillion of combined public and private sector debt at the end of the third quarter 2016. Of the $47 trillion, government debt amounted to more than $19 trillion. U.S. government debt increased to more than $20 trillion by the end of 2017 and is estimated to be close to $21 trillion by the end of 2018. Of the $47 trillion, household debt totaled $14.6 trillion, and business debt (non-financial), $13.4 trillion (Seeking Alpha 2017). U.S. government debt was 105.4 percent of GDP in 2017. U.S. debt also comprises the greatest proportion of global debt which, according to the Institute of International Finance (IIF), reached an all-time high of $233 trillion in the third quarter of 2017 (Chu 2018). Global debt increased $16 trillion from the end of 2016 to the third quarter of 2017 and total outstanding debt is more than three times the size of the global economy. U.S. government debt of $20 trillion makes up about one third of $63 trillion in global sovereign debt. Given this staggering amount of both domestic and global debt, identifying trends and understanding their implications are crucial.

Debt can be broadly classified into four categories: (1) government debt, (2) household debt, (3) non-financial corporate debt, and (4) financial sector debt. Although an obvious overall trend of increasing debt across categories exists, identifiable trends specific to the type of debt are also present. For example, according to the IIF, the largest portion, $68 trillion of the $233 trillion global debt, belongs to non-financial corporations and the second largest is attributed to government borrowings at $63 trillion (Chu 2018).

The chapter proceeds as follows. The second section focuses on trends in bond markets including developing country debt, Treasury bonds, the impact of the shrinking balance sheet of the U.S. Federal Reserve on bond markets and municipal bonds, and the effect of the recent tax reform on these bonds, and "exotic" bonds such as GDP-linked bonds and catastrophe bonds. The next section provides a description of trends in consumer debt including the rise of student debt and the next possible credit bubble, auto loans, mortgage loans, and credit card loans. Included in this discussion is the recent, and to some disturbing, trend of buying cryptocurrencies such as bitcoin with credit card debt. Finally, the chapter provides a summary and conclusions.

Trends in Bond Markets

Some major bond markets include sovereign (government) bonds, municipal (state and local government) bonds, and corporate bonds. In terms of overall bond market trends, a theory has been circulating in the markets since 2012 that a "great rotation" will occur from bonds into equities (Cox 2017). The idea of a "great rotation" seemingly started as a working theory at Bank of America Merrill Lynch in 2012 when Mitt Romney appeared likely to win the White House and Republicans would take control of both the House and Senate (Boesler 2012). Speculation existed that Romney would remove Ben Bernanke as the Chairman of the Federal Reserve and would potentially restructure the tax code, leading some at Bank of America to expect a move away from bonds into stocks. Expectations of lower bond yields combined with expectations of higher equity yields have fueled the flames of the "great rotation" theory. The theory circulated from 2012 until 2017, resulting in heated debates between investment professionals, until, in early 2017, the chief U.S. equity strategist at Goldman Sachs, David Kostin, called it "fake news." His point is that a huge exodus from bonds is unrealistic because many institutions are required to balance risk in their portfolios with fixed-income securities. The person to coin the phrase "great rotation," Michael Hartnett, chief strategist at Bank of America Merrill Lynch, recently said he still expects a rotation, but one that is subtler than simply a shift from bonds to stocks. Apparently, Kostin's remarks on CNBC largely ended this debate.

Bond holders saw substantial price appreciation as interest rates fell in the wake of the financial crisis of 2007–2008. Interest rates have remained at historically low levels for the last decade, although the Federal Reserve (Fed) raised short-term rates five times since December 2015, 25 basis points at a time, through 2017, with plans for further rate hikes in 2018 and 2019. Jerome Powell, President Trump's choice for Fed chairperson, was sworn in as the new Fed Chair in February 2018. Strong job gains, a low unemployment rate, increased inflation and a new Fed chairperson all indicate the likelihood of continued rate hikes and the Fed shrinking its balance sheet in the coming years. Such actions will affect the Treasury bond market and other debt markets alike. Clearly, many of the factors that influence Treasury bond markets are likely to affect other debt markets.

Treasury Bond Market

Two potential trends could emerge in Treasury bond markets. First, the Fed is making two moves designed to affect Treasury bond markets. At the Fed's September 2017 meeting, it indicated that it will raise the Federal funds rate three more times in 2018 and an additional two times in 2019. Due to the strength of the economy, low unemployment, a political agenda that includes infrastructure spending, and a surprising tax overhaul, some analysts expect the Fed to add at least one additional rate hike to both

2018 and 2019 (Appelbaum 2017). These rate hikes may mean a further flattening of the yield curve and a higher cost associated with short-term funding.

Second, the Fed has announced a winding down of its $4.5 trillion balance sheet, the result of the quantitative easing following the financial crisis of 2007–2008 (Miller 2017). During the period of quantitative easing, the Fed purchased Treasury bonds, mortgage backed securities (MBSs), and other securities to decrease interest rates and increase the money supply. The assets on the Fed's balance sheet contain mostly Treasury bonds (i.e., about $2.5 trillion or 18 percent of the U.S. government debt held by the public) and mortgage-backed securities (i.e., about $1.8 trillion representing more than 25 percent of the MBS market). The Fed purchased securities during several rounds of quantitative easing that provided liquidity to financial markets during and following the financial crisis. The Fed no longer plans to replace bonds and MBSs that mature, allowing them to "roll off" the balance sheet. The Fed's balance sheet represents about 25 percent of U.S. GDP.

In terms of the Treasury market, rates are expected to rise as a result of the unwinding. This change will increase the costs faced by the federal government in meeting the interest expense on its massive borrowings. Also, some analysts are concerned about which investors will pick up the slack and replace the demand for Treasuries that the Fed has been providing. The tax cut, passed in late 2017, is also expected to add to the deficit. As the Fed purchases less debt, investors must make up the difference. All of these factors are likely to affect Treasury markets going forward, but how and to what extent is still unknown. Some expect the "central bank bond bubble" to finally burst or at least deflate.

Another factor that is likely to affect U.S. Treasury bond markets in the future is the level of demand for U.S. government bonds from foreign governments. Currently, China is the largest foreign lender to the United States, holding about $1.2 trillion of U.S. Treasury bills, notes, and bonds. This amount represents nearly 20 percent of all foreign-held bonds and a sizeable amount of all U.S. debt (Amadeo 2017). Japan holds the second highest amount of U.S. Treasury debt with about $1.1 trillion. Although China has publicly denied that it might curb its purchases of U.S. government bonds, investors expressed concern in early January 2018 (Shell 2018). Bloomberg News reported that unnamed sources indicated China was considering slowing or stopping the purchase of U.S. Treasury securities. The State Administration of Foreign Exchange (SAFE) said that Bloomberg News "cited a wrong source, or could be fake news" (Yu 2018). The Bloomberg report indicated that other investments were becoming more attractive than U.S. bonds, according to the source. Japan has also indicated that it will reduce purchases of U.S. Treasury securities at the same time the Fed is curtailing purchases, allowing maturing debt to mature, rather than rolling it over. All of these factors could put substantial upward pressure on U.S. interest rates and increase borrowing rates not just for the U.S. Treasury but for other borrowers as well. Whether China said or did not say it would reduce purchases does not change the fact that its vast holdings of U.S. debt, trade tensions between the countries, and China's desire to replace the dollar as the de facto international currency, all have important implications for the future of bond markets.

The average maturity of Treasury securities outstanding as of January 2018 was 68.81 months, near its highest level since the financial crisis of 2007–2008 and well above the 30-year, 1980–2010 average of 58.1 months (U.S. Department of the Treasury 2018). Interest on U.S. debt is expected to be $280 billion in 2018 (Economist 2017a). In May 2017, the U.S. Treasury suggested the possibility of floating 40-, 50-, and 100-year bonds. Many countries have begun issuing very long-term bonds including the United Kingdom and Canada (50-year) and Mexico and Belgium (100-year). The idea is to lock in a lower borrowing cost for the long-term. However, demand for long-term issues is questionable and the government may not benefit if short-term rates stay below long-term rates. Rolling over short-term debt would be cheaper in that case. Rates on these bonds would have to be high enough to compensate investors for inflation and government debt risks. Economists surveyed by the Treasury to assess demand for these securities and potential maturity risk premiums, indicated about 30 basis points in additional return for 40-year bonds, relative to 30-year, about 50 additional basis points for the 50-year relative to the 30-year, and nearly a 100 additional basis points for the 100-year relative to the 30-year bond. The longest term bond was unpopular with economists, with about 60 percent indicating weak potential demand for a 100-year Treasury bond. President Donald Trump's Secretary of the Treasury Steven Mnuchin has indicated that he is open to longer maturities, so that may be a trend going forward into the 2020s.

Sovereign and Emerging Market Debt

Leading up to the financial crisis of 2007–2008, international balance sheets of emerging economies improved from 1999 to 2007. The improvement stemmed from various sources including current account surpluses, a shift from debt financing to equity financing, and an increase in the stockpiles of liquid foreign reserves. However, since 2010, several factors have led to a partial reversal of this trend. The major trend in sovereign debt, both in developed and emerging economies, over the decade following the financial crisis, is rising debt loads relative to GDP, coupled with increasing risk. The debt crisis in the Eurozone and the resulting "bail-in" of Greek debtors, including depositors in Greek banks, was a watershed moment. A *bail-in* occurs when lenders, such as bond holders or depositors, are forced to bear some of the costs typically borne first by shareholders (Khan 2015). A wave of debt restructurings by developed and developing countries in the years following the financial crisis has occurred. In 2012, Greece had the largest sovereign debt restructuring in history (Forni, Palomba, Pereira, and Richmond 2016). The issue of whether restructurings are beneficial or costly for the debtor country is ambiguous. The authors suggest that while restructuring debt can lead to reputational loss, higher spreads, and exclusion from capital markets, restructurings can actually support growth by reducing overall debt payments.

Many sovereigns have endured a loss of their practically risk-free status (Bank for International Settlements Conference on Sovereign Risk 2013). In a Bank for International Settlements (BIS) conference on sovereign risks, conference participants acknowledged the risks to the global economy associated with rising sovereign risks. With aging populations and sovereign promises of future healthcare and retirement funds, governments should be hesitant to continue to dramatically increase sovereign debt levels. Additionally, an appreciating dollar increases the value of dollar-denominated debt, increasing the burden to many borrowers. This situation has already occurred in emerging markets. The concern about rising debt costs for countries is both real and exacerbated by the end or at least slowing down of quantitative easing. In a move that surprised financial markets in mid-January, 2018, Japan reduced bond purchases by 5 percent (Kruger 2018).The private sector must now absorb what the Federal Reserve, the European Central Bank, and others are no longer purchasing.

Another trend in foreign markets that has emerged following the financial crisis of 2007–2008 is that of corporations, not just governments, borrowing in foreign markets. Since the financial crisis, increased international borrowings of large corporates are increasing in emerging economies. Over the past decade, the share of international debt as a proportion of total debt has ballooned, driven primarily by large, non-financial corporate borrowers. Additionally, these emerging economy corporate borrowers often play the role of financial intermediary but evade regulatory oversight. This situation poses a risk to both domestic banking systems and the broader economy (Acharya, Cecchetti, De Gregorio, Kalemli-Özcan, Lane, and Panizza 2015).

One factor that may affect the future of sovereign debt markets, specifically emerging markets, is the continued concern emerging market governments have with traditional bond rating agencies such as Moody's, Fitch, and S&P Global Ratings (formerly Standard and Poor's, S&P) (*Economist* 2017b). Emerging market borrowers contend that rating agencies unfairly rate their debt. For example, India, a country that has a relatively flat debt-to-GDP ratio and steady economic growth, has its debt rated at BBB–, while China, with slowing growth and an escalating debt-to-GDP ratio has a rating of AA–, upgraded from A+ in 2010. Rating agencies contend that developed countries such as the U.S. have a long history of debt repayments, 100+ years, to support the higher ratings. But rating agencies are quicker to downgrade emerging market borrowers, increasing the risk of another global financial crisis. Ferri, Liu, and Stiglitz (1999) examined the Asian financial crisis in 1997 and found that rating agencies fostered panic and contagion in the early stages of the crisis with ratings downgrades. As a result of this perceived (and perhaps true) unfairness toward emerging market borrowers, the BRICS (Brazil, Russia, India, China, and South Africa) countries plan to establish an independent rating agency (Economist 2017b). However, many investors are likely to view the newly established rating agency with skepticism. This situation may only exacerbate the feeling of unfairness felt by these borrowers.

In conclusion, the future of sovereign debt is about how countries are likely to emerge from this period of prolonged weakness, increasing debt levels, and heightened risk that followed the financial crisis, combined with a period of unprecedented easing by the world's central banks. Also, emerging economies with poor economic fundamentals and deep financial markets are likely to feel the greatest impact from Fed tightening. The impact of changing monetary policy may be experienced in terms of both price (higher interest rates) and quantity (less funding available in global markets).

Municipal Bonds

By the end of 2016, the municipal bond market had grown to $3.83 trillion, up from a mere $130 billion in 1980 (Frey 2017). A range of factors from tax reform to hurricanes and other natural disasters affects this market. Natural disasters can impair a municipality's ability to make interest and principal payments. For example, concerns exist about Puerto Rico's debt in the wake of Hurricane Maria in fall 2017.

Three trends should be watched in 2018 and beyond. First, how will tax reform affect municipal bond issuers and investors? The implications of the 2017 tax overhaul require time to assess. Second, like all credit markets, what impact will Fed policy have on municipal bond markets? Additionally, what is the effect of having a new Fed chair, Jerome Powell? Despite voting in line with Fed Chairperson Janet Yellen on most issues during her term, some are concerned that Powell will be a less "dovish" leader than Chairperson Yellen. Finally, what will municipal bond market investors learn from the Puerto Rico disaster? What will this disaster mean for general obligation creditors in terms of when they get paid or revenue bonds that have first claims to tax receipts? These factors are important to the future of municipal bonds both in the short term and going forward.

Mortgage-Backed Securities

From 2013 through 2016, a steady downward trend occurred in the issuance of residential mortgage-backed securities (RMBSs) (Ramirez 2017). The global securitized market was nearly $10 trillion in 2017 with the U.S. comprising about 86 percent of the total market (Morgan Stanley Investment Management Securitized Team 2017). *Loan securitizations* occur when banks pool assets, such as residential mortgages or car loans, and sell the associated cash flows (e.g., principal and interest payments) to investors as securities. In 2006, nearly $1.3 trillion of non-government agency RMBSs was issued compared with about $30 billion in 2016.

Several factors contributed to the decline in mortgage loan securitizations. First, low interest rates made loan securitization unappealing for many banks and mortgage lenders. Also, bank balance sheets were strong, allowing banks to hold the loans on their balance sheets rather than sell them. Finally, Fannie Mae and Freddie Mac dominated issuances. However, with rising rates forecasted for 2018 and 2019, the future looks brighter for loan securitizations. Some banks may try to sell the fixed rate mortgages on their books to take advantage of rising rates. As interest rates rise, prepayments should also slow down as individuals become less inclined to refinance mortgages or sell houses that have locked in, historically low long-term interest rates. The Fed, in its scale back of quantitative easing, is likely to reduce its purchases of RMBSs. All these factors might affect the loan securitization market in the future.

The Morgan Stanley Investment Management Securitized Team (2017) sees many investment opportunities in asset-backed securities from 2018 and beyond but cautions investors to understand the risks and do a "deep dive" into the rewards and risks of every bond. This advice means conducting loan-level analysis along with collateral analysis to make informed decisions. In the late 2010s, the outlook is for more issuances in RMBS and potentially more investor interest.

