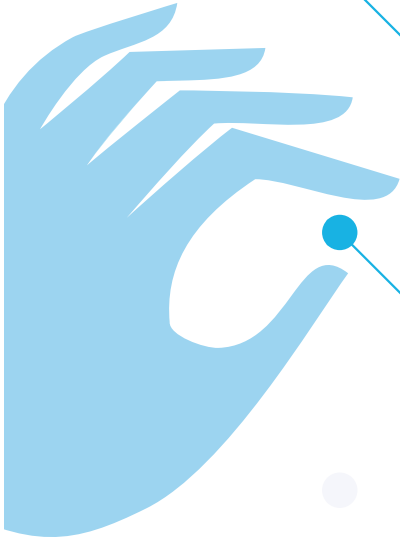




CFA Institute



# MEMBERS' GUIDE TO 2022 REFRESHER READINGS

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**CFA Institute**



# **MEMBERS' GUIDE TO 2022 REFRESHER READINGS**

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# Foreword

## Let's get practical

We know from your feedback that our members value Refresher Readings. We strive every year to make these Refresher Readings more targeted and to deliver the knowledge and insight that members seek to remain competent investment professionals.

Our aim is to increase the relevance of the CFA® Program, putting the real-life, day-to-day experience of investment professionals at the heart of the curriculum. And this approach does not apply solely to the curriculum. We plan to expand our portfolio of learning offerings, providing investment professionals who seek to upskill and reskill with high-quality practitioner-relevant content that can be integrated into their workflow.

We have introduced many new readings and revisions to the 2022 curriculum, adding to the large number of improvements made in recent years to respond to changing investment markets and practices. We have streamlined readings, making them more accessible through more engaging narratives and with the improved use of visual aids and practical examples.

The key changes in the 2022 curriculum broadly fall into six categories: Environmental, Social, and Governance (ESG); Ethics; Alternative Investments; Corporate Issuers; Investment Analysis; and Fixed Income:

- The evolving approach to **ESG** focuses on analysis of how well companies fare from an ESG standpoint. Innovative new content sets out, for example, possible approaches used to identify a company's, or an industry's, material ESG risks.
- Brand-new **ethics** content, inspired by actual events, illustrates many aspects of the CFA Institute Code of Ethics and Standards



## Foreword

of Professional Conduct. This content makes it intuitive to identify scenarios that apply to your particular area of interest.

- Growing investor focus on **alternative investments** has led to an expansion of this topic in the curriculum, with new readings demonstrating how alternatives may be deployed in a portfolio. Foundational knowledge is combined with exploration of how alternative asset classes, risk management, and alternative investment structures work.
- Substantial new content focusing on **corporate issuers** presents the choices a company makes when raising and using capital. Many practical examples and explanations illustrate why and how companies' capital choices vary over their lifecycles.
- **Investment analysis** techniques are always evolving, and several readings contain substantial new content on quantitative methods, thereby aligning the curriculum more closely to investment professionals' experience of an artificial intelligence–driven world. The focus is resolutely on the practical, with engaging visuals and code snippets.
- Finally, in an era of low interest rates, members will want to know how **fixed-income** portfolios are managed by their peers. New content on yield curve and credit strategies, as well as interest rate dynamics, offers valuable and practical insight.

I hope these Refresher Readings are genuinely useful in your work. We welcome your feedback and wish you every success.

You can reach us at [professionallearning@cfainstitute.org](mailto:professionallearning@cfainstitute.org).

Barbara S. Pécherot Petitt, PhD, CFA,  
Managing Director, Professional Learning



# Environmental, Social, and Governance Issues

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## Applicable Readings

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### **Environmental, Social, and Governance (ESG) Considerations in Investment Analysis (Level II)**

By Deborah S. Kidd, CFA, Young Lee, CFA, JD, and Johan Vanderlugt  
2 PL credits

Access the full reading: [cfainst.is/esgconsiderations](https://cfainst.is/esgconsiderations)

### **Introduction to Corporate Governance and Other ESG Considerations (Level I)**

By Assem Safieddine, PhD, Young Lee, CFA, Donna F. Anderson, CFA,  
Deborah S. Kidd, CFA, and Hardik Sanjay Shah, CFA  
1.5 PL credits

Access the full reading: [cfainst.is/corpgovandesg](https://cfainst.is/corpgovandesg)

### **Basics of Portfolio Planning and Construction (Level I)**

By Alistair Byrne, PhD, CFA and Frank E. Smudde, MSc, CFA  
1.5 PL credits

Access the full reading: [cfainst.is/portfolioplanning](https://cfainst.is/portfolioplanning)

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# What Is Changing in the 2022 Curriculum?

The CFA Program curriculum has evolved from treating environmental, social, and governance (ESG) issues as an internal corporate governance issue to placing the emphasis squarely on external analysis of companies' ESG activities. This innovation brings CFA Institute and its members to the forefront of investment thinking, in which ESG is a core component of investment analysis.

The revised reading “Environmental, Social, and Governance (ESG) Considerations in Investment Analysis” represents this re-focused approach as well as the current thinking of the CFA Institute ESG Working Group. The reading presents a new case showing how firms can execute climate change scenario planning and incorporates a user-friendly exhibit setting out an ESG Integration Framework.

The ESG Integration Framework shows how qualitative and quantitative research are key elements of an ESG strategy. Securities valuation, portfolio construction, asset allocation, scenario analysis, and risk management form the remainder of the framework.

In the associated case, we see how a well-crafted sustainability report by City Developments Limited (CDL) better prepares its business for the potential financial impacts of the physical and transition risks of climate change. We also see how CDL repositions its ESG activities to comply with the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) and the Intergovernmental Panel on Climate Change (IPCC). A systematic and holistic approach is used to assess and quantify all potential impacts on CDL's portfolio from climate-related risks and opportunities.

### *What Is Changing in the 2022 Curriculum?*

The updated reading “Introduction to Corporate Governance and Other ESG Considerations” has substantial new content, including another useful framework to guide analysts in their everyday work. This framework incorporates and explains six key ESG investment approaches: negative screening, positive screening, ESG integration, thematic investing, engagement/active ownership, and impact investing. New material on environmental and social aspects of ESG is provided in the reading as well as a discussion of ESG issues from micro and macro perspectives.

Additionally, how investment professionals integrate ESG into portfolio construction is explored in the updated reading “Basics of Portfolio Planning and Construction.”



## Why Does It Matter to Members?

With no globally accepted best practice for ESG integration, analysts must decide for themselves the materiality of ESG-related data. “Environmental, Social, and Governance (ESG) Considerations in Investment Analysis” explains how investment professionals can determine whether ESG-related factors are relevant to a company and identify applicable qualitative and quantitative data.

This reading sets out possible approaches used to identify a company’s, or an industry’s, material ESG factors, using proprietary methods, ratings, and analysis from ESG data providers, and not-for-profit industry initiatives and sustainability reporting frameworks.

“Introduction to Corporate Governance and other ESG Considerations” assists practitioners in assessing the efficacy of a company’s corporate governance structure and controls, including consideration of conflicts of interest and transparency of operations. This reading illustrates how increased data availability has increased the weight of corporate governance in the investment decision-making process.

The integration of ESG factors changes the portfolio construction process. ESG analysis affects both strategic asset allocation and implementation, and thus requires rethinking by investment managers in terms of the selection of securities, the exercise of shareholder rights, and the devising of investment strategies. “Basics of Portfolio Planning and Construction” serves as a guide for the integration of ESG and focuses on key factors, including scarcity of natural resources, physical impacts of climate change, global economic and demographic trends, diversity and inclusion, and the rise of social media.



# Environmental, Social, and Governance (ESG) Considerations in Investment Analysis

**Deborah S. Kidd, CFA, Young Lee, CFA, JD, and Johan Vanderlugt**  
*Deborah S. Kidd, CFA, is at CFA Institute (USA). Young Lee, CFA, JD, is at MacKay Shields (USA and Europe), MacKay Shields Europe Investment Management Ltd. (Ireland), and MacKay Shields UK LLP (United Kingdom). Johan Vanderlugt is at NN Investment Partners (Netherlands).*

*CFA Institute would like to thank Hardik Sanjay Shah, CFA, for his contributions to the 2022 update of this reading.*

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## Learning Outcomes

The candidate should be able to:

- a. describe global variations in ownership structures and the possible effects of these variations on corporate governance policies and practices;
- b. evaluate the effectiveness of a company's corporate governance policies and practices;
- c. describe how ESG-related risk exposures and investment opportunities may be identified and evaluated; and

- d. evaluate ESG risk exposures and investment opportunities related to a company.

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## Introduction

Environmental, social, and governance (ESG) considerations are increasingly being integrated into investment analysis. Evaluating how ESG factors potentially affect a company may provide analysts with a broader perspective on the risks and investment opportunities of a company's securities. Although corporate governance has long been recognized as having a significant impact on a company's long-term performance, investors have become increasingly concerned with environmental and social factors as well as how companies manage their resources and risk exposures that relate to such factors. Mismanagement of these resources has led to a number of high-profile corporate events that have negatively affected security prices. Increasingly stringent regulatory environments, potentially finite supplies of natural resources, and global trends toward energy conservation and waste reduction have led many investors to place a greater emphasis on the management of environmental risks. Similarly, such issues as worker health and safety policies, community impact, and marketing practices have increased the visibility of how a company manages its social capital.

This reading provides an overview of ESG considerations in investment analysis. Section 2 provides an overview of the global variations in corporate ownership structures, as well as how these ownership structures may affect corporate governance outcomes. In Section 3, we discuss company-specific factors that should be considered when evaluating corporate governance in the investment

process. Section 4 discusses the identification of ESG-related risks and opportunities that are relevant to security analysis. Section 5 demonstrates the evaluation of ESG-related risks and opportunities through several examples. The reading concludes with a summary of the key points discussed.

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## Summary

- Shareholder ownership structures are commonly classified as dispersed, concentrated, or a hybrid of the two.
- Dispersed ownership reflects the existence of many shareholders, none of which, either individually or collectively, has the ability to exercise control over the corporation. Concentrated corporate ownership reflects an individual shareholder or a group (controlling shareholders) with the ability to exercise control over the corporation.
- Controlling shareholders may be either majority shareholders or minority shareholders.
- Horizontal ownership involves companies with mutual business interests that have cross-holding share arrangements with each other. Vertical (or pyramid) ownership involves a company or group that has a controlling interest in two or more holding companies, which in turn have controlling interests in various operating companies.
- Dual-class (or multiple-class) shares grant one or more share classes superior or even sole voting rights, whereas other share classes have inferior or no voting rights.



## *Environmental, Social, and Governance Issues*

- Types of influential owners include banks, families, sovereign governments, institutional investors, group companies, private equity firms, foreign investors, managers, and board directors.
- A corporation's board of directors is typically structured as either one tier or two tier. A one-tier board consists of a single board of directors, composed of executive (internal) and nonexecutive (external) directors. A two-tier board consists of a supervisory board that oversees a management board.
- CEO duality exists when the chief executive officer also serves as the board chair.
- A primary challenge of integrating ESG factors into investment analysis is identifying and obtaining information that is relevant, comparable, and decision-useful.
- ESG information and metrics are inconsistently reported by companies, and such disclosure is voluntary, which provides additional challenges for analysts.
- In an ESG context, materiality typically refers to ESG-related issues that are expected to affect a company's operations or financial performance and the valuation of its securities.
- Corporate governance considerations, such as the structure of the board of directors, tend to be reasonably consistent across most companies. In contrast, environmental and social considerations often differ greatly.
- Analysts typically use three main sources of information to identify a company's (or industry's) ESG factors: (1) proprietary research, (2) ratings and analysis from ESG data providers, or (3) research from not-for-profit industry organizations and initiatives.

- In equity analysis, ESG integration is used to both identify potential opportunities and mitigate downside risk, whereas in fixed-income analysis, ESG integration is generally focused on mitigating downside risk.
- A typical starting point for ESG integration is the identification of material qualitative and quantitative ESG factors that pertain to a company or its industry.



# Introduction to Corporate Governance and Other ESG Considerations

**Assem Safieddine, PhD, Young Lee, CFA, Donna F. Anderson, CFA, Deborah S. Kidd, CFA, and Hardik Sanjay Shah, CFA**

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## Learning Outcomes

The candidate should be able to:

- a. describe corporate governance;
- b. describe a company's stakeholder groups, and compare interests of stakeholder groups;
- c. describe principal-agent and other relationships in corporate governance and the conflicts that may arise in these relationships;
- d. describe stakeholder management;

- e. describe mechanisms to manage stakeholder relationships and mitigate associated risks;
- f. describe functions and responsibilities of a company's board of directors and its committees;
- g. describe market and nonmarket factors that can affect stakeholder relationships and corporate governance;
- h. identify potential risks of poor corporate governance and stakeholder management, and identify benefits from effective corporate governance and stakeholder management;
- i. describe factors relevant to the analysis of corporate governance and stakeholder management;
- j. describe environmental and social considerations in investment analysis; and
- k. describe how environmental, social, and governance factors may be used in investment analysis.

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## Introduction

Weak corporate governance is a common thread found in many company failures. Lack of proper oversight by the board of directors, inadequate protection for minority shareholders, and incentives at companies that promote excessive risk taking are just a few of the examples that can be problematic for a company. Poor corporate governance practices have resulted in several high-profile accounting scandals and corporate bankruptcies over the past several decades and have been cited as significantly contributing to the 2008–2009 global financial crisis.

In response to these failures, regulations have been introduced to promote stronger governance practices to protect financial markets and investors. Academics, policy makers, and other groups have published numerous works discussing the benefits of good corporate governance and identifying core corporate governance principles believed to be essential to ensuring continuous, well-functioning capital markets and the stability of the financial system.

The investment community also has demonstrated a greater appreciation for the importance of good corporate governance. The assessment of a company's corporate governance structure and controls, including consideration of conflicts of interest and transparency of operations, has been an essential factor in investment analysis. More data availability and demands for better governance have increased the weight of corporate governance in the investment decision-making process. In addition, investors have become more attentive to environmental and social issues related to a company's operations. Collectively, these concepts often are referred to as environmental, social, and governance (**ESG**).

Section 1 of this reading provides an overview of corporate governance, including its underlying principles and theories. Section 2 discusses the various stakeholders of a company and conflicts of interest that exist among stakeholder groups. Section 3 describes the principal-agent and other relationships in corporate governance and the conflicts that may arise in these relationships. Section 4 describes stakeholder management, reflecting how companies manage their relationships with stakeholders. Section 5 focuses on mechanisms to manage stakeholder relationships and mitigate associated risks. Section 6 focuses on the role of the board of directors and its committees as overseers of the company. Section 7 explores certain key factors that affect stakeholder relationships and corporate governance. Section 8 highlights the risks and benefits that underlie a corporate governance structure. Section 9 synthesizes corporate

governance concepts that should be considered by investment professionals. Finally, Section 10 discusses the growing use of ESG factors in investment analysis and portfolio construction processes.

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## Summary

The investment community has increasingly recognized the importance of corporate governance as well as environmental and social considerations. Although practices concerning corporate governance (and ESG overall) will undoubtedly continue to evolve, investment analysts who have a good understanding of these concepts can better appreciate the implications of ESG considerations in investment decision making. The core concepts covered in this reading are as follows:

- Corporate governance can be defined as a system of controls and procedures by which individual companies are managed.
- Of the many systems of corporate governance, most reflect the influences of either shareholder theory or stakeholder theory, or both. Current trends, however, point to increasing convergence.
- A corporation's governance system is influenced by several stakeholder groups, and the interests of the groups often diverge or conflict.
- The primary stakeholder groups of a corporation consist of shareholders, creditors, managers and employees, the board of directors, customers, suppliers, and government/regulators.
- A principal–agent relationship (or agency relationship) entails a principal hiring an agent to perform a particular task or service.

In a corporate structure, such relationships often lead to conflicts among various stakeholders.

- Stakeholder management involves identifying, prioritizing, and understanding the interests of stakeholder groups and on that basis managing the company's relationships with stakeholders. The framework of corporate governance and stakeholder management reflects a legal, contractual, organizational, and governmental infrastructure.
- Mechanisms of stakeholder management may include general meetings, a board of directors, the audit function, company reporting and transparency, related-party transactions, remuneration policies (including say on pay), and other mechanisms to manage the company's relationship with its creditors, employees, customers, suppliers, and regulators.
- A board of directors is the central pillar of the governance structure, serves as the link between shareholders and managers, and acts as the shareholders' internal monitoring tool within the company.
- The structure and composition of a board of directors vary across countries and companies. The number of directors may vary, and the board typically includes a mix of expertise levels, backgrounds, and competencies.
- Executive (internal) directors are employed by the company and are typically members of senior management. Nonexecutive (external) directors have limited involvement in daily operations but serve an important oversight role.
- Two primary duties of a board of directors are duty of care and duty of loyalty.

- A company's board of directors typically has several committees that are responsible for specific functions and report to the board. Although the types of committees may vary across organizations, the most common are the audit committee, governance committee, remuneration (compensation) committee, nomination committee, risk committee, and investment committee.
- Stakeholder relationships and corporate governance are continually shaped and influenced by a variety of market and nonmarket factors.
- Shareholder engagement by a company can provide benefits that include building support against short-term activist investors, countering negative recommendations from proxy advisory firms, and receiving greater support for management's position.
- Shareholder activism encompasses a range of strategies that may be used by shareholders when seeking to compel a company to act in a desired manner.
- From a corporation's perspective, risks of poor governance include weak control systems; ineffective decision making; and legal, regulatory, reputational, and default risk. Benefits include better operational efficiency, control, and operating and financial performance, as well as lower default risk (or cost of debt).
- Key analyst considerations in corporate governance and stakeholder management include economic ownership and voting control, board of directors' representation, remuneration and company performance, investor composition, strength of shareholder rights, and the management of long-term risks.
- ESG investment approaches range from *value*-based to *values*-based. The six broad ESG investment approaches are negative



*Environmental, Social, and Governance Issues*

screening, positive screening, ESG integration, thematic investing, engagement or active ownership, and impact investing.

- Historically, environmental and social issues, such as climate change, air pollution, and societal impacts of a company's products and services, have been treated as negative externalities. Increased stakeholder awareness and strengthening regulations, however, are internalizing environmental and societal costs onto the company's income statement by responsible investors.



# Basics of Portfolio Planning and Construction

**Alistair Byrne, PhD, CFA and Frank E. Smudde, MSc, CFA**

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*CFA Institute would like to thank Hardik Sanjay Shah, CFA, for his contributions to the 2022 update of this reading.*

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## Learning Outcomes

The candidate should be able to:

- a. describe the reasons for a written investment policy statement (IPS);
- b. describe the major components of an IPS;
- c. describe risk and return objectives and how they may be developed for a client;
- d. explain the difference between the willingness and the ability (capacity) to take risk in analyzing an investor's financial risk tolerance;
- e. describe the investment constraints of liquidity, time horizon, tax concerns, legal and regulatory factors, and unique

- circumstances and their implications for the choice of portfolio assets;
- f. explain the specification of asset classes in relation to asset allocation;
  - g. describe the principles of portfolio construction and the role of asset allocation in relation to the IPS; and
  - h. describe how environmental, social, and governance (ESG) considerations may be integrated into portfolio planning and construction.