Corporate Bonds

The corporate bond market is a $50 trillion global market. In the United States alone, $1.5 trillion of corporate bonds were issued in 2016 (Economist 2017c). For comparison, the United States had approximately $6 trillion of non-financial corporate debt outstanding in the third quarter of 2017. Corporations, both financial and non-financial, have raised large amounts of capital in credit markets, in advance of expected rising rates. Raising debt capital by corporates does not, in many cases, appear to be for any specific need or project, but is simply a matter of shoring up capital while rates are low. For example, the day after borrowing costs on investment grade bonds fell to their lowest levels in nearly a decade, Goldman Sachs, borrowed another $7 billion in a "red-hot" primary market (Duncan 2017). Financial firms accounted for about half of the investment-grade corporate bond issues in 2017. Banks are using bonds to meet total loss-absorbing capital (TLAC) requirements. Partly as a result phasing in the new regulatory capital requirements, banks are likely to continue to issue debt. However, as the world looks for interest rates to increase, both in the United States and abroad, bond issues by banks such as Goldman Sachs do not appear to have the objective of satisfying regulatory requirements. Instead, these issues seem focused on taking advantage of favorable market conditions (i.e., cheap funds). Duncan contends that a "paper-hungry" investor base appears ready to buy these bonds. *Yield spreads*, yields on non-Treasury bonds relative to the maturity-matched Treasury security, continued to tighten into early 2018. However, the concern going forward is that yield spreads may widen in response to expectations of increasing risk.

More discussion occurred in the press in 2017 of *shorting* bonds and/or the bond market as investors, both individual and institutional, expect rates to rise. Because an inverse relation exists between bond yields and bond prices, bonds generally perform well in falling rate environments and not as well in rising rate environments. *Shorting* an asset means selling it first then repurchasing it at a later date, hopefully at a lower price. The investor can make a profit on falling asset prices as a result. Historically, individual investors had difficulty shorting bonds, but the rise in exchange-traded funds (ETFs) that own bonds has made shorting easier (Brown 2017). Although owning fewer bonds is, for most investors, the best way to avoid losses, for those willing to take the risk, shorting bonds is also a possibility. Several options exist. For individual investors with small accounts, shorting bond ETFs may be difficult. Selling bond futures, another way to profit from declining bond values, may also be out of reach of individual investors because taking speculative positions in futures contracts, either long or short, involves risk, patience, knowledge, and collateral. Another alternative is investing in a bond fund, such as the Guggenheim Inverse Government Long Bond Strategy fund, which is structured to profit from falling bond prices.

Fintech, the use of technology and computer programs to support banking and financial services, is likely to move beyond lending, payments, and wealth management and into less explored areas of banking including financial markets. For example, J.P. Morgan Chase announced that it would spend $9.4 billion annually on technology (Magdelinic 2016).

In contrast to the rise of fintech, most corporate bonds are still traded over the phone (Economist 2017c). Both stocks and derivatives are largely traded electronically but in 2017, 80 percent of bonds are still traded the old-fashioned way. Part of the reason is the uniqueness of bonds. A publicly traded company generally has one type of common stock that trades but may have a multitude of bonds at different rates, maturities, issue dates, seniority and even ratings. About 90 percent of bonds trade fewer than five times per year. As a result, market makers buy and sell in bond markets. Further, this market is a relationship business. Nearly all bond trades, whether electronic or over the phone, take place on "request-for-quote" platforms in which dealers are the only ones authorized to quote buy and sell prices. The problem for investors is that this system is opaque and dealers have much of the power. In the future, however, bond markets are likely to become more transparent. New legal requirements exist that started in Europe that require the reporting of prices on completed transactions. Also, new trading platforms such as MarketAxess allow some market participants to trade directly with each other, bypassing dealers.

The role of the maturity structure of a firm's debt has implications for the future, according to at least two studies. Choi, Hackbarth, and Zechner (2017) find that the maturity structure of a firm's debt is an important, but often ignored, dimension of the firm's capital structure. The authors maintain that firm characteristics and rollover risk drive the maturity structure of the outstanding debt. The study's two main conclusions are that maturity dispersion increases for firms that must roll over debt. They also find that the pre-existing maturity profile of the firm's debt significantly influences the maturities of newly issued bonds.

Following the financial crisis of 2007–2008, Almeida, Campello, Laranjeira, and Weisbenner (2009) examine the way the crisis affected investment decisions. The authors investigate if firms had substantial amounts of long-term debt maturing in 2008 that influences their investment decisions. The authors wanted to see how financial contracting affected real corporate behavior in terms of spending and investing. The results show that firms that had to refinance during the crisis had a greater decline in investments relative to those firms that did not have to refinance a large percentage of debt. Firms whose long-term debt was largely maturing after the start of the crisis (i.e., the third quarter of 2007) reduced investments by 2.5 percent quarterly, relative to firms whose long-term debt matured well after 2008. These studies are relevant to the future of bond markets in that they help to explain what may happen when the next financial crisis occurs.

Exotic Bonds

A growing interest has emerged in what has been termed "exotic" bonds. A "plain vanilla" bond, such as a U.S. Treasury bond, pays a fixed interest payment to bond holders over a bond's life and then returns the bond's principal to whomever holds the bond at maturity. Exotic bonds have payments tied to various events. These newer bonds have nonstandard payments tied to events such as a country's GDP or natural disasters including floods or hurricanes. Investors express an increased interest in these bonds as they search for higher yields than can be earned on Treasury bonds (Levitt 2015).

Fallen angel bonds are bonds once rated as investment grade (i.e., BBB or above using S&P's rating system) but have been downgraded by rating agencies to junk bond status (i.e., BB and below). Factors such as industry slowdowns or crises (e.g., the banking industry during the financial crisis of 2007–2008), increasing debt levels and/or weakening balance sheets, reduced cash flows, and other factors may cause a firm to see a ratings downgrade. Companies that once had investment grade debt that has been downgraded often have better prospects for repaying the debt than those firms that originally issued speculative grade debt. This relation means investors may be able to earn higher yields associated with junk bond ratings but potentially not bear a substantial amount of increased risk.

Crossover bonds straddle the rating spectrum between speculative and investment grade: at the lowest investment grade rating and the highest speculative grade rating (i.e., in the BBB+ to BB– range) (Arif and Brownell 2017). This gray zone, often called the "sweet spot" of the corporate bond market, allows investors to earn some extra yield without much additional risk. Also, these bonds have a lower correlation with Treasury securities than pure investment grade bonds. Historically, crossover bonds outperformed investment grade bonds on both a risk-adjusted and absolute basis. These bonds also exhibited lower credit risk versus the broader high-yield universe of bonds.

An increased demand for catastrophe bonds is occurring (Scism and Das 2017). *Catastrophe (cat) bonds*, created in the mid-1990s following Hurricane Andrew and the Northridge earthquake, allow insurers and reinsurers to share the risk of natural disasters with investors. Investors provide capital to insurers and share in the risks in the event of a natural disaster. Cat bonds allow insurers to cover losses and rely less on *reinsurance* (i.e., paying another insurance company to share in the losses in the event of a disaster). Investors may earn the promised returns on the bond assuming no stated disaster occurs or may lose some or all of their principal and interest payments if a disaster occurs. Principal and interest are held in escrow and are typically invested in Treasury bonds. Cat bonds are complex and better suited for sophisticated investors. Due to higher yields, the bonds have become more popular over time with pension funds, endowments, and wealthy families. Catastrophic events such as Hurricanes Irma, Harvey, and Maria, as well as an 8.1-magnitude earthquake in Mexico in 2017, may cause investors to rethink the risks inherent in these bonds. The period of increased investment in cat bonds mirrored a period of relative calm in terms of natural disasters. The question arises: Will investors leave the market or demand higher yields for perceived higher risks, given a rash of catastrophes? Based on 2017 disasters, the expectation is little impact is likely to occur on the payouts of these bonds. In the 12 months leading to June 2017, various entities issued a record $11.3 billion of new cat bonds. The market for cat bonds and other alternative reinsurance investments is about $90 billion.

A key concern of policymakers in today's credit markets is the increase in the ratios of public debt to GDP in countries across the globe. Some analysts maintain that another big shock, such as the financial crisis of 2007–2008, could tip the balance and lead to unsustainable debt ratios. One possible security that could potentially stabilize the situation is GDP-linked sovereign bonds (Blanchard, Mauro, and Acalin 2016). *GDP-linked bonds* are bonds that pay returns that vary based on a country's GDP. Returns may be linked to nominal GDP, real GDP, or a combination of both. Interest payments are indexed to growth, so governments can pay less when growth is low and more when growth improves.

GDP-linked securities have advantages not only to investors, but also to society as a whole. Shiller (1993) proposed the idea of creating "macro markets" that would have claims on a fraction of a country's GDP. Interest in growth-linked bonds generally re-emerges after financial crises when debt-to-GDP ratios soar. The bonds have been issued before but only as part of government debt restructuring including Bulgaria in 1994, Argentina in 2005, Greece in 2012, and Ukraine in 2015. No government in an advanced economy has issued these bonds as part of general funding but a renewed interest exists that this is the time, before the next crisis occurs. Investors would benefit in terms of diversification. Also, in the most recent crisis, debt-to-GDP ballooned across the globe contemporaneously with yields decreasing. In many cases, bond holders earned negative inflation-adjusted returns. These bonds would have a greater variability of payouts, possibly protecting investors against negative inflation-adjusted returns. Whether advanced economies are likely to adopt these bonds remains to be seen. Yet, increasing support arises from many fronts to issue these bonds.

Consumer Debt

Consumer debt encompasses mortgage debt, auto loan debt, credit card debt, and student debt. All of these categories have been increasing since the financial crisis of 2007–2008. According to the Federal Reserve Bank of New York (FRBNY), total consumer debt reached $12.58 trillion at the end of 2016 and crossed the $13 trillion mark in 2017 (Friedman 2017b). Non-housing debt topped $3.5 trillion in the first quarter of 2017. Total household debt loads are nearing 2008 levels, when household debt peaked at $12.68 trillion. Increases in non-housing debt are primarily driving the economic rebound (Vasel 2017). The FRBNY expects household debt to reach if not surpass its 2008 peak in 2017. Although potentially alarming, one positive difference is fewer delinquencies between 2008 and 2017. In the third quarter of 2008, the delinquency rate on all household debt was 8.5 percent. In the fourth quarter of 2016, the rate was only 4.8 percent. Of the various consumer debt categories, student debt has seen the greatest growth and engendered the most attention in the last decade.

Student Loan Debt

Student debt continues to rise each year and is now the second highest category of consumer debt after mortgage debt. Student debt is now greater than all U.S. credit card debt. The statistics are staggering—nearly $1.5 trillion of student debt exists in the United States alone, up from $1.3 trillion in the fourth quarter of 2016. This total is more than $620 billion more than total U.S. credit card debt (Student Loan Hero 2018). The largest holder of this debt is the government (i.e., primarily the Department of Education) with a student loan portfolio of about $1.25 trillion (Foroohar 2017). By comparison, the size of all subprime mortgage debt in 2007 was $1.3 trillion (Marquit 2017). More than 44 million borrowers currently exist. In a shocking statistic, the average class of 2016 graduate owes $37,172 in loans (Friedman 2017a). The average student loan debt per capita in the United States is $4,920, which is approaching one tenth of the per capita U.S. national debt, currently at $60,000 per person. According to the Fed, an 11.2 percent 90-plus day delinquency rate exists on student loans. According to the FRBNY, student debt has experienced the largest increase in non-housing consumer credit debt balances between 2004 and 2017. Since 2007, student debt grew 170 percent. Also, the cost of college continues to grow, which exacerbates the problem. Published tuition increases were, on average, 9 percent at state schools and 13 percent at private schools in 2016 and 2017. At the same time the consumer price index averaged a 2.7 percent increase (Foroohar 2017).

One concern is whether the student debt crisis is the next financial bubble to burst. Again, the amount of student debt now exceeds that of subprime mortgage debt leading into the financial crisis of 2007–2008. Many reasons exist to think that this ballooning problem may cause the next crisis. Students are encouraged to attend college out of high school. Many cannot afford it and loans are relatively easy to obtain (Marquit 2017). In early 2017, more than 11 percent of all student debt was delinquent (90-plus days) and 8 million borrowers were in default. That means that delinquencies existed on more than $150 billion of debt. Student debt is also rising at a time when wages are stagnating, which increases the difficulty of repaying the debt. If default rates increase, then student debt could be the next crisis.

Broader implications exist for the economy regardless of whether student debt is the next bubble. Growing student debt levels have been linked to millennials delaying major financial milestones such as home ownership (Marquit 2017). William Dudley, Chairman of the FRBNY, called it a headwind to stronger consumer spending (Foroohar 2017). Student debt has been linked to decreased rates of first-time homeownership, and as millennials rent longer, rising rental rates. Student debt is also linked to slower purchases of "white goods," all the durable goods that fill homes such as refrigerators and dishwashers. Student debt payments are consuming a greater portion of millennial incomes. Also, evidence suggests that millennials are less engaged in entrepreneurship than previous generations, according to the Small Business Administration (Foroohar 2017). With debt, one is less likely to undertake the risk of starting a business and more likely to accept a traditional job to pay the bills. The financial pressures have other consequences. Students with debt are postponing marriage and families and established links exist between student debt rates and depression. The financial strains facing an entire generation are likely to hurt the economy as a whole as these citizens are less able to spend and support the economy.

The problem affects not only millennials but also people of all ages. According to a report from the Government Accountability Office (GAO), the government is garnishing a greater number of Social Security checks to pay for government student loans, in some cases for loans for their children, but in other cases for baby boomers who have not yet paid off their own student loans (Farber 2016). Banks and other private sector lenders underwrote most student loans before 2007. However, student debt has since been funded largely through the federal government. In 2017, the Department of Education wrote 90 percent of new loans (Foroohar 2017). This fact is important because individuals cannot declare bankruptcy on student debt as is possible for mortgage, auto loan, or credit card debt. The government also has wide reaching authority to collect its debts. This means that the government is now going after debt repayment in places relatively unheard of before 2007, such as garnishing Social Security checks.

However, rather than a balloon ready to burst, one economist likened the student debt problem as more like a leaky balloon (Marquit 2017). Because one cannot simply declare bankruptcy and walk away from student debt, this situation decreases the likelihood of a major crash like the one experienced with subprime mortgage debt. Students are more likely to see their wages garnished, so again, instead of a bursting bubble, the effect is clearly negative but more prolonged. In terms of the future, Marquit (2017) suggests that Generation Z is considering community colleges and the affordability of college in ways that previous generations have not. However, if the government continues to shrink its support of higher education and tuitions continue to escalate, this credit market is likely to continue to pose a threat to the well-being of many, and the economy as a whole.

Some schools, notably Purdue University, are trying a novel approach to address the student debt problem. The university is trying a concept called *income share agreements* (Lobosco 2016). According to Mitch Daniels, the president of Purdue University and the former governor of Indiana, students sign a contract with an investor that gives the investor the right to a fixed, agreed-upon percentage of the student's income after college in exchange for the funds to attend college. In essence, the student is selling "equity" to raise the funds for school rather than borrowing. According to a report by the Center on Education and the Workforce (CEW), the choice of a major greatly affects one's employment and earnings prospects (Carnevale, Cheah and Strohl 2012). A criticism from some fronts is that students are borrowing large amounts of money for nonmarketable degrees, because they are choosing majors such as anthropology or archeology, which face low demand and earning power, according to the CEW study. Additionally, third- or fourth-tier universities or for-profit universities are often associated with high debt and low job prospects. According to Daniels, if an electrical engineer can sign a contract promising a lower percentage of earnings for a lesser number of years than someone choosing a less marketable degree, this situation provides information to the marketplace and, as some students and majors are better able to pay than others, the terms of the agreements are likely to shift.

In sum, the size of U.S. student debt is alarming and no indication exists that higher education costs are going to level off. The possibility of the bubble bursting in the way the housing market bubble burst is unlikely. However, real concerns exist for both the economy and borrowers. Fortunately, some are looking for alternative solutions to deal with these developing dilemmas.

Credit Card Debt

Credit card debt, similar to student debt, has been steadily increasing month-over-month in the United States, after a first quarter 2017 pay-down of $30.5 billion. According to one study, 2016 ended with $87.2 billion in new debt, the highest increase since 2007 and $50 billion of new credit card debt is expected in 2017. Total U.S. credit card debt hit $1.02 trillion for the first time in history, according to the Federal Reserve (Comoreanu 2017). Credit card banks have enticed borrowers with greater rewards. For example, some reward cards give cash back or airline miles. Teaser rates, often 0 percent, are offered and then rates rise to 15 to 20 percent after the first year. Also, large money center banks that offer credit cards have been able to earn higher rates of return on assets than other banks in a period of prolonged low interest rates.

Another trend in credit card debt is using credit cards to buy cryptocurrencies such as bitcoin. According to Morris (2018), nearly one-fifth of bitcoin buyers are using credit cards, and most of these individuals carry a balance on their cards. In the survey, those who did not pay off their balances each month indicated they plan to pay them off with bitcoin sales (i.e., bitcoin profits). Additionally, the cryptocurrency marketplace often charges hefty fees for purchases made with credit cards. For example, Coinbase charges a 4 percent transaction fee on credit card purchases. Many find this trend disturbing. Also, the value of one bitcoin has dropped to about $8,600 as of mid-March 2018, and is down more than 50 percent from its high of about $20,000 per coin in December 2017. For the person who used a credit card to purchase a $20,000 bitcoin in December 2017, that is very bad news.

Auto Loan Debt

Consistent with all other categories of household debt, auto loan debt is also on the rise. The area of concern for the FRBNY is the amount of subprime auto loans and the rising delinquency rate in the subprime market. An estimated 23 million borrowers hold subprime auto loans according to the FRBNY (Friedman 2017b). A *subprime auto loan* is a loan made to a borrower with a credit score below 620. Of all new auto loans originations, 20 percent are made to subprime borrowers.

Additionally, a Consumer Financial Protection Bureau (CFPB) 2017 report finds a sharp increase in higher risk, longer-term (six year) auto loans. The CFPB indicates that lenders make these longer-term loans to riskier borrowers with lower credit scores, for higher amounts, with higher default rates (Brevoort, Clarkberg, Kambara, and Kelly 2017). According to the report, the longer-term loans accounted for 26 percent of 2009 originations and 42 percent of 2017 originations. The CFPB warns that the rise in these longer-term loans to borrowers with lower credit scores may ultimately pose problems to both borrowers and lenders.

Housing Debt

According to a 2017 report from housing giant Freddie Mac (2017), the agency expects three trends in the housing market. First, it expects mortgage loan volume to increase, primarily driven by new home sales. Second, as interest rates rise, rate refinancing activity is expected to decline. The agency expects the shift away from refinancings to a purchase market to continue into 2018. Third, the agency expects cash-out home equity loans to increase. It sees this trend increasing as homeowners tap the equity in their houses to pay off student loan debt, consolidate debt, and/or make home improvements. In a cash-out home equity loan, the borrower refinances an existing mortgage to one with a higher principal balance to take out cash. As borrowers reduce their refinancings to take advantage of lower interest rates, the share of refinancings that take advantage of cash-out options increases.

Another trend to expect in mortgage lending is a greater move toward automated loans by lenders (Lewis 2017). Rocket Mortgage by Quicken Loans was one of the first to enter this market segment but others are rapidly following. Lenders not only want to automate the borrowing process but they also want to use automation to guide borrowers to loans that best suit their needs. Also on the horizon is tax reform, which takes effect in 2018 and lowers the amount of state and local property taxes that can be deducted for tax purposes to a combined total of $10,000 and itemized interest deductions from $1 million to $750,000 for a married couple filing jointly. This change may affect future home purchases. Finally, rising rates potentially make houses less affordable in the coming years.

Summary and Conclusions

Credit markets, both domestic and global, are massive in scale and scope and affect global economies in both obvious and subtle ways. The key identifiable trend in both U.S. government and household debt markets is one of increasing debt levels and potentially increasing risks. Concerns exist about the sustainability of rising debt to GDP ratios for sovereigns and debt-to-income ratios for households. The fear of a looming financial crisis has analysts looking at potential risk areas. One such area is rising student debt. Many believe it may be the next credit bubble. Rising U.S. government debt and increasing future deficits due to tax reform legislation are also causes for concern. Credit card debt is a harbinger of economic health and can also signal the potential for a meltdown after a period of over-borrowing. U.S. credit card debt continues to increase to pre-financial-crisis levels. Separately, each type of consumer debt is not that alarming. However, when viewed in aggregate, and when considering the growth in each of the consumer debt categories, a real cause for concern exists. Finally, rising interest rates, coming directly from the Federal Reserve, and indirectly from potentially shrinking demand for U.S. debt from foreign investors, is likely to affect borrowers and their ability to pay in the future. Overall, substantial risks appear in both U.S. and global credit markets. The future requires understanding and managing those risks.

Discussion Questions

1. List the primary borrowers in global debt markets.
2. Describe the various types of consumer/household debt.
3. Explain the concept of the "great rotation" and provide one reason the "great rotation" is unlikely to occur.
4. Explain which category of household debt is increasing fastest and provide two reasons this situation concerns financial market participants.

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DISCUSSION QUESTIONS AND ANSWERS (CHAPTERS 2–36)

Chapter 2: Debt Fundamentals and Indices

1. Describe two methods of bond issuance.

Two methods of bond issuance are syndicated offerings and auctions. Syndicated offerings are analogous to an equity security's initial public offering in which a group of banks (syndicate) jointly underwrite a bond issue and market it to their clients. Auctions are more common for federal bond issuance. The banking arm of the government runs these offerings to enable interested investors to submit competitive and noncompetitive bids for an issue.

2. Compare and contrast the risk and return characteristics of bonds relative to equity securities.

Market participants generally view bonds as lower risk and lower reward securities relative to equities. This assessment is largely due to the structure of bond repayment. In a traditional bond, investors can only hope to receive their original principal payment plus interest via the coupons. Market participants also view bonds as safer because defaults, particularly for investment grade borrowers, are rare as most borrowers make their promised repayments. Conversely, traditional equities have higher return potential. The value of a company's assets theoretically has no valuation limit. However, the residual claim of equity holders creates a higher risk associated with future cash flows. The worst-case scenario is that a company goes out of business and equity holders lose their entire investment. Finally, bonds tend to be less liquid than equities and have no voting rights.

3. List three reasons investors would hold bonds in their portfolios.

Investors hold bonds in their portfolios for three major reasons. First, bonds can provide income to meet portfolio cash flow needs. Coupon payments can provide a stable source of income to an investment portfolio. Second, bonds offer capital preservation. The low risk nature of bonds can limit capital losses while earning a sufficient return. Third, bonds can offer diversification to limit portfolio losses in declining equity markets.

4. Identify the credit rating range for investment grade bonds under the Moody's ratings system.

Under Moody's ratings system, investment grade bonds are defined as Aaa to Baa (Triple A to Triple B), which encompasses Aaa (Triple A), Aa (Double A), A and Baa (Triple B). Conversely, a bond rated below Baa (Triple B) is deemed non-investment-grade, speculative, high yield, or a junk bond. This category also includes Ba (Double B), B, Caa (Triple C), Ca (Double C), and C.

5. Discuss the challenges of constructing bond indices.

Constructing bond indices involves several challenges. One challenge is that the investible bond universe is much larger than the investible equity universe of securities. Index makers have more securities from which to choose with bonds to create an index. For example, a company in the S&P 500 index only has one class of outstanding common stock. In contrast, that same company could have many outstanding bond issues with different coupons, maturities, and other factors. Another challenge involves liquidity. Individual bond issues generally have lower market liquidity than stocks, and some issues may not publicly record a trade for several days. This situation of non-synchronous trading creates pricing transparency issues within the index. A final challenge is that a bond's risk profile dynamically changes as a bond approaches maturity. For example, the bond's interest rate sensitivity decreases but reinvestment risk increases as the issuer returns the principal. Therefore, index creators need to adjust their holdings to maintain certain criteria as the characteristics of individual holdings shift.

Chapter 3: Interest Rate Risk, Measurement, and Management

1. Define interest rate risk.

Interest rate risk is the risk that a security or portfolio will suffer losses due to changes in the yield curve. Generally, interest rate risk can be viewed in terms of price risk and reinvestment risk. Price risk considers the change in value of an asset's price whereas reinvestment risk includes the value of income generated by the asset when reinvested.

2. Explain how modified duration and convexity are used to approximate the change in the price of a bond for a given change in interest rates.

Modified duration can be used to provide a first-order approximation to a percentage change in price given a unit change in the yield, assuming a parallel shift in the yield curve across all maturities. Convexity provides a second-order approximation. The negative sign implies that bond prices and yields move inversely. The equation used is as given below:

$$\Delta P = -(\text{modified duration})(\Delta y) + \frac{1}{2}(\text{convexity measure})(\Delta y)^2$$

3. Identify the major financial instruments used in interest rate risk management.

The major financial instruments used in interest rate risk management include, but are not limited to, futures contracts, forward contracts, options, swaps, caps, floors, and collars. Futures and forward contracts lock in prices or interest rates to be used at a future expiration date. Options allow holders to benefit from the upside potential arising from changes in interest rates, while limiting downside losses to the loss of the premium paid for the option. Swaps permit the exchange of cash flows between fixed and floating rate payments. Caps, floors, and collars can all be used to limit losses that arise from unexpected changes in interest rates.

4. Describe the characteristics associated with portfolio immunization, asset-liability management, and gap analysis.

Portfolio immunization seeks to match the duration of asset cash flows with the duration of liability cash flows, so that changes in interest rates change the value of assets and liabilities by the same amount (i.e., the surplus is unchanged). Asset-liability management is more comprehensive, including other risks such as liquidity risk, capital markets risk, foreign exchange rate risk, credit risk, and funding risk, as well as profit planning and growth. Gap analysis examines the interest sensitivity of the gap between asset values and liability values.

Chapter 4: Other Risks Associated with Debt Securities

1. Explain how the seniority rank of debt affects the recovery rate for bond investors in the event of default on a fixed income security.

The seniority ranking of a fixed income security affects the recovery rate for bond investors. Not surprisingly, senior and secured claims have higher recovery rates than junior and subordinated claims. In bankruptcy, the courts typically follow a priority of claims whereby the lowest ranked claims and equity holders may receive nothing. Since the priority of claims is not absolute, the bankruptcy court has some latitude in the ultimate resolution.

2. Explain the effect of an upgrade from A to AA on the bond's credit spread.

When a firm receives an upgrade on its credit rating, the credit agency has determined that the fixed income security is less likely to default than previously thought. This should lead to a narrowing of the credit spread and credit default swap rates. In contrast, a downgrade should result in a widening of the credit spread and credit default swap rates.

3. Discuss the importance of inflation for fixed income investors.

Inflation hurts investors because it lowers a bond's real return. For example, if an investor receives a 6 percent coupon rate and inflation is 5 percent, the investor earns only a 1 percentage point real return. Because a fixed income debt payment does not adjust for inflation, investors earn a lower return than the nominal rate.

4. Explain how including ESG analysis might have helped to identify increased risk at British Petroleum before the Deepwater Horizon accident.

Even before the Deepwater Horizon accident, BP had a long history of major safety problems and egregious violations from OSHA. In 2005, an explosion at BP's Texas refinery killed 15 people and injured more than 180 others. In 2006, BP had a major oil spill in Alaska. Environmental, social and governance (ESG) analysis would have required increased due diligence about employee safety and environmental risks.

Chapter 5: Government Debt

1. Identify the different types of U.S. Treasury securities.

The major types of U.S. Treasury securities are bills, notes, bonds, Treasury inflation-protected securities (TIPS), and floating rate notes (FRNs).

2. Describe two types of auctions used for U.S. Treasury securities.

The two types of auctions used for U.S. Treasury securities involve competitive and noncompetitive bids. In a competitive auction, a bidder specifies an acceptable yield. In a noncompetitive auction, a bidder agrees to accept the discount rate or yield determined at auction and is guaranteed to receive the full amount of the bid.

3. Explain several uses and benefits of U.S. Treasury securities.

Market participants can use Treasuries in various ways including price discovery, portfolio management, hedging risk, position funding, financial speculation, and risk-return optimization. U.S. Treasury securities help to provide investors with information to determine whether to invest or borrow in a particular economy. Various financial products such as futures, options, repos, and cash bonds support Treasury securities. A multitude of products provides investors with additional tools to assist in portfolio management. Through the repo market, investors can borrow Treasury securities at relatively low rates to fund other investment opportunities. Market participants can also use U.S. Treasuries to hedge different positions due to their high correlations with other markets. Additionally, investors can invest and/or trade in Treasury securities to speculate on the direction of interest rates. Finally, market participants consider Treasury securities to be free of default risk, which helps them optimize the risk-return characteristics of their portfolios.

4. List some consequences of governments increasing the debt levels.

Some consequences of increasing government debt include: (1) decreased levels of income and long-term savings, (2) limited capacity to address unexpected events, (3) increased probability of a future financial crisis, and (4) budgetary pressures caused by higher interest costs.

Chapter 6: Municipal Bonds

1. Discuss the circumstances under which an issuer needs to repay municipal bonds.

The circumstances under which an issuer needs to repay municipal bonds vary. General obligation bonds involve a legal obligation to pay. Issuers repay revenue bonds exclusively by dedicated revenues and have no tax-pledge associated with their repayment. Appropriation-backed bonds saddle the issuer with a moral, but not legal, obligation to service the debt.

2. Discuss two ways that municipal debt can be structured.

Municipal bonds can be structured as fixed or variable rate bonds. With fixed rate debt, public officials know exactly what is owed and when each bond matures. By limiting their exposure to fixed rate debt, issuers can plan their budget and would not anticipate any surprises due to spikes in interest rates or other underlying drivers. Although conventional wisdom is that variable rate debt creates substantial risk for municipal issuers, it can also be structured as a hedge. An issuer wanting to take advantage of lower rates without risking the negative budgetary and cash impacts that result from short-term interest rate volatility can issue variable rate debt in an amount that corresponds to its short-term variable rate assets.

3. Explain the benefits of investing in municipal bonds.

Municipal bonds offer several potential benefits. Depending on the investor's tax situation, municipal bonds often yield more on a taxable equivalent basis due to the tax exemption of interest. Municipal bonds tend to be a safe investment with lower average default rates than similarly rated corporate bonds. Additionally, municipal bonds prices do not necessarily correlate with prices on other fixed income securities. For example, traditional bond yields fluctuate based on changes in the taxable yield curve, whereas municipal bonds are priced off the tax-exempt curve and due to their tax-exempt status may be unaffected by changes in the taxable yield curve.

4. Discuss the pros and cons of public-private partnerships.

The main benefit of a public-private partnership (P3) transaction is that a government receives access to private sector expertise, financing, or risk management without giving up total control of the project. The government can typically fire the private sector participant for gross negligence and retain the rights to receive the asset back after a specified period. Because P3s are lucrative for the private sector entity, companies may offer an upfront or ongoing cash payment to the government entity in exchange for the right to be a participant in the P3.

Although the private entity may offer a government cash as part of the P3 transaction, entering into a P3 is rarely a responsible way for governments to raise capital and can be detrimental to taxpayers. If a government entity receives upfront or ongoing payments from a private sector entity, these payments usually necessitate the project generating additional revenue, which often results in higher user fees.

Another potential disadvantage of P3s is that the private entity may not deliver on its construction, financing, or operating responsibilities. In this situation, the government usually retains the right to repossess the project and appoint new private sector entities to complete or maintain the project.

Chapter 7: Corporate Bond Markets

1. Discuss several common types of corporate bonds and their features.

Although most corporate bonds do not have embedded options such as plain vanilla bonds, other corporate bonds do. For example, a callable bond gives the issuer an option to call (i.e., buy back) the bond at a predetermined price based on a call schedule. The call feature effectively creates a price ceiling on the bond price. Another bond with an option feature is a puttable bond. Unlike a callable bond, which gives the issuing firm the right to call the bond, a puttable bond gives the bondholder the right to retire the bond at the put price. The put feature effectively sets a price floor for the bond. Still another corporate bond with an option feature is a convertible bond, which allows the holder to convert the bond to stock at a specified conversion price and ratio.

2. Identify the key relation between a bond's price and the market interest rate.

Interest rate risk occurs when market rates increase and bond prices decrease and vice versa. Moreover, due to convexity, the rate of change in bond prices is asymmetric based on the direction of a rate change. Due to convexity, a decrease in market rates results in a price increase of greater magnitude than the price decrease associated with a rate increase of the same magnitude.

3. Discuss several ways to estimate the change in a bond's price.

A bond's price change can be estimated using duration and convexity. Both terms are similar in that they are used to approximate a bond's price change for a given change in the yield to maturity. The difference is that duration is a linear approximation whereas convexity is a quadratic approximation. Two commonly used measures of duration are Macaulay and modified duration.

4. Describe how to protect a debt obligation's value from interest rate movements.

Immunization is the process of protecting a debt obligation's value from interest rate movements. The key to immunizing a bond portfolio is to set the duration of assets equal to the duration of the liability or obligation to be incurred. The next step is to solve for the optimal weights in which to invest in the assets so that the liability is fully funded.