---

## Introduction

To build a suitable portfolio for a client, investment advisers should first seek to understand the client's investment goals, resources, circumstances, and constraints. Investors can be categorized into broad groups based on shared characteristics with respect to these factors (e.g., various types of individual investors and institutional investors). Even investors within a given type, however, invariably will have a number of distinct requirements. In this reading, we consider in detail the planning for investment success based on an individualized understanding of the client.

This reading is organized as follows: Section 2 discusses the investment policy statement, a written document that captures the client's investment objectives and the constraints. Section 3 discusses the portfolio construction process, including the first step of specifying a strategic asset allocation for the client. Section 4 concludes and summarizes the reading.

## Summary

In this reading, we have discussed construction of a client's investment policy statement, including discussion of risk and return objectives and the various constraints that will apply to the portfolio. We also discussed the portfolio construction process, with an emphasis on the strategic asset allocation decisions that must be made.

- The IPS is the starting point of the portfolio management process. Without a full understanding of the client's situation and requirements, it is unlikely that successful results will be achieved.
- The IPS can take a variety of forms. A typical format will include the client's investment objectives and also list the constraints that apply to the client's portfolio.
- The client's objectives are specified in terms of risk tolerance and return requirements.
- The constraints section covers factors that need to be considered when constructing a portfolio for the client that meets the objectives. The typical constraint categories are liquidity requirements, time horizon, regulatory requirements, tax status, and unique needs.
- Clients may have personal objections to certain products or practices, which could lead to the exclusion of certain companies, countries, or types of securities from the investable universe as well as the client's benchmark. Such considerations are often referred to as ESG (environmental, social, governance).
- ESG considerations can be integrated into an investment policy by negative screening, positive screening, ESG integration,

thematic investing, engagement or active ownership, and impact investing.

- Risk objectives are specifications for portfolio risk that reflect the risk tolerance of the client. Quantitative risk objectives can be absolute, relative, or a combination of the two.
- The client's overall risk tolerance is a function of both the client's ability to accept risk and the client's "risk attitude," which can be considered the client's willingness to take risk.
- The client's return objectives can be stated on an absolute or a relative basis. As an example of an absolute objective, the client may want to achieve a particular percentage rate of return. Alternatively, the return objective can be stated on a relative basis—for example, relative to a benchmark return.
- The liquidity section of the IPS should state what the client's requirements are to draw cash from the portfolio.
- The time horizon section of the IPS should state the time horizon over which the investor is investing. This horizon may be the period during which the portfolio is accumulating before any assets need to be withdrawn.
- Tax status varies among investors, and a client's tax status should be stated in the IPS.
- The IPS should state any legal or regulatory restrictions that constrain the investment of the portfolio.
- The unique circumstances section of the IPS should cover any other aspect of a client's circumstances that is likely to have a material impact on portfolio composition. Certain ESG implementation approaches may be discussed in this section.

- Asset classes are the building blocks of an asset allocation. An asset class is a category of assets that share similar characteristics, attributes, and risk–return relationships. Traditionally, investors have distinguished cash, equities, bonds, and real estate as the major asset classes.
- A strategic asset allocation results from combining the constraints and objectives articulated in the IPS and capital market expectations regarding the asset classes.
- As time passes, a client’s asset allocation will drift from the target allocation, and the amount of allowable drift as well as a rebalancing policy should be formalized.
- In addition to taking systematic risk, an investment committee may choose to take tactical asset allocation risk or security selection risk. The amount of return attributable to these decisions can be measured.
- ESG considerations may be integrated into the portfolio planning and construction process. ESG implementation approaches require a set of instructions for investment managers with regard to the selection of securities, the exercise of shareholder rights, and the selection of investment strategies.

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# Ethics

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## Applicable Reading

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### **Ethics Application (Level I)**

1 PL, 1 SER credit

Access the full reading: [cfainst.is/ethicsapplication](https://cfainst.is/ethicsapplication)

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## What Is Changing in the 2022 Curriculum?

This wholly new reading for 2022 takes ethics theory and tests it in the real world. The reading presents a number of short vignettes, or scenarios, inspired by real-world situations and events. The vignettes are grouped into categories, corresponding to categories in the CFA Institute Code of Ethics and Standards of Professional Conduct (the Code and Standards), making it easy for readers to target their areas of interest.

The Code and Standards, for instance, emphasize professionalism and knowledge of the law. One scenario examines the case of Pellie, the CEO of a bank-owned investment group who has recently taken on a client of the parent bank. The client has a long-standing relationship with the parent bank, so Pellie waives through transactions that are flagged as anti-money-laundering risks because the client has been vetted. Is Pellie violating the Code and Standards?

Independence and objectivity are examined in another scenario. Myers, a partner in a \$3 billion hedge fund that makes environmental, social, and governance (ESG) investments, wants to personally donate \$10,000 to a candidate standing in state elections. Myers' primary reason is that the candidate is a passionate climate advocate who supports environmental policies. But Myers also hopes his political contribution might help his hedge fund attract funding from the state's pension plans. Is it ethical for Myers to make the donation?

A third scenario focuses on misconduct, by examining the actions of a fictional portfolio manager, Hanse, at a global investment bank. Hanse manages an ESG investment fund, and in her free time participates in civil disobedience demonstrations organized by

Extinction Rebellion. At several demonstrations she is arrested and convicted of minor offenses. Do Hanse's actions violate the Code and Standards?

Another scenario revolves around Marte, an asset manager in Puerto Rico, a US territory. The issue in this scenario is about the suitability of investments. Residents of Puerto Rico receive significant tax advantages when they invest in local securities. To capitalize on this advantage, Marte's firm offers its clients shares in a closed-end investment fund that holds at least 67% in local securities and is permitted to borrow against up to 50% of its assets. The fund is usually leveraged to the maximum permitted. Many of Marte's clients have a modest net worth and conservative or moderate investment objectives. Marte advises them to invest 85% or more of their assets in the closed-end fund. Is this ethical, or does it violate the Code and Standards?



## Why Does It Matter to Members?

The scenarios (vignettes) in the reading reinforce the practices, policies, and conduct that members are expected to adopt in order to comply with the CFA Institute Code of Ethics and Standards of Professional Conduct (the Code and Standards). There are too many scenarios in the reading to summarize them all, but most members will be able to find a scenario in the reading that closely matches their experience. Specifically, the scenarios offer learners detailed guidance on professionalism, integrity of capital markets, duties to clients, and duty to your employer.

Each vignette gives learners a chance to solidify their understanding of the Code and Standards by identifying whether—and why—a violation of the Code and Standards has taken place. After reading each scenario, you can use your knowledge of the Code and Standards to choose the best response to the multiple-choice questions. After making your choice, you can review the correct response and analysis to further broaden your knowledge of this important subject.



# Ethics Application

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## Learning Outcomes

The candidate should be able to:

- a. evaluate practices, policies, and conduct relative to the CFA Institute Code of Ethics and Standards of Professional Conduct; and
- b. explain how the practices, policies, and conduct do or do not violate the CFA Institute Code of Ethics and Standards of Professional Conduct.

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## Introduction

This reading presents a number of short vignettes, or scenarios, inspired by real-world situations and events. After reading the facts of each scenario, use your knowledge of the CFA Institute Code of Ethics and Standards of Professional Conduct to choose the best response to the multiple-choice question. After making your choice, be sure to review the correct response and case analysis, which discusses the rationale for why or why not a violation of the Code and Standards might have taken place and conduct that would comply with the Code and Standards.

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# Alternative Investments

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## Applicable Readings

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### **Introduction to Alternative Investments (Level I)**

By Steve Balaban, CFA, Steven G. Bloom, CFA, David Burkart, CFA, Nasir Hasan, and Barclay T. Leib, CFE, CAIA

3.75 PL credits

Access the full reading: [cfainst.is/altinvestments](https://cfainst.is/altinvestments)

### **Real Estate Investments (Level II)**

By Steven G. Bloom, CFA, Jeffrey D. Fisher, PhD, David Kruth, CFA, Bryan D. MacGregor, PhD, MRICS, MRTPI, Ian Rossa O'Reilly, CFA, and Anthony Paolone, CFA

3.75 PL credits

Access the full reading: [cfainst.is/rei](https://cfainst.is/rei)

### **Integrated Cases in Risk Management: Institutional (Level III)**

By Steve Balaban, CFA, Arjan Berkelaar, PhD, CFA, Nasir Hasan, and Hardik Sanjay Shah, CFA

2 PL credits

Access the full reading: [cfainst.is/riskmanagement](https://cfainst.is/riskmanagement)

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## What Is Changing in the 2022 Curriculum?

The growing focus on alternatives in the curriculum has been further expanded with new readings that broaden the coverage of alternatives and provide more detail on how to use them as part of an investment strategy. The result is a streamlined learning experience that combines foundational knowledge with in-depth examination of alternative asset classes, risk management, and alternative investment structures.

“Introduction to Alternative Investments” is a new reading that provides the learner with foundational knowledge of five major alternative investments: hedge funds, private capital, natural resources, real estate, and infrastructure. It also covers other types of alternative investment, such as private debt and farmland. The natural resources section features a new case study (Investing Responsibly in Timberland Assets), providing a real-life example of how investing in timberland can mitigate climate change.

This new reading provides in-depth coverage of two areas that are key for successful investing in alternatives: (1) investment and compensation structures, for example, general partnerships versus limited partnerships; and (2) investment approaches, such as direct investment, co-investment, and investment through funds.

The new reading “Real Estate Investments” provides an overview of real estate investments and then explores the relative merits of investing in real estate through private vehicles versus through publicly traded securities. The reading includes many examples and two real-life valuation examples. The first real-life example illustrates the “sales comparison” approach, and the second compares net operating

income (NOI)– and discounted cash flow (DCF)–based valuations, walking the learner through both an NOI calculation and a terminal value calculation.

Complementing the content on alternative asset classes is the new reading “Integrated Cases in Risk Management: Institutional,” which examines financial risks, enterprise risk management, environmental risks, and social risks. The learner then moves to the focus of the reading: a case study based on a theoretical portfolio of a sovereign wealth fund (SWF). The case study focuses on the risk management of the SWF’s long-term investments in infrastructure and private equity taking into account associated environmental and social risks.





## Why Does It Matter to Members?

“Introduction to Alternative Investments” covers areas that are key when considering an allocation to alternative investments: general partners versus limited partners, and direct investment versus fund investment. The reading prepares learners to conduct risk-return evaluations, fee calculations, and performance appraisal of alternative investments.

It is well known that real estate is an effective diversifier in balanced portfolios, but investors should be cognizant of the huge variance in the risk profile of real estate investments depending on the asset type. “Real Estate Investments” explains the risk profile of real estate equity versus real estate debt (as a lender or owner of mortgage-backed securities), primarily focusing on commercial property.

“Integrated Cases in Risk Management: Institutional” will be helpful to risk professionals at all levels. This case puts the learner in the position of a risk analyst at a small SWF. The risk analyst’s role in two investment committee (IC) meetings is evaluated. Learners are expected to review IC memos and IC discussions and analyze the various risk elements of the investment opportunities as the case unfolds over a five-year period. Ultimately, the learner is expected to make recommendations for making the SWF’s risk processes more secure and reliable.



# Introduction to Alternative Investments

**Steve Balaban, CFA, Steven G. Bloom, CFA, David Burkart, CFA, Nasir Hasan, and Barclay T. Leib, CFE, CAIA**

*Steve Balaban, CFA, is at Mink Capital Inc. (Canada). Steven G. Bloom, CFA, is at ARC Fiduciary (USA). David Burkart, CFA, is at Coloma Capital Futures, LLC (USA). Nasir Hasan is at Ernst & Young (UAE). Barclay T. Leib, CFE, CAIA, is at Spring Advisors LLC (USA).*

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## Learning Outcomes

The candidate should be able to:

- a. describe types and categories of alternative investments;
- b. describe characteristics of direct investment, co-investment, and fund investment methods for alternative investments;
- c. describe investment and compensation structures commonly used in alternative investments;
- d. explain investment characteristics of hedge funds;
- e. explain investment characteristics of private capital;
- f. explain investment characteristics of natural resources;
- g. explain investment characteristics of real estate;

## *Alternative Investments*

- h. explain investment characteristics of infrastructure;
- i. describe issues in performance appraisal of alternative investments; and
- j. calculate and interpret returns of alternative investments on both before-fee and after-fee bases.

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## Introduction

In this section, we explain what alternative investments are and why assets under management in alternative investments have grown in recent decades. We also explain how alternative investments differ from traditional investments, and we examine their perceived investment merit. We conclude this section with a brief overview of the various categories of alternative investments; these categories will be explored in later sections.

“Alternative investments” is a label for a disparate group of investments that are distinguished from long-only, publicly traded investments in stocks, bonds, and cash (often referred to as traditional investments). The terms “traditional” and “alternative” should not imply that alternatives are necessarily uncommon or that they are relatively recent additions to the investment universe. Alternative investments include such assets as real estate and commodities, which are arguably two of the oldest types of investments.

Alternative investments also include nontraditional approaches to investing within special vehicles, such as private equity funds and hedge funds. These funds may give the manager flexibility to use derivatives and leverage, to make investments in illiquid assets, and to take short positions. The assets in which these vehicles invest can

include traditional assets (e.g., stocks, bonds, and cash) as well as less traditional assets. Management of alternative investments is typically active. Alternative investments often have many of the following characteristics:

- Narrow specialization of the investment managers
- Relatively low correlation of returns with those of traditional investments
- Less regulation and less transparency than traditional investments
- Limited historical risk and return data
- Unique legal and tax considerations
- Higher fees, often including performance or incentive fees
- Concentrated portfolios
- Restrictions on redemptions (i.e., “lockups” and “gates”)

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## Summary

This reading provides a comprehensive introduction to alternative investments. Some key points of the reading are as follows:

- Alternative investments are supplemental strategies to traditional long-only positions in stocks, bonds, and cash. Alternative investments include investments in five main categories: hedge funds, private capital, natural resources, real estate, and infrastructure.

## *Alternative Investments*

- Alternative investment strategies are typically active, return-seeking strategies that also often have risk characteristics different from those of traditional long-only investments.
- Characteristics common to many alternative investments, when compared with traditional investments, include the following: lower liquidity, less regulation, lower transparency, higher fees, and limited and potentially problematic historical risk and return data.
- Alternative investments often have complex legal and tax considerations and may be highly leveraged.
- Alternative investments are attractive to investors because of the potential for portfolio diversification resulting in a higher risk-adjusted return for the portfolio.
- Investors can access alternative invests in three ways:
  - Fund investment (such as in a private equity fund),
  - Direct investment into a company or project (such as infrastructure or real estate), and
  - Co-investment into a portfolio company of a fund.
- Investors conduct due diligence before investing in alternative investments. The due diligence approach depends on the investment method (e.g., direct, co-investing, or fund investing).
- Operational, financial, counterparty, and liquidity risks may be key considerations for those investing in alternative investments. These risks can be analyzed during the due diligence process. It is critical to perform fund due diligence to assess whether (1) the manager can effectively pursue the proposed investment strategy; (2) the appropriate organizational structure and policies for managing investments, operations, risk,

and compliance are in place; and (3) the fund terms appear reasonable.

- Many alternative investments, such as hedge and private equity funds, use a partnership structure with a general partner that manages the business and limited partners (investors) who own fractional interests in the partnership.
- The general partner typically receives a management fee based on assets under management or committed capital (the former is common to hedge funds, and the latter is common to private equity funds) and an incentive fee based on realized profits.
- Hurdle rates, high-water marks, lockup and notice periods, and clawback provisions are often specified in the limited partnership agreement.
- The fee structure affects the returns to investors (limited partners), with a waterfall representing the distribution method under which allocations are made to limited partners and general partners. Waterfalls can be on a whole-of-fund basis (European) or deal-by-deal basis (American).
- Hedge funds are typically classified by strategy. One such classification includes four broad categories of strategies: equity hedge (e.g., market neutral), event driven (e.g., merger arbitrage), relative value (e.g., convertible bond arbitrage), and macro and commodity trading adviser strategies.
- Funds-of-hedge-funds are funds that create a diversified portfolio of hedge funds. These vehicles are attractive to smaller investors that do not have the resources to select individual hedge funds and build a portfolio of them.
- Private capital is a broad term for funding provided to companies that is sourced from neither the public equity nor debt markets.

## *Alternative Investments*

Capital that is provided in the form of equity investments is called private equity, whereas capital that is provided as a loan or other form of debt is called private debt.

- Private equity refers to investment in privately owned companies or in public companies with the intent to take them private. Key private equity investment strategies include leveraged buyouts (e.g., management buyouts and management buy-ins) and venture capital. Primary exit strategies include trade sale, initial public offerings, and recapitalization.
- Private debt refers to various forms of debt provided by investors to private entities. Key private debt strategies include direct lending, mezzanine debt, and venture debt. Private debt also includes specialized strategies, such as collateralized loan obligations (CLOs), unitranche debt, real estate debt, and infrastructure debt.
- Natural resources include commodities (hard and soft), agricultural land (farmland), and timberland.
- Commodity investments may involve investing in actual physical commodities or in producers of commodities, but more typically, these investments are made using commodity derivatives (futures or swaps). One can also invest in commodities through a commodity trading adviser (see hedge funds).
- Returns to commodity investing are based on changes in price and do not include an income stream, such as dividends, interest, or rent (apart from income earned on the collateral). Timberland, however, offers an income stream based on the sale of trees, wood, and other products. Timberland can be thought of as both a factory and a warehouse. Plus, timberland is a sustainable investment that mitigates climate-related risks.

- Farmland, like timberland, has an income component related to harvest quantities and agricultural commodity prices. Farmland, however, does not have the production flexibility of timberland, because farm products must be harvested when ripe.
- Real estate includes two major sectors: residential and commercial. Residential real estate is the largest sector, making up some 75% of the market globally. Commercial real estate primarily includes office buildings, shopping centers, and warehouses. Real estate property has some unique features compared with other asset classes, including heterogeneity (no two properties are identical) and fixed location.
- Real estate investments can be direct or indirect, in the public market (e.g., real estate investment trusts) or in private transactions, and in equity or debt.
- The assets underlying infrastructure investments are real, capital intensive, and long lived. These assets are intended for public use, and they provide essential services. Examples include airports, health care facilities, and power plants. Funding is often done on a public–private partnership basis.
- Social infrastructure assets are directed toward human activities and include such assets as educational, health care, social housing, and correctional facilities, with the focus on providing, operating, and maintaining the asset infrastructure.
- Infrastructure investments may be categorized by the underlying asset’s stage of development. Investing in infrastructure assets *that are to be constructed* is generally referred to as greenfield investment. Investing in *existing* infrastructure assets may be referred to as brownfield investment.