5. Discuss the importance of credit ratings to firms and investors.

Credit ratings are important to firms because they reflect a firm's ability to repay its debts on time and in full. A high credit rating indicates that a firm has a strong ability to remain solvent. Credit ratings also have implications for capital structure decisions, firm profitability, and corporate investment. Credit ratings are important to investors because they are the channel for transmitting information about a firm's creditworthiness. Investors use credit ratings to determine whether to lend funds to a firm.

Chapter 8: Securitized Debt Markets

1. Discuss the three main characteristics of securitized debt instruments.

Securitized debt instruments generally have three defining characteristics. First, a specific pool of collateral assets supports the payment of interest and principal on the securitized notes. Second, cash flows from the underlying collateral assets are distributed to the securitized debt investors in a predetermined manner where senior investors in the securitized debt are paid before more junior investors. Third, the risk of nonreceipt of promised payments—either interest or principal—on the securitized debt notes is limited to the credit risk of the underlying collateral asset pool and separated from the credit risk of the originator of these assets.

2. Explain the main differences between securitized debt and secured lending.

Although both securitized debt and secured lending are backed by assets that form the collateral supporting the debt, two main differences exist between securitized debt and secured lending. First, payments on the securitized debt notes are made only from the cash flows generated by the collateral assets and no other pool of assets. This situation may not be true for payments that are made on a secured loan, in which a firm may choose to use any available source of funds for servicing its debt. Second, in the case of collateral that backs a securitized debt transaction, investors in the securitized notes have a full claim to the collateral assets in case of any nonpayment of promised interest or principal. This situation may not be true for investors who issue a secured loan as bankruptcy laws may prevent them from making a claim on the collateral assets in the event of nonreceipt of promised interest or principal payments.

3. Describe the importance of a true sale in the context of securitized debt.

A key feature of securitized debt is the legal separation of the assets that support payments on the securitized notes. Such isolation is achieved in the form of a "true sale" of the assets to the special purpose entity (SPE) issuing the securitized notes. A "true sale" is generally understood to be a legal transfer of ownership of the assets to the SPE such that if the seller or originator of the assets encounters financial difficulties or becomes insolvent, a bankruptcy court would acknowledge that the seller no longer owns the assets. In rare instances and in certain jurisdictions, the bankruptcy court could reverse "true sales" under exceptional circumstances, especially if evidence shows that the company in distress transferred the assets to associated "third party" entities with the intent of either reacquiring them in the future or fraudulently shielding them from its creditors. Some could view these types of transfers as being unfair to the company's creditors and reversed in a bankruptcy court.

4. Discuss the importance of liquidity facilities in securitized debt transactions such as asset-backed commercial paper.

Liquidity facilities provide issuers of securitized debt with the necessary funds for managing temporary cash shortfalls and ensuring timely payments of scheduled interest or principal on the securitized notes. The most common reason for the temporary cash shortfall is that the collateral assets may generate cash flows at different frequencies and dates than the payment frequencies and dates on the securitized notes. In the case of asset-backed commercial paper (ABCP), short-term securitized notes are issued to purchase longer-term assets. To repay the outstanding short-term notes at maturity, new short-term notes are continuously issued, which is termed a *commercial paper rollover.* Issuing such notes protects holders of maturing notes against the possibility that the ABCP conduit cannot refinance or rollover its outstanding obligations on time, ABCP conduits have committed liquidity facilities, which can be used for repaying maturing ABCP notes.

5. Explain how cash flow and synthetic CDOs differ from market value CDOs.

For cash flow and synthetic collateralized debt obligations (CDOs), payment of promised interest and principal to the CDO tranches is a function of the credit risk of the underlying collateral assets or reference pool backing the transaction structure. Thus, the level of defaults and recoveries in the underlying collateral or reference pool of assets primarily drives the performance of both cash flow and synthetic CDO tranches. However, the performance of market value CDOs depends on the market valuation of the collateral assets and the ability of collateral managers to engage in profitable trading of the collateral. Market value CDO tranches can experience losses even in the absence of defaults, especially if sudden and substantial declines occur in the valuations of the underlying assets.

Chapter 9: Derivatives Markets

1. Discuss the size of the interest rate derivatives market in both absolute and relative terms using different measures.

The size of the interest rate derivative can be analyzed by using various measures. One measure is the notional amounts outstanding. Accordingly, the global interest rate derivatives market has increased from $50 trillion in 1998 to $416 trillion at the end of the second quarter of 2017. Based on the semiannual survey data maintained by the Bank for International Settlements (BIS), the pace of the growth in the over-the-counter (OTC) interest rates derivatives market has been higher than the rest of the OTC derivatives markets. Furthermore, the composition of the interest rate derivatives market has also changed during this period. The proportion of interest rate derivatives in all OTC derivatives has increased from 62 percent in 1998 to 77 percent in 2017.

This market's massive size can be recognized by comparing these figures to the size of global bond markets or the global output measured by the world gross domestic product (GDP). At the end of 2016, the notional amount of OTC interest rate derivatives outstanding was $368 trillion, which was four times the value of the global bond markets at that time and almost five times the 2016 world GDP.

Some use the gross market value as an alternative measure for the size of OTC interest rate derivatives markets. According to BIS, *gross market value* is defined as the maximum loss that investors would incur if all counterparties failed to meet their obligations and the contracts were replaced at the prevailing market prices. For example, at the end of June 2017, BIS estimated the gross market value of all OTC interest rate derivative contracts to be about $8.5 trillion compared with the notional amount of $416 trillion. This amount indicates that the systemic risk posed by these markets is not as large as what is reflected by the notional amounts. Conversely, gross market values may be influenced more by interest rate volatility and hence can be noisier than notional values.

Another commonly used measure reported by BIS triennially is turnover, which is a measure of new market activity in OTC interest rate derivatives markets. As an approximate measure of liquidity, turnover has increased from $0.2 trillion in 1995 to $2.7 trillion in 2016. The turnover data confirm the higher liquidity of organized exchanges as the turnover in exchange-traded interest rate derivatives has been consistently higher than their OTC counterparts.

2. Identify the key dates for a forward rate agreement (FRA) and discuss their role in its trading mechanism.

An FRA is essentially a forward-starting loan without the exchange of principal. The notional amount is used to compute interest payments. The buyer of an FRA locks in a borrowing rate, protecting against a rise in interest rates. Conversely, the seller who obtains a fixed lending rate receives protection against a fall in interest rates. The life of an FRA has two distinct periods: the waiting period and contract period. The *waiting period* is the period between spot and settlement date while the contract period is between settlement and maturity date. Five key dates characterize an FRA trading mechanism. The first date is the *trade date* on which the FRA contract is negotiated and transacted between the two counterparties. The trade date plus two (T + 2) is called the *spot date* for FRAs in most currencies including U.S. dollars (USD). GBP is a notable exception with T + 0. The *fixing date* is the date on which the reference rate is determined (i.e., the rate to which the FRA rate is compared). This date is two days before the settlement date for contracts in USD, which is in line with the T + 2 value date convention. The contract period starts with the settlement date and ends with the maturity date. The *settlement date* is the date on which the amount of interest is calculated as the difference between the FRA rate and the reference rate as a percentage of the notional amount. The settlement amount is calculated after the fixing date and paid on the settlement date. Finally, the *maturity date* is the date when the notional load expires. Both the waiting period (i.e., the time between the spot and settlement dates) and the contract period can be up to 12 months. The maturity of the reference rate also matches the length of the contract period.

To quote an FRA starts with identifying the settlement and maturity dates in terms of the number of months from the spot date. For example, a 2 × 5 FRA on USD LIBOR implies that the FRA rate and the three-month LIBOR will apply for the three-month period (five minus two) that starts two months from the spot date. This example indicates that the FRA rate is locked on the trade date and the waiting period, which is two months in this example, for the settlement date begins on the spot date. The value of the three-month LIBOR is observed on the fixing date, which is two days before the settlement date. This rate is compared against the FRA rate to compute the settlement sum, which is based on the notional principal amount, difference between the rates, length of the contract period, and day count convention.

3. Discuss the characteristics of the Eurodollar futures contract.

Eurodollar futures are based on a $1 million face-value, three-month maturity Eurodollar time deposits traded on the Chicago Mercantile Exchange (CME). Therefore, the contracts are settled in cash against three-month LIBOR fixed two days before the third Wednesday of the contract expiration month. These contracts mature during the months of March, June, September, or December, extending outward 10 years into the future. Additionally, the exchange offers contracts in the nearby four months that do not fall into the March quarterly cycle, resulting in a total of 44 contracts.

These contracts are quoted in terms of an index that is equal to 100 less the implied yield on the annualized three-month LIBOR level at the termination date. For example, if a trader expects the underlying three-month LIBOR to be 2 percent, the trader would quote the futures price as 98 (100 minus 2). These contracts are marked-to-market daily and the value of the contract can fluctuate by a minimum of one basis point. This change in the futures price translates into a $25 gain/loss in the value of a single contract (i.e., $1 million × 0.01 percent × 90/360). For example, a long position in one Eurodollar futures contract would lose $250 if the quoted price falls by 10 basis points from 98.2 to 98.1 in one day.

A notable feature of these contracts is the availability of multiple expiry dates at any given time and how far they extend into the future. For example, in January 2018 a trader can use Eurodollar futures to speculate on the three-month LIBOR in February 2018 or hedge against the three-month LIBOR in December 2027. The ability to hedge with such a long-range contract creates substantial versatility. Not surprisingly, many traders consider Eurodollar futures to be the best hedging vehicle for a wide range of situations.

4. Discuss the main features of a credit default swap (CDS).

A *CDS* is a swap that allows the transfer of credit exposure of a fixed income product between two or more parties. It is essentially insurance against nonpayment or the risk of a default by a corporate, municipal, mortgage-backed security, or sovereign debt issuer.

The issuer is known as the *reference entity* and its default is considered a credit event. Under the contract, a CDS buyer is compensated for any loss resulting from a credit event in a reference instrument. The total face value of the bonds that can be sold is known as the *notional principal* of the CDS. In return, the CDS buyer makes periodic payments to the seller until the end of the CDS's life or until a credit event occurs. The total amount paid per year is computed as a percent of the notional principal and is called the *CDS spread*. Typically, payments are made quarterly and the day count convention is actual/360. From the seller's perspective, a CDS provides a source of profits if no credit events occur. If the reference entity does not default during the life of the CDS, nothing is received in return. If the reference entity defaults, the seller of the CDS pays the buyer the difference between the principal and the current market value for the bonds.

Chapter 10: Short-Term Funding and Financing Alternatives

1. Explain why letters of credit are primarily used within international trade.

Letters of credit (LC) allow parties from different countries to engage in business transactions without prior dealings or proof of a creditworthy track record. The LC financing structure mitigates the credit risk inherent in new business relations, as well as the potential legal and political risks associated with cross-border transactions. Standby LCs are often used as a form of insurance against failure to complete an agreement, which is a major risk among unfamiliar business counterparties.

2. Explain how collateral risk and counterparty risk can change over the life of a repurchase agreement.

When a repo is initiated, the level of collateral risk depends on the quality and value of collateral provided by the borrower, and the counterparty risk is linked to the borrower's creditworthiness. The borrower is required to repurchase the collateralized securities at maturity in accordance with the repurchase agreement, and therefore the rate of borrowing at repo initiation is based on the risk assessment at that time. The *haircut*, or difference between the collateral value and the loan amount, is also based on the lender's perceived uncertainty regarding the collateral's market value over the life of the repurchase agreement. The greater the uncertainty in the collateral's value, the larger the haircut required by the lender at initiation.

Over the life of the repurchase agreement, unforeseen circumstances may occur that negatively impact the credit of the borrower and increase the *counterparty risk*, which is the risk that the borrower may not fulfill the agreement. A decrease in counterparty risk could result from an improvement in the borrower's credit rating after establishing the repurchase agreement. Also, the valuation of securities held as collateral may increase or decrease during the agreement, resulting in a decrease or increase, respectively, in collateral risk. Monitoring collateral risk over the life of a repurchase agreement would involve routine revaluation of the collateralized securities.

3. Discuss three key differences between traditional bank financing and accounts receivable financing.

Several differences exist between traditional bank financing and accounts receivable financing. The first difference involves the number of parties involved in each process. Traditional bank financing is bilateral, involving the lender (bank) and the borrower. Factoring financings involve three parties: the lender (factor), borrower (seller of goods), and debtor (buyer of goods who is obligated to pay the factored invoice). Second, factoring can be structured as non-recourse, off-balance-sheet debt, whereas a traditional bank loan is accounted for as a liability on the borrower's financial statements. Third, due diligence in traditional bank financing focuses on a borrower's creditworthiness. However, factors focus primarily on the creditworthiness of a borrower's customers because the invoices being purchased are repayment obligations of the customers. In effect, the credit analysis is "passed through" to the customers.

4. Explain why a lender should size a borrower's revolving credit facility properly.

Lenders should size a borrower's credit facility properly to ensure adequate liquidity for the borrower and a maximum return on the bank's own invested capital. When a bank extends revolving credit to a borrower, it commits its own funds in an amount equal to the facility's limit. This opportunity cost can reduce the return on capital to the lender if unused. Because borrowers can draw down on the line as needed, the borrower's interest costs and the lender's interest income will fluctuate. Therefore, banks sometimes encounter periods where their committed capital might earn a sub-optimal return when considering their own borrowing costs and opportunity costs (foregone interest earnings).

Chapter 11: Private Debt Markets

1. Discuss why a company might borrow from the syndicated loan market rather than from a bank.

A company might borrow from the syndicated loan market for several reasons. First, the company may be unable to obtain a bank loan due to a lack of trading history, lack of security, or poor credit quality. The syndicated loan market includes lenders that are willing to invest in loans such as term loans, mezzanine loans, and payment-in-kind loans to lower credit quality companies, younger companies, or companies with fewer tangible assets. Second, a company may already have bank debt and want to borrow additional funds to finance productive activities. Again, subordinated loan investors invest in such loans trading off security (lower priority behind bank debt) for a higher yield. Third, the company's owners may want to manage or preserve current cash flow during a period of operational restructuring. For example, a private equity owner might use debt and equity to acquire a company but need to defer interest payments for several years until new products are launched or production processes improved. A payment-in-kind loan, covenant-lite loan, or unitranche loan provides the company with flexibility over short-term cash flow while being able to pay interest and the loan in the future, once the company has increased revenue and earnings.

2. Explain why companies are motivated to issue private versus public debt.

The choice of firms borrowing privately is primarily influenced by the credit quality of the issuance firm, which is driven by the borrower's information environment. Firms with the highest (lowest) credit quality chose to borrow from public (non-bank private) sources, whereas firms with medium credit quality source the financing from banks. Evidence from empirical studies is largely supportive of the theoretical literature on information asymmetry, borrower reputation, and efficient renegotiation. Furthermore, empirical evidence shows that the source of non-bank private debt plays an important role in complementing other public sources of borrowing by accommodating firms with low credit quality.
The theoretical literature hypothesizes that "arm's-length" investors are not as efficient and effective as banks and other private lenders in monitoring loan performance. This view implies that firms with higher information asymmetry would prioritize private debts. Having a diverse array of debtholders monitor a borrower with higher levels of information asymmetry is inefficient. This problem arises because individual debtholders do not have a strong incentive to properly monitor the borrower. Therefore, private debt is more appropriate for informationally problematic firms given that debtholders are more concentrated and therefore have a strong incentive to incur costly monitoring

expenses. In short, borrowers shift from private to public debt as the information environment and company reputation improve.

3. Discuss whether a private debt investor is better off buying and holding a primary issuance or a secondary issuance.

Primary issuances are more likely to be of higher quality because the original lender of the loan probably conducts due diligence and would only fund higher quality private companies. Conversely, sale prices of secondary issuances can be abnormally depressed from adverse selection and seller illiquidity. Thus, the returns from secondary purchases should be different from buying and holding primary issuances. Empirical studies from large samples of private loans are more likely to exhibit superior risk-adjusted returns based on internal rate of return and return on investment in secondary transaction strategies relative to primary issuances, even after controlling for country and industry factors, legal and economic system, and size and age of credit markets.

4. Discuss why institutional investors such as pension funds, foundations, and endowments allocate capital to private debt investments such as syndicated loans and direct lending.