## *Alternative Investments*

- Conducting performance appraisal on alternative investments can be challenging because these investments are often characterized by asymmetric risk–return profiles, limited portfolio transparency, illiquidity, product complexity, and complex fee structures.
- Traditional risk and return measures (such as mean return, standard deviation of returns, and beta) may provide an inadequate picture of alternative investments’ risk and return characteristics. Moreover, these measures may be unreliable or not representative of specific investments.
- A variety of ratios can be calculated to review the performance of alternative investments, including the Sharpe ratio, Sortino ratio, Treynor ratio, Calmar ratio, and managed account report (MAR) ratio. In addition, batting average and slugging percentage also can be used. The internal rate of return (IRR) calculation often is used to evaluate private equity investments, and the cap rate is often used to evaluate real estate investments.
- Redemption rules and lockup periods can bring special challenges to performance appraisal of alternative investments.
- When comparing the performance of alternative investments versus an index, the analyst must be aware that indexes for alternative investments may be subject to a variety of biases, including survivorship and backfill biases.
- Analysts need to be aware of any custom fee arrangements in place that will affect the calculation of fees and performance. These can include such arrangements as (1) fee discounts based on custom liquidity terms or significant asset size; (2) special share classes, such as “founders’ shares”; and (3) departures from the typical management fee plus performance fee structure in favor of either/or fees.



# Real Estate Investments

**Steven G. Bloom, CFA, Jeffrey D. Fisher, PhD, David Kruth, CFA, Bryan D. MacGregor, PhD, MRICS, MRTPI, Ian Rossa O'Reilly, CFA, and Anthony Paolone, CFA**

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## Learning Outcomes

The candidate should be able to:

- a. compare the characteristics, classifications, principal risks, and basic forms of public and private real estate investments;
- b. explain portfolio roles and economic value determinants of real estate investments;
- c. discuss commercial property types, including their distinctive investment characteristics;
- d. explain the due diligence process for both private and public equity real estate investments;
- e. discuss real estate investment indexes, including their construction and potential biases;
- f. discuss the income, cost, and sales comparison approaches to valuing real estate properties;

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- g. compare the direct capitalization and discounted cash flow valuation methods;
- h. estimate and interpret the inputs (e.g., net operating income, capitalization rate, and discount rate) to the direct capitalization and discounted cash flow valuation methods;
- i. calculate the value of a property using the direct capitalization and discounted cash flow valuation methods;
- j. calculate and interpret financial ratios used to analyze and evaluate private real estate investments;
- k. discuss types of real estate investment trusts (REITs);
- l. justify the use of net asset value per share (NAVPS) in REIT valuation and estimate NAVPS based on forecasted cash net operating income;
- m. describe the use of funds from operations (FFO) and adjusted funds from operations (AFFO) in REIT valuation;
- n. calculate and interpret the value of a REIT share using the net asset value, relative value (price-to-FFO and price-to-AFFO), and discounted cash flow approaches; and
- o. explain advantages and disadvantages of investing in real estate through publicly traded securities compared to private vehicles.

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## Introduction

Real estate offers investors long-term stable income, some protection from inflation, and generally low correlations with stocks and bonds. High-quality, well-managed properties with low leverage generally

are expected to provide higher returns than high-grade corporate debt (albeit with higher risk) and lower returns and risk than equity. Real estate investment can be an effective means of diversification in many balanced investment portfolios. Investors can choose to have the equity, or ownership, position in properties, or they may prefer to have exposure to real estate debt as a lender or owner of mortgage-backed securities. Residential real estate constitutes by far the largest portion of the real estate market, most of which is owner occupied. Nonetheless, we will focus almost exclusively on rental, or commercial, properties. These include office buildings, shopping centers, distribution facilities, and for-rent residential properties.

Private real estate investments often hold the greatest appeal for investors with long-term investment horizons and the ability to accept relatively lower liquidity. Pension funds, sovereign wealth funds, insurance companies, and high-net-worth individuals have been among the largest investors in private real estate. Securitized real estate ownership—shares of publicly traded, pooled real estate investments, such as real estate operating companies (REOCs), real estate investment trusts (REITs), and mortgage-backed securities (MBS)—historically has provided smaller investors with ready access to the asset class because of low share prices and the benefits of higher liquidity and professional management. Institutional investors also pursue securitized real estate when the market capitalization of the vehicles can accommodate large investor demand. In fact, institutional ownership of US REITs has increased from 6.6% in 1990 to 64.5% in 2015, according to a 2019 research paper (Huerta, Ngo, and Pyles 2019).<sup>1</sup>

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<sup>1</sup>Huerta, Daniel, Thanh Ngo, and Mark Pyles. 2019. “*The Role of Institutional Ownership in REIT Acquisitions.*” Working paper (August): 3. [www.fmaconferences.org/NewOrleans/Papers/TheRoleofInstitutionalOwnershipinREITAcquisitions.pdf](http://www.fmaconferences.org/NewOrleans/Papers/TheRoleofInstitutionalOwnershipinREITAcquisitions.pdf).

Regardless of vehicle type, the risk profile of the underlying investment can vary significantly. High-quality properties in leading markets with long-term leases and low leverage have a conservative risk profile, as do those mortgages that represent only slightly more than half of the asset's value. Older properties with short-term leases in suburban markets with ample room for new development and higher leverage constitute higher-risk properties. Below-investment-grade, nonrated, and mezzanine debt similarly carries higher risk. Development property is often considered to be the riskiest because of long lead times and the dependence on contractors, suppliers, regulators, and future tenants for success.

Section A presents real estate as an asset class, delves into its role in portfolios, and contrasts the different characteristics of the major property types. Sections B and C explore private and public investing, respectively, with particular attention to valuation. Investment valuation and performance can be analyzed at the property and vehicle level. The end of the reading returns to the role of real estate in the portfolio and discusses whether investors' goals are best served by choosing private or public real estate vehicles.

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## Summary

Real estate property is an asset class that plays a significant role in many investment portfolios and is an attractive source of current income. Investor allocations to public and private real estate have increased significantly over the past 20 years. Because of the unique characteristics of real estate property, real estate investments tend to behave differently from other asset classes—such as stocks, bonds, and commodities—and thus have different risks and diversification benefits. Private real estate investments are further differentiated

because the investments are not publicly traded and require analytic techniques different from those of publicly traded assets. Because of the lack of transactions, the appraisal process is required to value real estate property. Many of the indexes and benchmarks used for private real estate also rely on appraisals, and because of this characteristic, they behave differently from indexes for publicly traded equities, such as the S&P 500, MSCI Europe, FTSE Asia Pacific, and many other regional and global indexes.

## General Characteristics of Real Estate

- Real estate investments make up a significant portion of the portfolios of many investors.
- Real estate investments can occur in four basic forms: private equity (direct ownership), publicly traded equity (indirect ownership claim), private debt (direct mortgage lending), and publicly traded debt (securitized mortgages).
- Each of the basic forms of real estate investment has its own risks, expected returns, regulations, legal structures, and market structures.
- Equity investors generally expect a higher rate of return than lenders (debt investors) because they take on more risk. The returns to equity for real estate investors have two components: an income stream and capital appreciation.
- Many motivations exist for investing in real estate income property. The key factors are current income, price appreciation, inflation hedge, diversification, and tax benefits.
- Adding equity real estate investments to a traditional portfolio will potentially have diversification benefits because of the

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less-than-perfect correlation of equity real estate returns with returns to stocks and bonds.

- If the income stream can be adjusted for inflation and real estate prices increase with inflation, then equity real estate investments may provide an inflation hedge.
- Debt investors in real estate expect to receive their return from promised cash flows and typically do not participate in any appreciation in value of the underlying real estate. Thus, debt investments in real estate are similar to other fixed-income investments, such as bonds.
- Regardless of the form of real estate investment, the value of the underlying real estate property can affect the performance of the investment. Location is a critical factor in determining the value of a real estate property.
- Real estate property has some unique characteristics compared with other investment asset classes. These characteristics include heterogeneity and fixed location, high unit value, management intensiveness, high transaction costs, depreciation, sensitivity to the credit market, illiquidity, and difficulty of value and price determination.
- There are many different types of real estate properties in which to invest. The main commercial (income-producing) real estate property types are office, industrial and warehouse, retail, and multifamily properties. Other types of commercial properties are typically classified by their specific use.
- Certain risk factors are common to commercial property, but each property type is likely to have a different susceptibility to these factors. The key risk factors that can affect commercial real estate include business conditions, lead time for new development, excess supply, cost and availability of capital, unexpected

inflation, demographics, lack of liquidity, environmental issues, availability of information, management expertise, and leverage.

- Location, lease structures, and economic factors—such as economic growth, population growth, employment growth, and consumer spending—affect the value of each property type.
- An understanding of the lease structure is important when analyzing a real estate investment.
- Appraisals estimate the value of real estate income property. Definitions of value include market value, investment value, value in use, and mortgage lending value.
- Due diligence investigates factors that might affect the value of a property before making or closing on an investment. These factors include leases and lease history, operating expenses, environmental issues, structural integrity, lien/proof of ownership, property tax history, and compliance with relevant laws and regulations.
- Appraisal-based and transaction-based indexes are used to track the performance of private real estate. Appraisal-based indexes tend to lag transaction-based indexes and appear to have lower volatility and lower correlation with other asset classes than transaction-based indexes.

## Private Equity Real Estate

- Generally, three different approaches are used by appraisers to estimate value: income, cost, and sales comparison.
- The income approach includes direct capitalization and discounted cash flow methods. Both methods focus on net operating income as an input to the value of a property and indirectly or directly factor in expected growth.



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- The cost approach estimates the value of a property based on adjusted replacement cost. This approach is typically used for unusual properties for which market comparables are difficult to obtain.
- The sales comparison approach estimates the value of a property based on what price comparable properties are selling for in the current market.
- When debt financing is used to purchase a property, additional ratios and returns calculated and interpreted by debt and equity investors include the loan-to-value ratio, the debt service coverage ratio, and leveraged and unleveraged internal rates of return.

### **Publicly Traded Real Estate Securities**

- The principal types of publicly traded real estate securities available globally are real estate investment trusts, real estate operating companies, and residential and commercial mortgage-backed securities.
- Publicly traded equity real estate securities offer investors participation in the returns from investment real estate with the advantages of superior liquidity; greater potential for diversification by property, geography, and property type; access to a larger range of properties; the benefit of management services; limited liability; protection accorded by corporate governance, disclosure, and other securities regulations; and in the case of REITs, exemption from corporate income taxation within the REIT if prescribed requirements are met.
- Disadvantages include the costs of maintaining a publicly traded corporate structure and complying with regulatory filings,

pricing determined by the stock market and returns that can be volatile, the potential for structural conflicts of interest, and tax differences compared with direct ownership of property that can be disadvantageous under some circumstances.

- Compared with other publicly traded shares, REITs offer higher-than-average yields and greater stability of income and returns. They are amenable to a net asset value approach to valuation because of the existence of active private markets for their real estate assets. Compared with REOCs, REITs offer higher yields and income tax exemptions but have less operating flexibility to invest in a broad range of real estate activities and less potential for growth from reinvesting their operating cash flows because of their high income-to-payout ratios.
- In assessing the investment merits of REITs, investors analyze the effects of trends in general economic activity, retail sales, job creation, population growth, and new supply and demand for specific types of space. They also pay particular attention to occupancies, leasing activity, rental rates, remaining lease terms, in-place rents compared with market rents, costs to maintain space and re-lease space, tenants' financial health and tenant concentration in the portfolio, financial leverage, debt maturities and costs, and the quality of management and governance.
- Analysts make adjustments to the historical cost-based financial statements of REITs and REOCs to obtain better measures of current income and net worth. The three principal figures they calculate and use are (1) funds from operations or accounting net earnings, excluding depreciation, deferred tax charges, and gains or losses on sales of property and debt restructuring; (2) adjusted funds from operations, or funds from operations adjusted to remove straight-line rent and to provide for maintenance-type

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capital expenditures and leasing costs, including leasing agents' commissions and tenants' improvement allowances; and (3) net asset value or the difference between a real estate company's asset and liability ranking before shareholders' equity, all valued at market values instead of accounting book values.

- REITs and some REOCs generally return a significant portion of their income to their investors and, as a result, tend to pay high dividends. Thus, dividend discount or discounted cash flow models for valuation are also applicable. These valuation approaches are applied in the same manner as they are for shares in other industries. Usually, investors use two- or three-step dividend discount models with near-term, intermediate-term, or long-term growth assumptions. In discounted cash flow models, investors often use intermediate-term cash flow projections and a terminal value based on historical cash flow multiples.



# Integrated Cases in Risk Management: Institutional

**Steve Balaban, CFA, Arjan Berkelaar, PhD, CFA, Nasir Hasan, and Hardik Sanjay Shah, CFA**

*Steve Balaban, CFA, is at Mink Capital Inc. (Canada). Arjan Berkelaar, PhD, CFA, is at KAUST Investment Management Company (USA). Nasir Hasan is at Ernst & Young (UAE). Hardik Sanjay Shah, CFA, is at GMO LLC (Singapore).*

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## Learning Outcomes

The candidate should be able to:

- a. discuss financial risks associated with the portfolio strategy of an institutional investor;
- b. discuss environmental and social risks associated with the portfolio strategy of an institutional investor;
- c. analyze and evaluate the financial and nonfinancial risk exposures in the portfolio strategy of an institutional investor;
- d. discuss various methods to manage the risks that arise on long-term direct investments of an institutional investor; and
- e. evaluate strengths and weaknesses of an enterprise risk management system and recommend improvements.

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## Introduction

The focus of this reading is a fictional case study. The case study will focus on the portfolio of a sovereign wealth fund (SWF) specifically looking at risk in terms of the SWF's long-term investments. There are three learning outcome statements (LOS) associated within this case. Before the case study, we provide two LOS to offer background information that will be helpful to the candidate in understanding the case.



# Capital and Corporate Issuers

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## Applicable Readings

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### **Sources of Capital (Level I)**

By Edgar A. Norton, Jr., PhD, CFA, Kenneth L. Parkinson, MBA, CCM, Pamela Peterson Drake, PhD, CFA, and John D. Stowe, PhD, CFA

1 PL credit

Access the full reading: [cfainst.is/sourcesofcapital](https://cfainst.is/sourcesofcapital)

### **Uses of Capital (Level I)**

By John D. Stowe, PhD, CFA, and Jacques R. Gagné, FSA, CFA, CIPM

1 PL credit

Access the full reading: [cfainst.is/usesofcapital](https://cfainst.is/usesofcapital)

### **Capital Structure (Levels I and II)**

By Raj Aggarwal, PhD, CFA, Glen D. Campbell, MBA, Pamela Peterson Drake, PhD, CFA, Adam Kobor, PhD, CFA, and Gregory Noronha, PhD, CFA

1.5 PL credits

Access the full reading: [cfainst.is/capitalstructure](https://cfainst.is/capitalstructure)

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## What Is Changing in the 2022 Curriculum?

A variety of debt and equity claims that companies rely on for their sources of capital are assessed in the new reading “Sources of Capital.” The reading also considers sources of liquidity and how to judge the liquidity positions of companies.

The range of financing options (short- and long-term, internal and external) that are open to companies is discussed, along with the practical considerations of these options. The reading focuses on working capital management for the purpose of assessing corporate liquidity, as opposed to the management of working capital items from a company perspective (which was the previous focus of this topic).

The strategic process for determining long-term capital investment is explored in a major revision of the reading “Uses of Capital.” The reading now contains less detail on individual project cash-flow evaluation from a company perspective. The aim is to equip learners with the two main methods—net present value (NPV) and internal rate of return (IRR)—used by companies to allocate capital. Importantly for practitioners, the reading sets out the advantages and limitations of each method.

Practical examples and explanations as to why companies’ debt use varies over their lifecycles are found in a major revision to the reading “Capital Structure.” Conflicts that arise between company stakeholders and equity and debtholders in particular are addressed, alongside a detailed example of why management may choose to support the former over the latter. The case for debt in the capital structure is also assessed, with reference to the Modigliani–Miller propositions.



## Why Does It Matter to Members?

The streamlined information in “Sources of Capital” provides members with the knowledge needed to assess the choices a company makes for its funding and a company’s liquidity position relative to its peers.

Meanwhile, “Uses of Capital” explains how and why sound capital allocation decisions ultimately decide the future success of many corporations. As members may know, capital investments can describe a company’s prospects better than its working capital or capital structure, which is often similar across the corporate spectrum. The reading indicates how analysts may assess a company’s capital investment strategy and, in doing so, better evaluate corporate decisions.

The reading also explains how analysts may be able to appraise the quality of the company’s capital allocation process on the basis of whether the company has an accounting focus or an economic focus. In doing so, analysts can derive insights into how the company is creating value (or otherwise) for investors.

A company’s capital structure is the result of financing decisions guided by capital structure policies or targets set by management and the board. “Capital Structure” explains how capital structure is also the result of factors, such as company size and maturity, which influence the financing options available to a company. The reading further helps the understanding of learners by explaining how capital structure can be significantly affected by mergers and acquisitions (M&A) as well as by the proceeds of divestments and asset sales. How capital structure is affected over time by a company’s operations and dividend policies is also explored.



# Sources of Capital

**Edgar A. Norton, Jr., PhD, CFA, Kenneth L. Parkinson, MBA, CCM, Pamela Peterson Drake, PhD, CFA, and John D. Stowe, PhD, CFA**

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## Learning Outcomes

The candidate should be able to:

- a. describe types of financing methods and considerations in their selection;
- b. describe primary and secondary sources of liquidity and factors that influence a company's liquidity position;
- c. compare a company's liquidity position with that of peer companies; and
- d. evaluate choices of short-term funding.

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## Introduction

Raising capital is a fundamental business activity, and companies have multiple short-term and long-term financing choices.

Short-term funds without explicit interest rates, such as accounts payable, are part of **working capital management**, which is the management of short-term assets and liabilities. Other debt and equity obligations used to finance the business longer term are considered part of the firm's **capital structure**. The goal of effective working capital management is to ensure that a company has adequate, ready access to the funds necessary for day-to-day operations, while at the same time making sure that the company's assets are invested in the most productive way. The goal of capital structure management is to balance the risks and costs of the firm's long-term finances. In this reading, we examine a variety of debt and equity claims that companies rely on for their sources of capital. This reading also considers sources of liquidity and explains how to judge the liquidity position of firms.

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## Summary

In this reading, we considered key aspects of capital alternatives and short-term financial management: the financing choices available to a company and effective liquidity management. Both are critical to ensure a company's solvency and ability to remain in business. If done improperly, the results can be disastrous for the company.



# Uses of Capital

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## Learning Outcomes

The candidate should be able to:

- a. describe the capital allocation process and basic principles of capital allocation;
- b. demonstrate the use of net present value (NPV) and internal rate of return (IRR) in allocating capital and describe the advantages and disadvantages of each method;
- c. describe expected relations among a company's investments, company value, and share price;
- d. describe types of real options relevant to capital investment; and
- e. describe common capital allocation pitfalls.