Pension funds, foundations, endowments, and other fiduciaries of capital are charged with managing an organization's assets solely in the interests of participants and beneficiaries. In terms of investments, fiduciaries must act "prudently," investing assets to maximize risk-adjusted returns and avoid conflicts of interest. The case for investing in private debt such as syndicated loans and direct lending is based on empirical evidence that the return to a fixed income portfolio can be enhanced and risk reduced by investing in "less liquid" loans in the private debt market. In particular, investment in private debt provides diversification of interest rate risk, credit risk, and liquidity risk.

Specialist intermediaries tend to originate, structure, and syndicate private debt investments. These intermediaries then present a loan or pool of loans in a standardized investment vehicle for institutional investors. Originating a borrower/loan, undertaking due diligence on the borrower and determining credit quality, negotiating terms and conditions, financing, monitoring, and managing the loan including the potential for renegotiation in the case of default are specialized skills not typically located within an institutional investor. If an investor has a global fixed income portfolio, investing in private debt becomes more complicated by incorporating additional factors such as legal and tax systems, creditor rights, business culture, and foreign currency. Institutional investors choose to "outsource" many of these tasks to private debt managers, collateralized loan obligation fund managers, or investment banks and concentrate investment decisions, with the help of investment consultants, on the investment merits of the products presented by these intermediaries.

A more recent trend in private debt markets, like many other alternative assets, is for larger institutional investors such as pension funds and sovereign wealth funds to be more active in the origination and due diligence process. This development can be accomplished through co-investing with a private debt fund in a loan or directly sourcing and evaluating loans on their own account. These organizations have made a broader strategic decision to manage a portion of their capital in-house and to build internal investment teams with requisite deal-making and investment evaluation skills. For example, pension funds in Canada, Australia, and the Netherlands often partner with private debt managers at the start of the loan due diligence process and contribute to structuring the loan. Smaller pension funds, foundations, and endowments are unlikely to emulate larger pension funds and implement a "direct investment" model given their smaller scale and more limited financial and human resources.

Chapter 12: Yield Curves, Swap Curves, and Term Structure of Interest Rates

1. Explain the meaning of the term arbitrage-free yield curve.

In the most general terms, the arbitrage-free yield curve is designed such that a price of any bond derived from the curve will be an arbitrage-free price. Consider, for example, a yield curve that corresponds to discount factors that do not decrease with maturity (i.e., $Z(T_1) < Z(T_2)$ for $T_1 < T_2$). An investor can buy a zero coupon bond that matures at T_1, sell the bond that matures at T_2, and pocket the profit. At T_1 the investor receives the principal of one unit of currency from the matured first bond, and at T_2 pays that same one unit to the holder of the matured second bond. This situation is a pure arbitrage transaction because the trade guarantees profit with absolute certainly. Thus, such a curve is not arbitrage-free.

2. Explain the difference between equilibrium and market curves.

Equilibrium yield curves reflect an unobservable equilibrium state of the given market under the assumption that the observed prices of the modeled securities are the arbitrage-free prices perturbed by the finite effects of liquidity, local supply-demand imbalances, transaction costs, and other factors. The curves are built using only the subset of securities that are assumed to have minimal deviation from arbitrage-free prices. The market curves are built to recover the prices of all securities in a given market such as a swap curve that reproduces the par rates of the swaps of all traded maturities. Thus, they are built under the assumption that all observed security prices are arbitrage-free.

3. Discuss why duration is an inappropriate measure of interest rate risk for interest rate swaps.

Duration is the percentage change of a security's price for a given percentage change in interest rates. Since swaps are bilateral trades and can have a price of zero, duration is no longer mathematically well-defined. The resolution to this situation is to move away from using price as the denominator in duration calculations instead focusing on a quantity called *duration basis* in the denominator. The duration becomes the percentage of the duration basis resulting from a given shift in interest rates. This definition of duration includes the original case, where the duration basis is simply equal to the price of the security. A common duration basis for swaps is the sum of the notional and the swap price.

4. Give one reason countries are moving away from the LIBOR averaging process and opting for market traded rates similar to Australia and New Zealand.

During the LIBOR polling process, Tier 1 banks submit their answer to the question "At what rate could you borrow funds, were you to do so by asking for and then accepting interbank offers in a reasonable market size just before 11:00 a.m.?" Given that these same banks have billions of dollars of exposure to securities that use LIBOR to set their coupons, this situation could incentivize the banks to manipulate the average. Such a situation occurred in the marketplace, resulting in one conviction and billions of dollars in fines. To remove the possibility of another such scandal, LIBOR could instead be fixed by some judiciously chosen volume-weighted transaction in the marketplace. New Zealand and Australia adopted this solution and much appetite exists for a similar approach internationally. In fact, the Financial Conduct Authority in the United States announced in 2017 that the broad Treasury financing rate would replace LIBOR as soon as 2021.

Chapter 13: Models of the Yield Curve and Term Structure

1. Discuss what the calibration of a short-term model involves.

Two possible ways are available to calibrate an interest rate model depending on the ultimate usage of the model. To construct an interest rate model under a real world probability measure requires analyzing the statistical properties of an observed short rate time series and from that analysis determining the values of the short rate drift and volatility and then estimating a utility function of bond investors to determine the market price of risk. On the other hand, the same model under the risk-neutral measure can be calibrated by pricing a given set of bonds such that their computed prices match their market quoted prices. This way the values of the risk-neutral drift and volatility are determined. This approach allows using the model to compute relative prices of other securities given the set of calibration bonds. Nothing can be said in this case about the real world behavior of the bond prices.

2. Define the market price of risk.

The *market price of risk* is the return in excess of the risk-free rate that the market wants as compensation for taking risk.

3. Discuss the conditions under which an interest rate model is arbitrage-free.

According to Heath, Jarrow, and Morton (1992), the specific relation between the drift and the diffusion terms of the instantaneous forward rate curve guarantees that the model is arbitrage-free. They derived this requirement by analyzing the prices of tradeable securities under a general model and imposing that the prices are martingales. All interest rate models used for relative pricing must be arbitrage-free, whereas those used for economic estimates are free from this constraint.

4. Identify the available numeraires in the LIBOR market model.

Only a discrete set of numeraires are available in the LIBOR market model (LMM). The "spot" measure is analogous to the cash accumulation process but is written in terms of the simply compounded LIBOR forward rates. The other available measures are the T-forward measures, where the terminal time T is coincident with one of the maturity times of the LIBOR rates being modeled, which is a martingale under this measure since it is proportional to a forward rate agreement and therefore a tradeable asset. LIBOR rates maturing after time T have a positive drift, and those maturing before time T have a negative drift.

Chapter 14: International Bonds

1. Discuss the impact of trade volatility on fixed income in an open economy.

Countries with high volatility across macroeconomic measures present greater sovereign credit risk than countries with similar economic development but low volatility. A positive correlation exists between trade volatility and yield spreads, as greater volatility is associated with higher spreads. Additionally, a change or uncertainty in trade policy or terms of trade between a nation and its major trade partners negatively affects creditworthiness. Lastly, trade openness (a positive direct factor) and uncertainty about a country's political and macroeconomic conditions (a negative direct factor) are important factors influencing credit default swaps.

2. Discuss the level of integration between sovereign debt markets and comment on the differences between developed and emerging economies.

Sovereign bonds from developed countries are sensitive to global factors. Bond yields from developed nations appear, on average, to respond more strongly to global macroeconomic factors than domestic macroeconomic factors. For example, global interest rates explain more than 45 percent of all variation in the sovereign yields of developed countries. Bonds from developed nations respond strongly to global economic conditions and exhibit some degree of long-run predictability. Research indicates that the deviation from long-run expected rates typically adjusts within six months. This situation suggests minimal benefits of diversification into dollar-denominated sovereign bonds issued by developed nations. However, a similar situation does not apply to developing or emerging market economies. Although these economies show some degree of integration, bond yields still respond strongly to domestic macroeconomic risk factors. Additionally, economic, political, and cultural values affect the development of a country's domestic debt market. For example, gross domestic product (GDP) per capita, bureaucratic quality, as well as the depth and quality of the domestic banking system positively affect the development of bond markets in emerging economies. Therefore, benefits from diversification exist even when buying dollar-denominated debt issued by emerging market economies.

3. Explain how governance quality affects debt relief.

Little evidence suggests that governance affects a country's ability to receive debt relief. However, if debt relief is provided, governance appears to affect the outcomes. Perhaps the most important aspect of governance is the signals sent to markets before issuance. For example, high quality governance evidenced by the capacity of a government to engage in economic policies that can stimulate the economy, increase tax revenue, and reduce government spending signals to the market that default is less likely. Furthermore, countries with high fiscal deficits, poor governance, and lower monetarization have a higher probability of being heavily indebted and poorer.

4. Explain the impact of sovereign risk on the private sector.

Empirical evidence suggests that sovereign debt transfers risk to the private sector. In particular, firms located in countries experiencing sovereign default are likely to suffer a decline in access to international credit markets. Evidence also suggests that investment within a country rises temporarily when a positive rating change occurs. However, the converse is also true when a negative rating change occurs.

Chapter 15: Floating Rate Notes

1. Explain the difference between a capped and a floored FRN.

A capped floating rate note (FRN) sets a maximum interest rate and a floored FRN sets a minimum interest rate. These maximum and minimum rates are set regardless of the associated benchmark. Investors would benefit from a note with a floor if interest rates fell below the floor because the floor establishes a minimum return. Conversely, issuers would benefit from a note with a ceiling if interest rates rose above the ceiling because the ceiling limits their interest payments.

2. Identify the main components that affect an FRN's performance.

Three major components affect an FRN's performance. First, a reference rate or external benchmark such as LIBOR, the prime rate, or U.S. Treasury bills determines the additional number of basis points provided by the issuer. Second, the frequency at which an FRN is adjusted or its ability to be called affects its overall performance and eventual payout for the borrower. Third, the maximum and minimum interest rates, often referred to as capped or floored notes, influence the payout on FRNs over time.

3. Identify when the spread for life and effective margin methods are appropriate.

When the spread between the present coupon and the base rate is small, the spread for life (SFL) method is sufficient to use. However, when the spread between the present coupon and base rate becomes large, the effective margin (EM) method is more accurate.

4. Identify the most accurate method of determining an FRN's relative value and explain why.

The EM method tends to be the most accurate method because it considers the effect of the current yield over a shorter period of time where it measures the relative value until the next coupon reset date. The EM method differs from the SFL method in that the SFL method measures the value over the floater's life.

5. Identify a main drawback of using relative valuation methods for FRNs.

A main drawback of using relative valuation methods is that they fail to consider embedded options. Such options include callable and puttable floaters as well as floaters with caps and floors that complicate accurately pricing floating rate securities. Instead, a preferred approach for valuing floaters is to use arbitrage-free binomial interest rate trees and Monte Carlo simulations because they can price securities with interest rate dependent cash flows.

Chapter 16: Bonds with Embedded Options

1. Compare and contrast callable and puttable bonds.

Callable bonds have an embedded option belonging to the issuer, whereas puttable bonds have an embedded option in the investor's possession. Callable bonds may exhibit negative convexity, which essentially creates a ceiling on the bond price. Puttable bonds exhibit more positive convexity than straight bonds when interest rates rise. The put option provides downside protection to the investor, but the call option limits the investor's upside potential. Although callable and puttable bonds have important differences, they also share some similarities. Both callable and puttable bonds contain options that potentially reduce the bond's life, and each bond may contain protection periods that limit the option's exercisability.

2. Discuss the advantages and disadvantages of convertible bonds to investors.

Convertible bonds offer several potential benefits to investors. For example, they provide upside participation in the form of equity with downside protection in the form of a bond. Although convertible bonds have historically outperformed the S&P 500 index, a proxy for the U.S. equity market, in price appreciation, they also have drawbacks for investors. The market for these securities is less liquid than other fixed income or equity products. Issuer profiles tend to be skewed toward less creditworthy issuers and companies needing access to capital that cannot access the traditional equity or fixed income markets. Including a conversion option for convertible investors allows issuers to pay a lower coupon in the near-term, trading off possible future equity dilution. Poorly performing stock leaves the investor with a relatively lower yielding bond compared to a nonconvertible bond.

3. Describe negative convexity and its impact on callable bonds.

Convexity is a measure of the curvature of the bond price function. Because the relation between bond prices and interest rates is nonlinear, duration calculations overestimate (underestimate) the corresponding price movement based on an increase (decrease) in interest rates. With negative convexity, the rate of price increase is lower than an equivalent decrease in interest rates. In other words, the bond's price increases at a decreasing rate as yields drop. Callable bonds exhibit negative convexity when interest rates fall because the call option on the bond belongs to the issuer. When interest rates fall, there is an increased probability that the issuer will redeem the bonds before maturity. The call price creates a price ceiling for callable bonds. Investors are exposed to reinvestment risk because if the bond is called, they must reinvest the proceeds into a new asset that may have a lower rate of return.

4. Discuss why convertible bonds are considered hybrids of debt and equity.

A convertible bond is a hybrid debt and equity instrument, meaning that the financial instrument displays characteristics of both debt and equity products at different points depending on the value of the conversion option, whether it is in-the-money, at-the-money, or out-of-the money. Convertibles follow a predictable price path relative to the underlying share price. When the share price is close to zero, the convertible bond trades like a distressed debt instrument with little, if any, consideration of the equity conversion option. As the share price increases when distress is not an important consideration, a convertible bond trades like a normal option-free bond. As the conversion options moves closer toward being in-the-money, the convertible takes on characteristics of both debt and equity. The convertible bond participates more with increases in the share price but retains downside protection of the bond when the share price declines. Finally, once the share price increases beyond the conversion price, the convertible bond trades with a very high (close to one) delta, capturing the majority of the equity appreciation.

5. Discuss two examples of more complex embedded options than traditional callable, puttable, and convertible bonds.

One example of a more complex embedded option is an extendible bond, which can be viewed as a portfolio consisting of a short-term bond and a call option to purchase a longer-term bond. If, at maturity, the call option is exercised, the investor uses the proceeds from the short-term bond to buy the longer-term bond. A bond with a combination of embedded options is another example. The rights attributed to the option-holder by call, put, and conversion options are independent of one another, allowing issuers to offer bonds with a combination of options. However, once one of these options is exercised, the other options expire worthless.

Chapter 17: Bond Mutual Funds, Closed-End Bond Funds, and Exchange-Traded Funds

1. Explain the difference between an open-end fund and a closed-end fund.

With an open-end fund, the fund stands ready to sell new shares to an investor wanting to buy and redeem (buy back) shares from any investor who wants to sell. With a closed-end fund, the number of shares is typically fixed. When an investor buys open-end fund shares, the fund issues shares and then invests the money received, which means the number shares outstanding changes over time. A closed-end fund has an initial public offering of shares and rarely offers new shares. If investors want to buy shares, they must buy them from other investors. Likewise, if investors want to sell shares, then they must sell to another investors. The shares of closed-end funds are traded (intra-day) on the open market at prices that may differ from their net asset values (NAVs).

2. Explain the differences between a mutual fund and an ETF.

One major difference between a mutual fund and an ETF is that retail investors trade ETF shares on a stock exchange through a broker-dealer. In contrast, mutual fund shares are not listed on stock exchanges but are purchased and sold either directly from the fund or through various investment professionals. Another difference is that investors can trade ETF shares throughout the day at a market-determined price. Mutual funds are forward priced, meaning that although investors can place orders to buy or sell shares throughout the day, all orders placed during the day receive the same price when the NAV is computed at the end of the day. ETFs can also be shorted and may have associated derivative contracts.

3. Identify the factors responsible for the growth of funds and net assets of ETFs between 1998 and 2016.

According to Investment Company Institute, net asset value under management for ETFs increased from $16 billion in 1998 to more than $2.5 trillion in 2016. This increase represents a compounded annual growth of 30.5 percent during this period. The share of ETFs over the total net asset in the industry increased from 0.3 percent in 1998 to 13.1 percent in 2016. Demand for ETFs is higher because of institutional investors using ETFs as a convenient vehicle for participating in, or hedging against, broad movements in the market. Furthermore, retail investors' increased interest with the help of financial advisers also influenced demand for ETFs. Researchers cite a lack of transparency and liquidity in the over-the-counter bond market as a reason for the rapid growth in the bond ETF market.