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## Introduction

To achieve profitability and reach sustainability, a company must use its resources effectively and make long-term investments that increase revenues and profits. Investment opportunities returning

long-term benefits and future cash flows greater than their associated cost to fund generate value for companies and corresponding wealth for their owners. Decisions on where and when to make long-term capital investments are, therefore, key management decisions central to a company's operating success and longevity. Understanding how companies allocate their capital among competing priorities and their resulting portfolios of investment activity is a fundamental area of knowledge for financial analysts for many reasons.

The allocation and investment of capital are important corporate activities. Capital investments (also referred to here as capital projects) are investments with a life of one year or longer, and they make up the long-term asset portion of the balance sheet. They can be so large that sound capital allocation decisions ultimately decide the future success of many corporations. Capital investments also describe a company's future prospects better than its working capital or capital structure, which are intangible and often similar for companies. Analysts may attempt to estimate the process, within reason, for companies that are not too complex and, in doing so, better evaluate corporate decisions that extend to financing and other related activity. Analysts also may be able to appraise the quality of the company's capital allocation process—for example, on the basis of whether the company has an accounting focus or an economic focus. In doing so, analysts derive insights into how the company is creating value for investors.

This reading is organized as follows: Section 2 presents the steps taken by companies in a typical capital allocation process and the basic principles of capital allocation. In Section 3, we introduce basic investment decision criteria, and in Section 4, we discuss capital allocation options—known as real options—that allow their holders, in this case companies, to make decisions in the future that alter the value of their capital investment decisions made today. Section 5

covers a discussion of the common capital allocation pitfalls often made by companies, and a summary concludes the reading.

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## Summary

Capital allocation is the process that companies use for decision making on capital investments—those investments with a life of a year or longer. This reading developed the principles behind the basic capital allocation model, the cash flows that go into the model, and several extensions of the basic model.

- Capital allocation supports the most critical investments for many corporations—their investments in long-term assets. The principles of capital allocation have been applied to other corporate investing and financing decisions and to security analysis and portfolio management.
- The typical steps in the capital allocation process are (1) generating ideas, (2) analyzing investment opportunities, (3) planning the capital allocation, and (4) monitoring and postauditing.
- Types of investments appropriate for the capital allocation process can be categorized as (1) replacement; (2) expansion; (3) new products and services; and (4) regulatory, safety, and environmental.
- Capital allocation decisions are based on incremental after-tax cash flows discounted at the opportunity cost of funds. Financing costs are ignored because both the cost of debt and the cost of other capital are captured in the discount rate.

- The NPV is the present value of all after-tax cash flows, or

$$\text{NPV} = \sum_{t=0}^n \frac{\text{CF}_t}{(1+r)^t},$$

where the investment outlays are negative cash flows included in the  $\text{CF}_t$ s and where  $r$  is the required rate of return for the investment.

- The IRR is the discount rate that makes the present value of all future cash flows sum to zero. This equation can be solved for the IRR:

$$\sum_{t=0}^n \frac{\text{CF}_t}{(1+\text{IRR})^t} = 0.$$

- The capital allocation decision rules are to invest if the  $\text{NPV} > 0$  or if the  $\text{IRR} > r$ .
- For mutually exclusive investments that are ranked differently by the NPV and IRR, the NPV criterion is more economically sound.
- The fact that projects with positive NPVs theoretically increase the value of the company and the value of its stock could explain the popularity of NPV as an evaluation method.
- Real options can be classified as (1) timing options; (2) sizing options, which can be abandonment options or growth (expansion) options; (3) flexibility options, which can be price-setting options or production-flexibility options; and (4) fundamental options.

# Capital Structure

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## Learning Outcomes

The candidate should be able to:

- a. describe how a company's capital structure may change over its life cycle;
- b. explain the Modigliani–Miller propositions regarding capital structure;
- c. describe the use of target capital structure in estimating weighted average cost of capital (WACC), and calculate and interpret target capital structure weights;
- d. explain factors affecting capital structure decisions; and
- e. describe competing stakeholder interests in capital structure decisions.

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## Introduction

**Capital structure** refers to the specific mix of debt and equity used to finance a company's assets and operations. From a corporate perspective, equity represents a more expensive, permanent source of capital with greater financial flexibility. In contrast, debt represents a cheaper, finite-to-maturity capital source that legally obligates the company to fixed, promised cash outflows with the need to refinance at some future date at an unknown cost.

A company's capital structure is the result of such financing decisions that may be guided by capital structure policies or targets set by management and the board. Capital structure is also the result of such factors as company size and maturity, which influence the financing options a company may have available. Besides equity and debt issuance, capital structure can be significantly affected by merger and acquisition (M&A) activity, which can be financed by cash, borrowing, share assumption, or debt assumption in addition to proceeds from divestitures and asset sales. Capital structure is also affected over time by the company's operations, which might consume or generate cash, and by management decisions regarding dividends and share buybacks.

Because we are considering how a company minimizes its overall cost of capital, our focus is on the market values of debt and equity. Therefore, capital structure is also affected by changes in the market value of a company's securities over time, particularly the share price.

We tend to think of capital structure as the result of a conscious decision by management, but it is not that simple. For example, unmanageable debt, or financial distress, can arise because a company's capital structure policy was too aggressive, but it can also occur because operating results or prospects deteriorate unexpectedly.

This reading reviews some of the key factors affecting capital structure, including the following:



- **Company life cycle:** Companies typically evolve over time from cash consumers to cash generators, with decreasing business risk and increasing debt capacity.
- **Cost of capital:** From a theoretical perspective, company management seeks to maximize shareholder value and determines an optimal capital structure to minimize the company's **weighted average cost of capital (WACC)**. "Optimal capital structure" involves a trade-off between the benefits of higher leverage, which include the tax deductibility of interest and the lower cost of debt relative to equity, and the costs of higher leverage, which include higher risk for all capital providers and the potential costs of financial distress.
- **Financing considerations:** From a practical perspective, company management may consider several factors in capital structure decisions and the use of leverage.
- **Competing stakeholder interests:** In seeking to maximize shareholder value, company management may make capital structure decisions that are not in the interests of other stakeholders, such as debtholders, suppliers, customers, or employees.

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## Summary

- A company's stage in the life cycle, its cash flow characteristics, and its ability to support debt largely dictate its capital structure because capital not sourced through borrowing must come from equity (including retained earnings).
- Generally speaking, as companies mature and move from start-up, through growth, to maturity, their business risk declines as

operating cash flows turn positive with increasing predictability, allowing for greater use of leverage at more attractive terms.

- Modigliani and Miller's work shows us that managers cannot change firm value simply by changing the firm's capital structure. Firm value is independent of the capital structure decision.
- Given the tax deductibility of interest, adding leverage increases firm value to a point but also increases the risk of default for capital providers who demand higher returns in compensation.
- To maximize firm value, management should target the optimal capital structure that minimizes the company's WACC.
- In practice, financing decisions typically are tied to investment spending and are based on the company's ability to support debt given the nature of its business and operating cash flows.
- Managers may provide investors with information ("signaling") through their choice of financing method. For example, commitments to fixed payments can signal management's confidence in the company's future prospects.
- Management's capital structure decisions affect various stakeholder groups differently. In seeking to maximize shareholder wealth or their own, conflicts of interest may arise in which one or more groups are favored at the expense of others.

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# Investment Analysis Techniques

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## Applicable Readings

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### **Hypothesis Testing (Level I)**

By Pamela Peterson Drake, PhD, CFA

2.5 PL credits

Access the full reading: [cfainst.is/hypothesistesting](http://cfainst.is/hypothesistesting)

### **Introduction to Linear Regression (Levels I and II)**

By Pamela Peterson Drake, PhD, CFA

2 PL credits

Access the full reading: [cfainst.is/linearregression](http://cfainst.is/linearregression)

### **Probability Concepts (Level I)**

By Richard A. DeFusco, PhD, CFA, Dennis W. McLeavey, DBA, CFA, Jerald E. Pinto, PhD, CFA, and David E. Runkle, PhD, CFA

2 PL credits

Access the full reading: [cfainst.is/probabilityconcepts](http://cfainst.is/probabilityconcepts)

### **Common Probability Distributions (Level I)**

By Richard A. DeFusco, PhD, CFA, Dennis W. McLeavey, DBA, CFA, Jerald E. Pinto, PhD, CFA, and David E. Runkle, PhD, CFA

2 PL credits

Access the full reading: [cfainst.is/probabilitydistributions](http://cfainst.is/probabilitydistributions)

### **Sampling and Estimation (Level I)**

By Richard A. DeFusco, PhD, CFA, Dennis W. McLeavey, DBA, CFA, Jerald E. Pinto, PhD, CFA, and David E. Runkle, PhD, CFA

1.5 PL credits

Access the full reading: [cfainst.is/samplingestimation](http://cfainst.is/samplingestimation)

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## What Is Changing in the 2022 Curriculum?

The new reading “Hypothesis Testing” includes important new content for analysts. The new content includes interpretation of significance in the context of multiple tests (false discovery approach), nonparametric tests (Spearman rank correlation), and tests of independence using contingency table data.

Other important innovations in this reading include a six-step framework for conducting hypothesis tests. This framework will now be used throughout the CFA Program curriculum for hypothesis testing in other topic areas. Members will also learn about Excel functions, and Python and R code for calculating values for the various test statistics used in hypothesis testing.

An introduction to indicator variables (dummy variables), and the presentation of different functional forms for simple linear regression models (log-lin, lin-log, log-log) form an important part of the new reading “Introduction to Linear Regression.” This reading also includes code snippets for calculating simple linear regression models and generating analysis of variance (ANOVA) output.