4. Compare the empirical evidence between studies involving international and U.S. bond mutual funds.

Research evidence shows that most U.S. bond funds underperform their passive benchmarks. Most foreign bond funds also underperform their benchmark indexes. Yet several studies provide evidence of outperformance by global bond funds relative to domestic bond funds.

Chapter 18: Other Bond Products: Social Impact Bonds, Death Bonds, Catastrophe Bonds, Green Bonds, and Covered Bonds

1. Explain how an SIB is structured and why it may be issued in lieu of conventional financing.

A social impact bond (SIB) is an investment by private organizations that has the ability and willingness to bear risk in a government-sponsored project aimed at addressing social issues. The payout to the private investor of the SIB is based entirely on the program's success and the verification by an independent third party that the desired outcome has been achieved. As such, the government sponsoring the project reduces the risk of loss on the project and the upfront capital outlay.

2. Explain the advantages and risks of investing in death bonds.

The advantages of investing in death bonds include relatively high yield and diversification. In particular, the higher yield arises from the zero coupon bond structure. The low correlation to other investments is due to the lack of dependence on the overall health of the economy and tendency to perform well in recessionary times when insured individuals need more upfront cash due to declining yields on fixed income securities.

The disadvantages of death bonds include the impact of medical technology continuously advancing that has allowed insured individuals to live longer, decreasing the bond yield by increasing the time to payout. The small market for these securities has a relative lack of oversight, leading to possible corruption. Individuals may also misrepresent their health in order to receive a higher payout on their policy. Finally, the relatively long time frame for investment leads to high risk from changes in interest rates.

3. Explain the unique characteristic of catastrophe bonds and SIBs.

Although catastrophe bonds are issued as debt securities, such bonds are tied to a specific event making them similar to derivative investments. The purchaser of a catastrophe bond has no claim or any recourse in the event a catastrophe occurs. SIBs are similar to catastrophe bonds in that the outcome of the financing is tied to a specific set of events, which in this case is the successful outcome of the project being implemented.

This situation makes SIBs similar to derivative investments. SIBs are also similar to equity investments in that if the project's outcome is successful, then the holder receives a payment. Thus, the project must generate some form of positive cash flow (greater than the cost of expenses) in order to repay the investor.

4. Discuss some types of projects that can be financed by green bonds and explain why investing in green bonds can be mutually beneficial to both society and investors.

Green bonds can finance any type of project that results in creating real property and is focused on positive environmental outcomes. Examples include efficient power generation systems, district combined heating, cooling, and power projects, wastewater treatment plants, and electrified railway systems. Investing in green bonds is a way of making investments that value long-term growth. Most valuation models use a discounted cash flow approach. Although distant future cash flows have far less impact on a project's net present value (NPV) due to greater discounting than cash flows in the near term, green bond projects can still provide a positive NPV. Green bond investments are a way to ensure future cash flows by investing to improve society as a whole.

5. Explain why an organization would issue a covered bond and use an example of a mortgage origination to demonstrate the process. Also, explain why covered bonds issuance in the United States has recently increased in popularity.

Issuers use covered bonds to gain additional funding to issue mortgages and other asset-backed securities. When an organization issues a mortgage, it provides funding to purchase real property. The mortgage originator then has a claim to the property in the event the borrower cannot repay. The lender can issue a covered bond using the claim to the real property to cover the bond and receive additional funding to finance mortgages. Until the financial crisis of 2007–2008, government sponsored entities (GSEs) would buy mortgages from banks and sell them in the secondary market. During the financial crisis, GSEs encountered liquidity issues and had to scale back their mortgage purchase operations. Although they have resumed their role as a financer to the mortgage market, covered bonds have also gained in popularity as a means to maintain mortgage funding.

Chapter 19: Inflation-Linked Bonds

1. Explain the difference between the inflation protection that investors receive from nominal bonds compared to inflation-linked bonds.

Nominal bonds provide investors protection from expected inflation over the bond's term as part of the yield to maturity at purchase. Nominal bonds also compensate investors for bearing the risk of inflation uncertainty. In contrast, inflation-linked bonds provide protection from unexpected inflation (i.e., realized inflation exceeds expected inflation at the beginning of the holding period). Because investors are not exposed to inflation, they are not compensated for bearing inflation risk and are only guaranteed a real return.

2. Describe the effect of deflation on inflation-linked bonds and the type of protection offered by a deflation floor. Identify the economic environment that deters issuers from offering deflation protection.

Since the principal value of an inflation-linked bond is indexed to changes in inflation, investors risk the downward adjustment to principal during periods of deflation. If deflation is persistent over the bond's term, investors may receive a principal payment at maturity that is less than the bond's initial par value. Given that most investors are attracted to inflation-linked bonds because they are low-risk investments, many issuers include a deflation floor to offer an additional layer of protection. The deflation floor is equivalent to a put option on the bond in which a minimum principal payment that is often equal to par is guaranteed to the investor. The additional layer of protection comes at a cost to investors in terms of lower yields. During periods of extended deflation, offering the additional protection of a deflation floor could be too costly. In many cases, the excessive cost would equate to negative real yields.

3. James Jameson inherited a $1 million stock portfolio. He is concerned with the current valuations in the stock market and his primary goal is to maintain the portfolio's purchasing power while earning a minimal return. In 10 years, Jameson plans to liquidate the entire portfolio. He is considering investing the entire portfolio in either 10-year Treasuries or 10-year TIPS. Discuss the factors that should guide his choice.

The difference between the break-even inflation rate and realized inflation primarily drives the relative performance between the 10-year Treasury and the 10-year TIPS. As such, Jameson must assess his outlook on inflation over the next 10 years and compare it with the market's current expectations. If a possibility exists that Jameson may liquidate the portfolio before the bonds mature, he should also consider the duration of the different bond types. Jameson should also consider the possibility of changes in the real interest rate.

4. Jameson decides to ask his neighbor Michael Clay for advice. Clay tells Jameson that since Treasuries and TIPS are both risk-free securities, he should invest in Treasuries because of their greater yield. Convinced by his neighbor, Jameson decides to invest the entire $1 million portfolio in 10-year Treasuries with a yield of 3.0 percent, instead of 10-year TIPS with a yield of 1.2 percent. Identify why Clay's statement is incorrect with respect to comparing the yields of Treasuries versus TIPS. Calculate the break-even inflation rate at the time of Jameson's investment. If average inflation over the next 10 years is greater than the break-even inflation rate, which investment will have better performance?

Clay's comparison of Treasury and TIPS yields is flawed. Treasury bonds are quoted in nominal yields while TIPS are quoted in real yields. At the time of Jameson's investment, the break-even inflation rate was 1.8 percent or the spread between the yield on the Treasury and TIPS. If inflation over the holding period is greater than the break-even inflation rate, Jameson's portfolio will experience better returns if he holds TIPS. Each year the coupon and principal payment of the Treasury remains constant in nominal terms but is eroded by the rate of inflation in real terms. However, the coupon and principal payment of the TIPS adjusts each year for the rate of inflation in nominal terms and remains constant in real terms.

Chapter 20: Securitization Process

1. Discuss the main benefits of securitization for lenders/issuers and investors.

Securitization allows lenders/issuers to recycle capital, effectively lending out capital multiple times in a given period instead of lending once and holding the loan for the entire loan term. Securitization connects the larger institutional capital providers to underserved markets, benefiting borrowers through increased availability and lower cost of capital. Benefits to investors include diversification into otherwise difficult-to-access markets and assets with relatively high risk-adjusted returns.

2. Identify potential market-level drawbacks to the securitization of assets.

Securitization can be extremely complex. Even institutional investors have difficulty completely understanding and accounting for the risks in certain transactions. Securitization also separates the lender performing the underwriting from the ultimate default and loss risk, removing some of the incentives to exercise complete due diligence, underwriting, and risk assessment. Securitization of asset-backed debt and the resulting flow of capital to those securitizations can lead to outsized increases in the value of the underlying assets. When asset values increase, borrowers often borrow more, which can lead to market distortions and eventual increases in default rates.

3. Describe the general structure of a securitization in terms of risk, reward, and ratings.

In general, securitizations consist of a pool of assets such as loans and leases. That pool is split into multiple tranches. Bonds at the top of a senior-junior waterfall structure are the highest rated, most insulated from loss, and carry lower expected returns. The lower tranches are lower rated, higher risk, and therefore have higher expected returns.

4. Identify the important parties that operate a securitization and associated responsibilities.

The trustee, master servicer, and special servicer are the main parties in operating a securitization. The trustee administers payments to bondholders, monitors the various servicers, and ensures the securitization operates according to the pooling and servicing agreement. The master servicer generally collects the loan payments from borrowers, manages communication between borrowers and the trust, and monitors borrower performance. The special servicer usually manages an asset or loan in a securitization when the loan is in danger of going into or has already entered default. The special servicer is obligated to work out the distressed or defaulted loan in the best interest of all bondholders.

Chapter 21: Mortgage-Backed Securities

1. Explain the MBS securitization process.

The mortgage-backed security (MBS) securitization process generally involves the following steps.

- A financial institution originates a property loan, secured by placing a lien on the residential or commercial real property.
- The issuer bundles together individual mortgage loans, held by the lenders, into a mortgage pool. The underlying mortgages do not necessarily need the same characteristics such as interest rate and maturity to be bundled. The mortgage pool is then used as collateral for a homogeneous security, which is created by the MBS issuer.
- The MBS issuer sells the security to institutional investors such as pension funds, insurance companies, mutual funds, hedge funds, or retail investors. Subsequently, the MBS is tradable in the secondary market.

2. Discuss how WAC differs from an MBS pass-through rate.

As mortgage pool loans generally have different mortgage rates, the weighted average cost (WAC) provides the weighted average interest rate on the loans by weighting the note interest rates on each underlying mortgage loan by the outstanding loan balance. In contrast, the MBS pass-through rate is the coupon rate on the MBS, also referred to as *net coupon*. The net coupon is lower than WAC because it deducts servicing and guarantee fees. The servicing spread is the difference between WAC and net coupon.

3. Discuss the sources of prepayment risk of MBSs.

Prepayment risk is unique to mortgage securities. It is the most important risk for residential mortgage-backed securities (RMBS) as residential mortgage borrowers, in the absence of prepayment restrictions, tend to refinance loans when they can take advantage of more favorable mortgage rates. In contrast, commercial mortgage borrowers typically face lockout provisions and substantial prepayment penalties, which substantially reduce the prepayment risk for commercial mortgage-backed securities (CMBS). The three main sources of prepayment risk are refinancing behavior, relocation, and default.

As market interest rates decrease, residential mortgage borrowers have an incentive to refinance their loans to take advantage of lower interest costs. Furthermore, over time borrower's credit standing could also improve and so they may be able to take advantage of reduced borrowing costs. If borrowers want to cash out some of their built-up equity, one alternative, as opposed to using a second mortgage or a home equity credit line, is through refinancing. Relocation is the second most important factor driving prepayment. As homeowners move due to employment change, marriage, divorce, and a change in family size, the mortgage loan is repaid upon the sale of their property. Finally, mortgage default also causes prepayment due to the GSE guarantee on most RMBS. Loan seasoning affects further prepayment behavior due to the factors described. Higher prepayment rates are observed for seasoned loans as well as during the summer months.

4. Discuss the difference between agency and private label MBSs.

Agency MBS are securities created by one of three GSEs: Government National Mortgage Association (known as GNMA or Ginnie Mae), Federal National Mortgage (FNMA or Fannie Mae), and Federal Home Loan Mortgage Corp. (Freddie Mac). Because GNMA bonds are backed by the full faith and credit of the U.S. government, they are free from default risk. Although FNMA and Freddie Mac securities lack this same backing, the risk of default is negligible. Non-agency or private-label MBS refer to MBS issued by private institutions other than GSEs. Neither the U.S. government or any GSE guarantees these bonds because they often consist of pools of borrowers who could not meet agency standards. Compared to the agency MBS average daily trading volume, non-agency MBS volume represents less than 1 percent of trading activity in the MBS market, which is also reflective of a similar proportion of outstanding non-agency versus agency MBS.

5. Explain the benefits of a CMO structure relative to a traditional pass-through structure.

A collateralized mortgage obligation (CMO) is similar to an MPTS and MPTB in that principal and interest are passed through to the investor. However, by using a multi-class structure, CMOs allow the creation of instruments with various maturities and different priorities of payment of principal and interest. Such securities present different investment options for investors with varying investment horizons and risk-preferences. Thus, CMOs provide a wider range of investment opportunities than simple pass-through securities and cash flow patterns that meet the investment objectives of different types of investors.

Chapter 22: Asset-Backed Securities

1. Define an SPV and explain its economic benefits involving an ABS.

A special purpose vehicle (SPV), sometimes called a special purpose entity (SPE), may take the form of a limited liability company, a limited partnership, a corporation, or a trust. The objective is to separate the assets that are being securitized from the originator, so that the assets are not at risk in case the originator becomes insolvent. This structure creates several economic benefits for both the issuer and the investor:

- Investors have the highest priority claim on a specific and well-identified pool of assets legally segregated from the rest of the company's assets, which protects investors in case of default of the issuer.
- Due to bankruptcy remoteness, the originator may be able to obtain funding at a lower cost than funding from a bond issuance.
- When the issuer is a bank, an additional benefit accrues by reducing the size of the bank's balance sheet, thus improving its regulatory capital ratios.

2. Discuss how SPVs differ from master trusts used in the case of credit card ABS.

Although the underlying logic is similar, the master trust technically differs from a classical SPV because it is adapted to reflect the revolving nature of the credit card business. The master trust is based on a single trust able to receive a flow of numerous pools of credit card loans over time and issue securities backed by the cash flows of all the receivables in the trust. This construction means that no asset in the trust is specifically segregated to support a single security.

3. Define tranching and explain how it can be used as a mechanism of internal credit enhancement.

Tranching consists of creating different classes of an asset-backed security (ABS), typically senior, "mezzanine," and junior tranches that follow different priority rules for receiving cash flow payments. In case of a cash shortfall, the senior tranche starts absorbing losses only after the junior and mezzanine tranches have been completely wiped out. Therefore, the existence of junior and mezzanine tranches provides credit protection and enhancement to the rights of the holders of the most senior tranches.

4. Explain how and why prepayment of the underlying obligations may represent a risk to many types of ABS investors.

In general, the embedded prepayment option in the underlying assets of many ABSs can threaten to prematurely end the security's term and force investors to replace the security with another asset that may have a lower investment yield resulting in reinvestment risk. This process is not a major factor for credit card ABSs because of their revolving nature. That is, unlike mortgages or auto loans, they do not have a payment schedule set at the beginning of the contract. Therefore, credit card ABSs differ from other types of ABSs in that the underlying assets can completely "turn over" every few months. In other words, the balances of customers who are paying off their loans can be replenished by customers who are accumulating balances through purchases or balance transfers.

5. Discuss which ABS category faces the highest prepayment risk.

Different factors typically influence the prepayment/repayment rates of which the most relevant is the possibility of refinancing the loan at a lower interest rate, which typically depends on the type of collateral. Prepayment risk represents a major risk factor in the case of auto loans and residential mortgages, where the obligations tend to have a stated term and potentially large economic gains to refinancing.

6. Explain how the naturally revolving nature of credit card debt is reflected by the typical securitization structures applied when originating credit card ABSs.

Unlike mortgages or auto loans, credit card loans do not have a payment schedule set at the beginning of the contract. Instead, the underlying assets can completely "turn over" every few months. That is, the balances of customers who are paying off their accounts can be replenished by customers who are building balances through purchases or balance transfers. To reflect the revolving nature of the credit card business, a master trust, typical in credit card ABSs, is based on a single trust able to receive a flow over time of numerous pools of credit card loans and to issue securities backed by the cash flows of all the receivables in the trust. As a result, no asset in the trust is specifically segregated to support a single security.

Chapter 23: Collateralized Debt Obligations, Collateralized Bond Obligations, and Collateralized Loan Obligations

1. Describe how CDOs, CBOs, and CLOs differ.

CDOs, CLOs, and CBOs are differentiated by the type of security that underlies each structured product. Although CDOs primarily pool mortgage-backed securities, the term broadly encompasses both collateralized loan obligations (CLOs) and collateralized bond obligations (CBOs). A CLO typically holds bank loans while a CBO is reserved for high yield debt.

2. Describe the primary parties to a CDO.

The primary parties to a CDO include an investment bank, rating agency, traders, manager, insurance company, and investors. The investment bank underwrites or creates the security. The rating agency reviews the product and provides a rating based on its risk profile. CDO traders serve as market makers and facilitate the movement of the product from one investor to another. The CDO manager builds portfolios of these products and gives retail and institutional investors access to a diversified fund of CDOs. The insurance company offers protection to the investors in a CDO. Finally, the end investor such as an insurance company, pension fund, or other institution ultimately buys these structured products.

3. Discuss the process and importance of tranching.

The tranche system is designed to offer investors a variety of risk and return profiles from a single CDO. The claims of interest and principal payments are prioritized and distributed to holders of the highest quality tranche, typically rated AAA, before investors in the lower quality tranches receive payment. Through a process similar to a waterfall, interest flows into each subsequent group or tranche. The lowest quality tranche is considered a form of equity that is typically held by the underwriters.

4. Explain the attraction of the CDO structure to investors.

CDOs offer investors access to a diversified basket of securities that otherwise may be too risky to invest in directly. Although an institution may not have an appetite for holding a single bank loan, it may be willing to tolerate the risk associated with investing in a diversified portfolio of loans. The CDO structure enables investors in the AAA tranche to earn a return above other AAA-rated debt securities with seemingly little additional risk. During the financial crisis of 2007–2008, these products were not as safe as market participants initially perceived.

5. Explain why banks use SPVs.

An SPV serves to remove the CDO and any associated assets and liabilities from a bank's balance sheet. Some U.S. financial institutions that accept deposits have limitations on the type of assets they hold. By removing the CDO from the balance sheet, their asset pool consists of fewer below-investment-grade credits. An SPV enables banks to create CDOs without exceeding regulatory requirements based on the stability of their assets.

Chapter 24: Factors Affecting Bond Pricing and Valuation

1. List the main factors that could influence bond valuation.

The main factors that could influence bond valuation include the Treasury yield, bond liquidity, credit ratings, corporate governance, accounting quality, product market competition, creditor rights, equity volatility, and financial innovation.

2. Discuss why the corporate bond market is illiquid.

The composition of investors in the corporate bond market is the main reason for illiquidity. Unlike the stock market, the major investors such as insurance companies, pension funds, and banks in the U.S. corporate bond market are passive investors. These investors adopt a buy-and-hold investment strategy, contributing illiquidity in the corporate bond market.

3. Discuss why accounting disclosure can influence bond value.

High accounting disclosure quality can reduce the information asymmetry between bond issuers and creditors, lessen investment uncertainty, and stimulate demand of bonds.

4. Discuss how the advent of CDSs could reduce borrowing costs.

Trading credit default swap (CDSs) brings two types of benefits to investors: new credit risk hedging opportunities and additional and timely credit risk information. These benefits associated with CDSs could stimulate the demand for corporate bonds and reduce borrowing costs.

Chapter 25: Valuing and Analyzing Bonds with Embedded Options

1. Discuss how the binomial interest rate tree incorporates interest rate uncertainty.

The binomial interest rate tree models the short-term interest rate at each time-step and allows the short rate to change over time. It incorporates interest rate uncertainty by allowing the interest rate to randomly increase or decrease (or increase less than the "up" move) from each node. The up- and down-nodes are separated by a factor (chosen for modeling tractability) of $e^{2\sigma}$ in which σ (per period) is the interest rate volatility that measures the interest rate uncertainty. If the volatility is large, the up- and down-nodes are further separated, and vice versa.

2. Explain the application of the binomial interest rate model to value callable and/or puttable bonds.

To apply the binomial interest rate model and value callable or puttable bonds, the first step is to compute the bond value at all nodes as if it were the equivalent, option-free straight bond. Then, starting from the end of the tree (i.e., maturity), all bond values at maturity are revised according to callable or puttable provision: replace the bond values higher (lower) than call (put) prices with the call (put) price. After revising one time-step, all bond values are recomputed in the rest of the tree. The next iteration then starts by revising the previous time-step and recomputing all earlier time-steps again. This "revise-recompute" cycle is repeated until the time-step of the earliest available call or put is completed.

3. Discuss why the Z-spread for a callable bond is higher than its OAS, while for a puttable bond the Z-spread is less than its OAS.

The difference between the Z-spread and option adjusted spread (OAS) represents the yield required to compensate for the effect of the option. For callable bonds, the issuer owns the call option and bondholders bear the risks associated with the call. Therefore, the Z-spread must be higher than the OAS to compensate the bondholder for taking additional risk associated with the callable provision. For puttable bonds, the put option is owned by the bondholders who will rationally pay more for the bond (accept lower yield). Since less risk than a similar option-free bond exists, the OAS must be smaller than the Z-spread for a similar option-free bond. The bondholders accept a lower yield to accommodate this additional option. Therefore, the Z-spread is lower than the OAS.

4. Discuss the difference between the Z-spread and the OAS.

The Z-spread is the hypothetical fixed spread added to all zero-rates on the spot curve. Implicitly, it considers only one path of interest rates. It measures all bond-specific risks, including risks introduced by embedded options. The OAS, conversely, is the constant spread added to each node of a binomial tree that has incorporated the effect of embedded options. Therefore, OAS measures the bond-specific risks other than the risk of the embedded option. The difference between Z-spread and OAS represents the basis points equivalent of the option cost.

5. Describe the approach to valuing convertible bonds.

The traditional static approach uses the current market stock price to evaluate a convertible bond. It usually calculates the conversion premium and other measures to compare the larger value between holding the straight bond and converting to equity, given current market conditions. The options approach, however, calculates the convertible bond as a package of the straight bond with an exchange option that allows bondholders to exchange one dynamic asset value—the bond value—with a second dynamic asset value—the stock value.

Chapter 26: Valuing and Analyzing Mortgage-Backed and Asset-Backed Securities

1. Discuss the primary differences between traditional (option-free) bonds and MBSs.

Compared to option-free bonds, MBSs have very different characteristics. First, MBSs have a more frequent coupon (monthly) and the coupon is composed of both interest and principal (as opposed to interest-only coupons on traditional bonds). The level of the coupon varies depending on the prepayment amount in the current month. In addition, the bond's effective maturity is unknown at issuance.

2. Discuss some of the strengths and weaknesses of the zero-volatility spread in valuing an MBS.

The strengths of the zero-volatility spread are that it can be applied across the entire spot-rate curve and to an ABS that does not experience fluctuations in prepayment activity. The weaknesses include its implicit assumption about prepayment rates, and its failure to strip out prepayment risk, potentially overvaluing an investment.

3. Identify the four core elements in an MBS valuation model.

The four core elements in an MBS valuation model are (1) establishing short-term interest rate model and volatility assumptions, (2) producing cash flow projections for all interest rate paths, (3) determining the PV of the cash flows along each interest rate path, and (4) aggregating all the PVs to compute the theoretical value of an MBS or ABS.

4. Explain the concept of negative convexity and why an MBS exhibits this phenomenon.

Negative convexity is the phenomenon whereby when interest rates decline, the price of the fixed income security increases at a decreasing rate and potentially declines, which differs from the typical inverse price/yield relation. Negative convexity is present in MBSs due to changes in prepayment rates, and reduced cash flows into the pool, as interest rate changes.

Chapter 27: Valuing and Analyzing Fixed Income Derivatives

1. Discuss how fixed income derivatives valuation has changed as a result of the interest rate market dynamics during and after the financial crisis of 2007–2008.

The most important and disruptive change is the dismissal of LIBOR as the choice of the risk-free discount rate in valuation models. Before the financial crisis of 2007–2008, the difference between LIBOR and less risky rates such as Treasury yields and overnight indexed swap (OIS) rates was negligible. Considering that most fixed income derivatives had LIBOR-linked payoffs, many market participants were comfortable with LIBOR discounting for derivatives pricing. However, during the financial crisis, the large spread between LIBOR and these rates resulted in replacing this approach. Standard practice is now to use OIS discounting for fixed income derivatives valuation.

The other important change or adaptation in models is due to the negative interest rates that became a common characteristic in various currency markets due to monetary policy response in those economies. Most interest rate models, including the widely used Black model, do not allow for negative interest rates. Both practitioners and academics have adopted more flexible models, such as shifted lognormal and Bachelier normal, that can accommodate negative interest rates without added complexity.

2. Identify the differences between the valuation of forward rate agreements and short-term interest rate futures contracts.

Two major settlement differences occur between futures and forwards. First, futures are settled daily by marking to the market whereas forwards are settled at the end of the contract life. Second, futures gains or losses are realized at the maturity date of the futures contract whereas the forward payoff is computed at the end of the contract period even though the discounted value of this payoff can be paid at the settlement date. The latter of these two differences is negligible especially for long-term contracts. However, the combined effect, which is called the *convexity bias*, is important for futures contracts with maturities longer than one year. Due to the convexity bias, futures rates must be higher than the forward rates with the same maturity to preclude arbitrage.

3. Identify the differences between the valuation of European OTC bond options and options on Treasury bond futures.

Two main differences exist between the valuation of European OTC bond options and options on Treasury bond futures. The first is the fact that Chicago Mercantile Exchange (CME) options on futures are American style options and the Black formula developed for OTC bond options applies to European options. This issue is not particularly important because American futures options are exercised early only when they are deep in the money. Hence, the Black model should work reasonably well.

The other difference is more challenging. Futures contracts that serve as the underlying reference for the CME options have two features that are effectively two "free" options held by the short party in the futures contract. These delivery options, pertaining to when and which bond would be delivered, are difficult to value. The Black model works under the assumption that these delivery options do not exist. Therefore, in high-interest rate environments where timing and quality options are valuable, practitioners use more complex models to value futures options.

4. Discuss the need for alternatives to the Black model as applied to different types of fixed income options.

The Black model strictly works for European options and assumes constant volatility throughout the option's life. Furthermore, it adopts the lognormal distribution assumption for the underlying variable, which can be interest rates or bond prices.

Due to the non-zero early exercise probability, the Black model would not be the best choice for options on Eurodollar futures or Treasury bonds, both of which are American style. Additionally, both OTC European bond options and options on Treasury bond futures pose a major challenge for the constant volatility assumption as the volatility of these underlying assets converge to zero due to the pull-to-par effect. Finally, for those options with an interest rate underlying, the lognormal distribution assumption may not be valid as it does not allow for negative interest rates.

Lattice-based models help value American-style options. Stochastic volatility models can tackle the non-constant volatility and shifted lognormal or Bachelier normal models can accommodate negative interest rates. However, none of these models has the parsimony, versatility, and the elegance of the Black model. As a result, practitioners still widely use the Black model.

Chapter 28: Credit Analysis and Ratings

1. Explain why capacity analysis is important when a lender is evaluating a potential credit relationship.

Capacity analysis is important because it assists in determining whether a company has enough liquidity and flexibility to take on new and/or service existing debt on its balance sheet. This review requires the analyst to obtain historical financial statements, identify trends, and detect whether any negative results of the analysis would lead to being able to pay principal and interest payments.

2. Discuss four risks associated with a company's cash conversion cycle and offer some examples.

The first of four major risks associated with a company's cash conversion cycle are as follows.

- *Supply risk* is generally associated with the procurement of raw materials and goods and the availability of replacements or substitutes. This also includes paying suppliers/vendors for materials. A recent example is the emergence of high-quality shaving accessories from smaller upstart brands that ship directly to the consumer and replace typically expensive blades with lower priced ones. Globalization, and therefore greater access to quality manufacturers for competitive prices, has allowed start-ups to compete aggressively in this market.
- *Production risk* is usually associated with labor force dynamics, property, plant, and equipment expenditures and depreciation, or regulatory change. For example, tariffs on imports of foreign steel into the United States represent a regulatory change that could pose production risk to a corporation that makes, imports, sells, or uses steel in its business model.
- *Demand risk* is associated with consumer tastes, substitute products, and other factors. It is present in consumption goods that represent fads or current trends.
- *Collection risk* is risk associated with accounts receivable and procurement of cash. For example, banks holding mortgages during the recession created by the housing bubble in 2007–2009 experienced severe losses from collection risk associated with their customers' inability to meet their obligations.

3. Explain how the cash flow statement is organized and its importance to credit analysts.

The cash flow statement consists of three sections: cash flow from operations (CFO), cash flow from investing activities (CFI), and cash flow from financing activities (CFF). The analyst should review the CFO to determine the health of the company's business, CFI to identify if the firm has made the necessary capital expenditures in the previous 12 months, and CFF to assess the sources of financing and terms related to current obligations.

4. Explain the role of credit rating agencies in the debt markets.

Credit rating agencies (CRAs) in the debt markets serve largely as gatekeepers to debt investments. Their opinions drive investor sentiment toward the debt obligation depending on risk appetite. CRAs integrate both quantitative and qualitative information to determine a holistic rating for the debt issuer that takes many of the same factors into consideration that a credit analyst would when deciding whether to lend to a potential client.

Chapter 29: Bond Auctions

1. List the auctioneers' main objectives in treasury auctions.

Auctioneers in treasury auctions have three main objectives: (1) maximizing auction revenue, (2) preventing market manipulation, and (3) promoting a liquid post-auction secondary market.

2. Differentiate between a discriminatory auction and a uniform-price auction.

In a discriminatory auction, winning bidders pay their own bids. In a uniform-price auction, winning bidders all pay the last accepted (lowest) winning bid. In doing so, bidders in uniform-price auctions face less uncertainty and may be willing to bid more aggressively, reducing the likelihood of the "winner's curse." Whether the auctioneer raises more revenue in uniform-price auctions is an empirical question.

3. Discuss the roles of primary dealers and the reason for underpricing in U.S. Treasury auctions.

Primary dealers are obligated to participate in both open market operations and Treasury auctions. They also stand ready to buy from or sell to investors after the auctions. Underpricing could be the compensation for services performed and the risks assumed by primary dealers.

4. Discuss the role of private information in Treasury auctions.

Private information helps bidders better estimate the value of the to-be-auctioned securities and form their bids. As the value of the securities is not exactly known to market participants at the auction, bidders' private information of market demand and interest rate expectations are crucial in forming auction bids.

5. Discuss how governments prevent a short squeeze in the Treasury markets.

A short squeeze arises when a particular security is in short supply in the secondary market. This situation may happen in the Treasury market if a single bidder acquires most of the offering in the auction. Governments prevent a short squeeze in the Treasury markets by establishing a bidding limit on the quantity or through frequent reopening auctions of outstanding securities.

Chapter 30: Bond Accounting

1. Define prepayments and discuss how they are estimated and how an entity should account for them when calculating premium/discount amortization on a bond or loan transaction.

A *prepayment* is the settlement of an obligation either in whole or in part before the actual scheduled payment date. Investors and issuers sometimes estimate prepayments using different prepayment models or by using historical factors. Prepayments may be subject to prepayment penalties. The net effect of prepayment is that it subjects the investor to reinvestment risk because the amount prepaid curtails future interest income and will be reinvested at the current interest rate. The effect of the change in estimated prepayment on amortization income/expense should be adjusted to income in the period of change.

2. Explain the difference between discount and premium amortization and the impact on net income.

Amortization of a bond discount is a non-cash expense that increases net interest expense whereas amortization of a bond premium is considered income that increases net interest income or decreases net interest expense. If the market rate at which a bond is issued is higher than the stated rate, the bond is issued at a discount. An example of an instrument that is issued at a discount is a zero-coupon bond or a Treasury bill. The original instrument is issued at a discount to par, and the balance accretes to par value at maturity. If a bond is issued at a stated interest rate that is higher than the market rate, then the bond is issued at a premium and the unpaid principal balance ultimately amortizes to par. For floating rate notes, the note is issued at par if the issue spread is equal to the discount margin. If the issue spread is greater (less) than the discount margin, the note is issued at a premium (discount). Regardless of whether a bond is issued at a premium or a discount, the carrying amount of the debt remains the unpaid principal balance plus/minus the discount/premium amortization and unamortized issue cost.

3. Explain the difference between the effective interest and straight-line methods of amortization and indicate which is permissible under GAAP.

Per guidance in ASC 470 and SFAS 91, the amortization income or expenses on a debt or loan should be calculated over the contractual life of the financial instrument using the effective interest method. The *effective interest rate* is the market yield on a bond or the internal rate of return (IRR) that sets the net present value (NPV) of future cash flows on the bond to zero. According to SFAS 91, net fees or costs that are recognized as yield adjustments over the life of the related loan are recognized by the interest method. SFAS 91 also states that the objective of this method is to arrive at a periodic income including recognition of fees and costs at a constant effective yield. That is, discounts/premiums are amortized as a proportion of the carrying value. Therefore, for bonds issued at a discount, amortization expenses are lower and then progressively increase as the amortized balance accretes. For bonds issued at a premium, the converse is true (i.e., amortization income is greater in the beginning and then gets progressively smaller as the bond amortizes). The net implication is that the difference between the interest calculated based on the stated rate and that calculated based on the effective interest rate (i.e., the IRR) is adjusted to income at every reporting period.

The straight-line amortization method amortizes the same amount to income every reporting period. Reporting entities cannot use other methods unless they can prove that the amortization amounts generated using the different method are not materially different from those generated using the prescribed method.

4. Discuss how a negative interest rate may alter the cash flow payable or receivable by the bond issuer and explain why bond investors still invest in such bonds.

In a typical interest rate environment, interest rates are positive and a company that issues a bond pays interest to the bond investors. A negative interest rate implies that the issuing company will receive interest rather than pay interest on the issued bonds. Negative interest rates usually occur when the central bank substantially lowers its deposit rate to negative as part of an unconventional macroeconomic policy to prevent the economy from falling into deflation.

Investors invest in such bonds for several reasons. One reason is that some investors believe that the rate could fall more and if they buy now and rates fall later, they could make a profit on their investments. Companies also invest in these types of bonds for diversification purposes because bond investments are generally not as volatile as equity investments. Thus, paying a 1 percent interest rate would be the better alternative than suffering, say, a 10 percent loss on an investment portfolio in one year's time.

Chapter 31: High Yield Bonds

1. Discuss the characteristics of a bond that is an HYB.

In general, a high yield bond (HYB) is a bond that any of the three NRSROs rate below investment grade.

2. Describe the evolution of the HYB market including one positive and one negative aspect of this asset class from the issuer's perspective.

The issuance of HYBs by corporations is often associated with the now-defunct securities firm Drexel Burnham Lambert ("DBL"), which focused much of its activity on financing companies with lower initial credit ratings and facilitated the early growth of the leveraged buyout (LBO) and private equity buy-out industry. A positive aspect for issuers is that the HYB market provides below-investment-grade (IG) companies an avenue to raise capital efficiently. A negative aspect for issuers is that HYB issuers pay higher interest rates due to their low rating.

3. List the key parties involved in an HYB issue, define the term "lead left," and discuss some reasons for issuing HYBs.

The key parties are the issuer, leading, and syndicating bank(s). "Lead left" is the bank leading the syndication. A company could issue HYBs to fund its growth, acquire a business, or refinance existing debt. A private equity sponsor would issue HYBs to fund an LBO.

4. Define the term "covenants" and describe the difference between "incurrence-based" and "maintenance-based" covenants.

Covenants are a set of rules that the issuer must follow until maturity. Covenants are either incurrence-based or maintenance-based. HYBs contain incurrence-based covenants and leveraged loans have maintenance-based covenants. Incurrence-based covenants are event-driven while maintenance-based covenants are tied to a company's ongoing financial health.

5. Define "staple" financing and discuss why this type of financing is controversial.

LBO transactions require a large amount of financing, sometimes prearranged by the investment bank representing the seller of a company. Such prearrangement is known as *staple financing*. This financing term sheet was traditionally stapled to the deal term sheet. Staple financing is controversial because it could possibly be signaling a floor price that must be paid for the assets/company being sold. Additionally, the bank advising the sellers and lining up the financing earns fees from both sides of the transaction—the buyer and the seller.

Chapter 32: Distressed Debt

1. Define distressed debt.

Distressed securities refer to the financial claims on a firm in financial distress. Distressed debt is a subset within this broader asset class consisting of the loan agreements or bonds issued by financially distressed firms. Although no universal metric is currently available to neatly capture financial distress, a firm in financial distress is typically close to if not already in default and is associated with particularly high yields and credit ratings below CCC/Caa.

2. Define an underwater loan and describe the key factors driving the risk to investors in these loans.

A loan is *underwater* if the outstanding loan principal exceeds the value of the underlying collateral. The risk of strategic default is particularly high in these situations because the debtor is often financially better served by simply walking away from the loan and leaving behind the less valuable underlying assets to the lenders. The risk of involuntary default is often high in these situations because the diminished valuation of the underlying assets is correlated with the debtor's free cash flows and anticipated ability to continue to make payments going forward.

3. Define principal write-down and discuss the risks and benefits of this method of debt restructuring.

A *principal write-down* entails restructuring a loan's terms to reduce the outstanding loan balance, often in conjunction with altering other aspects of the loan agreement. Risks arise from the potential underestimation of the willingness to pay and the natural cure rate (i.e., the principal balance may have been reduced unnecessarily). Other costs arise from underestimating the ability to pay (i.e., the restructuring was unnecessary because the borrower would eventually default despite the principal reduction). Benefits arise from the increase in future expected cash flows because reduced leverage mitigates the likelihood of asset substitution, underinvestment due to debt overhang, and strategic default.

4. Describe other terms or focal points in restructuring debt, besides reducing the principal balance.

Distressed debt exchanges and debt restructurings entail renegotiating major structural terms of the loan agreement pertaining to repayment, as well as renegotiating the non-payment-related terms (i.e., the debt covenants). The restructuring of major debt service terms includes altering the outstanding principal balance, interest rate, or the timing or ultimate maturity of the debt due. Nonpayment-related terms may also be restructured, including limits on capital expenditures or research and development, limits to leverage, or minimum requirements on various liquidity ratios and debt-service coverage ratios.

5. Explain the risk of asset substitution and underinvestment that arises in distressed situations.

The risk of asset substitution arises in financially distressed firms in which the equity holders are incentivized to forgo or to replace less risky investments with substantially riskier projects due to their limited liability in default. Conversely, excess leverage in other circumstances may incentivize equity holders to forgo positive NPV investments because the profits accrue entirely, or at least disproportionately, to the lenders rather than to the equity holders.

Chapter 33: Microstructure of Fixed Income Trading

1. Explain why a foreign government would buy U.S. debt.

Holding Treasuries can improve a lender's creditworthiness, offering high levels of liquidity and security. Nations may also purchase U.S. debt to promote economic and political interdependence, which may stimulate trading and reduce the chance of war.

2. Discuss why short interest is a signal for bond prices.

High levels of short interest may indicate that investors are concerned about downside risk. This concern can affect bond prices, which are particularly sensitive to an issuer's credit rating. Short interest sends a signal to traders who use this information along with their knowledge of the market to form prices.

3. Describe the relation between a municipal bond's spread and risk premium.

Although credit and tax status can affect yield, the largest contributor to a municipal bond's price is its liquidity. As the municipal bond market trades infrequently, market makers are hesitant to hold illiquid municipal bonds on their balance sheets. This reluctance reduces the opportunity for quote and price discovery, creating an uncertainty that translates into higher bid-ask spreads.

4. Discuss the potential benefits and risks of automation in the fixed income market.

Automation reduces transaction costs, making smaller trades more profitable and leading to more liquidity. Each additional trade generates information that compounds into prices, leading to a more efficiently priced market. Yet, delegating the trading process to algorithms also involves risk. As automation becomes more prevalent, the market becomes more prone to sudden "flash crashes" and short-term overcorrections.

Chapter 34: Debt Investment Strategies

1. Explain why adding short-term bonds to a portfolio can reduce the portfolio's vulnerability to inflation.

The yearly interest rate needed for longer term bonds to be attractive must be reflective of both the currently available short-term interest rate and the potential higher interest rates that might be available in the future (e.g., if the rate of inflation increases). When investors hold long-term bonds at a fixed rate that is "locked in" during the entire term, they are unsure how much they will actually return after adjusting for inflation. Investors benefit if inflation remains steady or decreases during the term and suffer opportunity costs if inflation causes interest rates to increase while still holding the securities. By adding shorter-term bonds to the portfolio, investors have fewer worries about future fluctuations in interest rates, making bonds less vulnerable to inflation.

2. Describe any differences in terms of risk, return, and liquidity between (a) owning two bonds with the same maturity and (b) owning one bond with a longer and one bond with a shorter maturity, in which the pair has the same present value and the same overall duration.

Option (a) is referred to as a bullet strategy and option (b) resembles a barbell strategy. Given that both bonds have the same duration, they are equally exposed to the price change from a change in interest rates. The shape of the interest rate yield curve is usually concave, so the bullet strategy is likely to have a higher overall rate of return. The barbell strategy is more liquid because the shorter term bond is closer to its maturity date than the other bonds.

3. Describe a situation in which a strategy developed for an institutional investor cannot be implemented by an individual.

Institutional investors such as pension funds, insurance companies, and banks can use strategies such as liability-duration investing (LDI) that are inappropriate for individual investors. LDI strategies are best for institutional investors that have reliable information about the specific liabilities they are required to pay out and can invest their assets to match those liabilities. For example, a pension fund manager can invest assets to match the payments expected to be paid to retirees. The investment manager of a bank can invest assets or lend money to match the interest obligations to the depositors. Individual investors may not be as savvy about their specific future financial needs, especially when they cannot accurately predict for how long they will need to cover living expenses. Individuals are often advised to invest in a way that maximizes the potential growth in assets, subject to their tolerance for investment risk, in the hope that the gains will be sufficient for their individual requirements. Individual investors face a more limited set of available investment options than larger institutions because of issues such as lot sizes, liquidity, minimum purchase requirements, and differential information sets.

4. Explain how a portfolio manager can use an active bond strategy using country, currency, and credit risk based on the manager's views on interest rates.

A bond manager can observe the correlation between yields in the domestic market and yields in some foreign market. If the manager wants to seek higher, more attractive yields abroad, then investing in emerging markets may provide a better risk/reward opportunity set. Often developed and international markets go through economic and business cycles at different times giving the investor an opportunity for higher-yielding assets abroad. The bond manager can also buy debt denominated in the local currency of the foreign market if the manager believes that the currency will strengthen relative to the domestic currency. Investment grade bonds are typically more sensitive to changes in interest rates while high-yield bonds are more sensitive to spread changes. If rates are rising because of a strengthening economy, high-yield debt typically outperforms its investment grade counterparts. If rates are falling due to a contracting economy, investment grade bonds usually benefit more from an increase in price.

5. Describe which types of institutional investors are best suited to use LDI strategies and the main benefits of doing so.

Pension funds, insurance companies, and banks are most likely to benefit from asset-liability duration strategies. Pensions clearly have defined obligations they are contractually required to pay out each year. Insurance companies can try to hedge their risk by investing premiums they receive into bond strategies that match the estimated duration of their payouts to the extent they are known. Life insurance companies are more flexible because they know how much they will need to pay out, even if the timing is uncertain. Property and casualty insurance companies typically use shorter duration debt because both the timing and the total amount of the payouts are unknown. Banks can use liability-driven investment (LDI) strategies to offset assets in their balance sheet.

Chapter 35: Debt Portfolio Management

1. Explain the key principle behind the immunization strategy and how it compares to using beta in an equity investment.

The foundation of immunization is to eliminate a portfolio's sensitivity to changes in the term structure by matching the duration of the asset used to fund the liability to the duration of the liability itself. When durations are matched, the values of the assets and liabilities rise or fall by the same amount for any given change in the interest rate. Combining an asset and a liability with the same beta results in constructing a zero beta portfolio with returns that do not fluctuate with the market.

2. Explain a dedication strategy and the risks associated with this strategy.

The key principle that underlies a dedication strategy is the goal of constructing a bond portfolio that produces the same cash flows as the liability on the due date. In practice, cash flow surplus is generated in early periods and then the surplus is invested to fund part of the cash flows in latter periods. Because this strategy assumes timely bond payments, it is subject to the credit risk of the bond issuers. However, a dedication strategy is exposed to reinvestment risk when cash flow surplus from early years is reinvested to fund cash flow needs of the later years.

3. Consider a 4-year bond with a coupon rate of 7 percent and face value of $1,000. Further assume the yield curve is flat, with a 9 percent yield to maturity. Assuming the yield curve remains flat, calculate the bond's duration and convexity today and in two years.

Today, the bond price P_0 is calculated as follows:

$$P_0 = \frac{\$70}{(1.09)^1} + \frac{\$70}{(1.09)^2} + \frac{\$70}{(1.09)^3} + \frac{\$1{,}070}{(1.09)^4} = \$935.21$$

The bond duration D_0 is calculated as:

$$D_0 = \frac{\frac{\$70}{(1.09)^1}}{\$935.21} * 1 + \frac{\frac{\$70}{(1.09)^2}}{\$935.21} * 2 + \frac{\frac{\$70}{(1.09)^3}}{\$935.21} * 3 + \frac{\frac{\$1{,}070}{(1.09)^4}}{\$935.21} * 4 = 3.61 \text{ years}$$

The convexity of the C_0 is calculated as

$$C_0 = \left(\frac{1}{2}\right) * \left[\frac{\frac{(1)(2)(\$70)}{(1.09)^1} + \frac{(2)(3)(\$70)}{(1.09)^2} + \frac{(3)(4)(\$70)}{(1.09)^3} + \frac{(4)(5)(\$70)}{(1.09)^4}}{\$935.21}\right] = 8.71$$

In two years, the bond price P_2 is calculated as:

$$P_2 = \frac{\$70}{(1.09)^1} + \frac{\$1{,}070}{(1.09)^2} = \$964.82$$

The duration D_2 is calculated as:

$$D_2 = \frac{\frac{\$70}{(1.09)^1}}{\$964.82}(1) + \frac{\frac{\$1{,}070}{(1.09)^2}}{\$964.82}(2) = 1.93 \text{ years}$$

An observation can be made that as a bond approaches its maturity, its duration decreases.

The convexity C_2 is calculated as

$$C_2 = \left(\frac{1}{2}\right)\left[\frac{\frac{(1)(2)(\$70)}{(1.09)^1} + \frac{(2)(3)(\$1070)}{(1.09)^2}}{\$964.82}\right] = 5.67$$

4. Consider a 5-year bond with a coupon rate of 12 percent and a face value of $1,000. Given the following hypothetical interest rates and assuming the pure expectations theory is correct, calculate the bond's expected price in two years.

Period	Current One-Period Forward Fate (%)
1	5
2	6
3	7
4	8
5	9

The bond's cash flows are as follows:

Year	Cash Flow
1	$120
2	120
3	120
4	120
5	1,120

The bond price in year 2 should be the discounted value of cash flows from year 3 to maturity. Assuming pure expectation theory holds, the future spot rate equals the current forward rate. Thus, P_2 is calculated as:

$$P_2 = \frac{\$120}{(1.07)} + \frac{\$120}{(1.07)(1.08)} + \frac{\$1,120}{(1.07)(1.08)(1.09)} = \$1,105.16.$$

Chapter 36: Debt Trends and Future Outlook

1. List the primary borrowers in global debt markets.

Borrowers in global debt markets can be broadly divided into governments, also called sovereigns, households, nonfinancial corporate borrowers, and financial corporate borrowers.

2. Describe the various types of consumer/household debt.

Consumer/household debt includes housing and non-housing debt. Housing debt is money borrowed in mortgage markets to fund the purchases of houses. Student debt funds college and graduate school education. Credit card debt funds everything from lunches to bitcoins. Auto loans are used to buy cars, trucks, and other forms of transportation.

3. Explain the concept of the "great rotation" and provide one reason the "great rotation" is unlikely to occur.

The "great rotation" is a theory that investors will withdraw their money from bonds and reallocate it to equity securities. Although many believe this may happen, some refer to this theory as "fake news." The great rotation is unlikely to occur because so many institutional investors are required to hold fixed-income securities to maintain a diversified portfolio.

4. Explain which category of household debt is increasing fastest in the U.S. and provide two reasons why this situation concerns financial market participants.

Student debt is increasing at the fastest rate of all the types of household debt. Such debt is a concern because it hurts the overall economy as consumers burdened with debt spend less, which affects the growth of the economy. Millennials with high student debt are more likely to postpone home ownership and other types of spending needed to spur economic growth. Also, if the delinquency rates rise too much, fears exist that student debt may be the next credit bubble to burst.

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