Updated and streamlined coverage of key probability concepts, as well as new engaging visuals, graphics, and flowcharts are key elements of the revised reading “Probability Concepts.” In addition to aiding understanding of basic probability, members can refresh their knowledge on frequencies of events, the total probability rule, Bayes’ formula, the multiplication rule, and other important probability concepts. The reading includes plenty of theory, but the focus is resolutely on the practical application.

The revised reading “Common Probability Distributions” consolidates discussion of a range of key probability distributions, including discrete and continuous uniform; Bernoulli and binomial; normal, standard normal, and lognormal; and Student’s  $t$ -, chi-square- and F-distributions. Also included are engaging visuals, graphics, and flowcharts that should further readers’ understanding of concepts like the evolution of pdfs and cdfs for various distributions, as well as the process of Monte Carlo simulation. Code snippets are used to calculate probabilities using the different distributions. The reading also illustrates how probability distributions along with a payoff diagram are used in Monte Carlo simulation to generate the expected outcomes from a call option.

As analysts, we are accustomed to using sample information to assess, for example, how stock markets around the world are performing. In addition to updating and streamlining coverage of existing key sampling and estimation concepts, the revised reading “Sampling and Estimation” introduces important new sampling techniques. These concepts include cluster sampling, nonprobability sampling (convenience and judgmental), and resampling (bootstrap and jackknife).



# Why Does It Matter to Members?

The tools that allow us to make decisions with consistency and logic in an investment landscape loaded with risk are based on probability concepts. “Probability Concepts” presents the essential probability tools needed to frame and address many real-world problems. These tools can be applied to a variety of issues, such as predicting investment manager performance, forecasting financial variables, and pricing bonds so they fairly compensate bondholders for default risk.

“Common Probability Distributions” provides working knowledge that can form a base to study and use other quantitative methods, such as hypothesis testing, regression analysis, Monte Carlo simulation, and back testing.

The central limit theorem and estimation, the core method presented in “Sampling and Estimation,” is used in many investment applications. This reading helps with the interpretation of statistical results based on the way in which financial data are collected as well as the possible pitfalls of this process.

The many engaging visuals, graphics, and flowcharts in “Hypothesis Testing” held readers select the appropriate test statistic and understand concepts such as Type I and Type II errors, critical values, interpreting  $p$ -values, and Spearman rank correlation, among others. The six-step framework and other new content make this reading important for any analyst or investment professional who uses hypothesis testing in their decision-making processes.

“Introduction to Linear Regression” will help readers determine whether data and regression results (residuals) adhere to the assumptions underlying simple linear regression and understand and interpret ANOVA as well as create and interpret prediction intervals.



# Hypothesis Testing

**Pamela Peterson Drake, PhD, CFA**

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## Learning Outcomes

The candidate should be able to:

- a. define a hypothesis, describe the steps of hypothesis testing, and describe and interpret the choice of the null and alternative hypotheses;
- b. compare and contrast one-tailed and two-tailed tests of hypotheses;
- c. explain a test statistic, Type I and Type II errors, a significance level, how significance levels are used in hypothesis testing, and the power of a test;
- d. explain a decision rule and the relation between confidence intervals and hypothesis tests, and determine whether a statistically significant result is also economically meaningful.
- e. explain and interpret the  $p$ -value as it relates to hypothesis testing;
- f. describe how to interpret the significance of a test in the context of multiple tests;



*Investment Analysis Techniques*

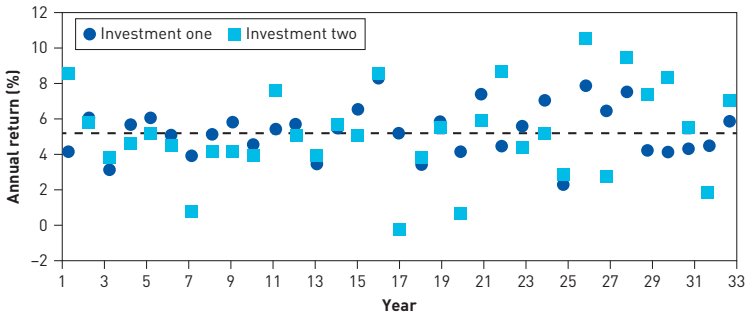
- g. identify the appropriate test statistic and interpret the results for a hypothesis test concerning the population mean of both large and small samples when the population is normally or approximately normally distributed and the variance is (1) known or (2) unknown;
- h. identify the appropriate test statistic and interpret the results for a hypothesis test concerning the equality of the population means of two at least approximately normally distributed populations based on independent random samples with equal assumed variances;
- i. identify the appropriate test statistic and interpret the results for a hypothesis test concerning the mean difference of two normally distributed populations;
- j. identify the appropriate test statistic and interpret the results for a hypothesis test concerning (1) the variance of a normally distributed population and (2) the equality of the variances of two normally distributed populations based on two independent random samples;
- k. compare and contrast parametric and nonparametric tests, and describe situations in which each is the more appropriate type of test;
- l. explain parametric and nonparametric tests of the hypothesis that the population correlation coefficient equals zero, and determine whether the hypothesis is rejected at a given level of significance; and
- m. explain tests of independence based on contingency table data.

## Introduction

### Why Hypothesis Testing?

Faced with an overwhelming amount of data, analysts must deal with the task of wrangling those data into something that provides a clearer picture of what is going on. Consider an analyst evaluating the returns on two investments over 33 years, as shown in Exhibit 1.

**Exhibit 1. Returns for Investments One and Two over 33 Years**



Although “a picture is worth a thousand words,” what can we actually glean from this plot? Can we tell if each investment’s returns are different from an average of 5%? Can we tell whether the returns are different for Investment One and Investment Two? Can we tell whether the standard deviations of the two investments are each different from 2%? Can we tell whether the variability is different for the two investments? For these questions, we need to have more precise

tools than simply a plot over time. We need a set of tools that can aid us in making decisions based on the data.

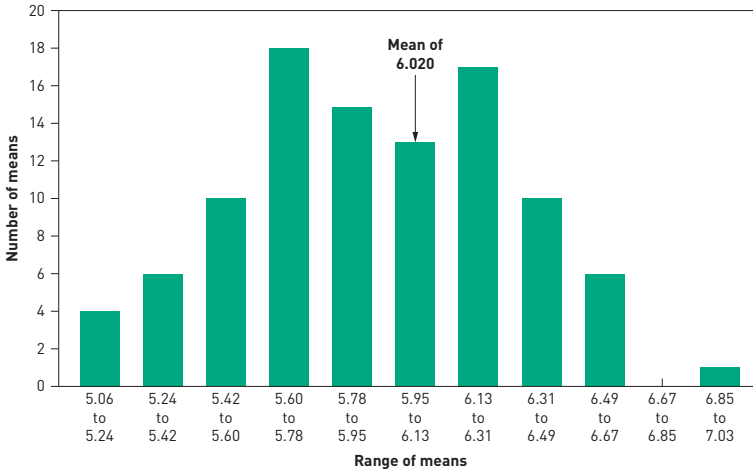
We use the concepts and tools of hypothesis testing to address these questions. Hypothesis testing is part of statistical inference, the process of making judgments about a larger group (a population) based on a smaller group of observations (i.e., a sample).

### Implications from a Sampling Distribution

Consider a set of 1,000 asset returns with a mean of 6% and a standard deviation of 2%. If we draw a sample of returns from this population, what is the chance that the mean of this sample will be 6%? What we know about sampling distributions is that how close any given sample mean will be to the population mean depends on the sample size, the variability within the population, and the quality of our sampling methodology.

For example, suppose we draw a sample of 30 observations and the sample mean is 6.13%. Is this close enough to 6% to alleviate doubt that the sample is drawn from a population with a mean of 6%? Suppose we draw another sample of 30 and find a sample mean of 4.8%. Does this bring into doubt whether the population mean is 6%? If we keep drawing samples of 30 observations from this population, we will get a range of possible sample means, as shown in Exhibit 2 for 100 different samples of size 30 from this population, with a range of values from 5.06% to 7.03%. All these sample means are a result of sampling from the 1,000 asset returns.

## Exhibit 2. Distribution of Sample Means of 100 Samples Drawn from a Population of 1,000 Returns



As you can see in Exhibit 2, a sample mean that is quite different from the population mean can occur. Although this situation is not as likely as drawing a sample with a mean closer to the population mean, it can still happen. *In hypothesis testing, we test to see whether a sample statistic is likely to come from a population with the hypothesized value of the population parameter.*

The concepts and tools of hypothesis testing provide an objective means to gauge whether the available evidence supports the hypothesis. After applying a statistical test of a hypothesis, we should have a clearer idea of the probability that a hypothesis is true or not, although our conclusion always stops short of certainty.

This reading focuses on the framework of hypothesis testing and on tests concerning mean, variance, and correlation—the three quantities frequently used in investments.

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## Summary

In this reading, we have presented the concepts and methods of statistical inference and hypothesis testing.

- A hypothesis is a statement about one or more populations.
- The steps in testing a hypothesis are as follows:
  1. State the hypotheses.
  2. Identify the appropriate test statistic and its probability distribution.
  3. Specify the significance level.
  4. State the decision rule.
  5. Collect the data and calculate the test statistic.
  6. Make a decision.
- We state two hypotheses: The null hypothesis is the hypothesis to be tested; the alternative hypothesis is the hypothesis accepted if the null hypothesis is rejected.
- There are three ways to formulate hypotheses. Let  $\theta$  indicate the population parameters:
  1. Two-sided alternative:  $H_0: \theta = \theta_0$  versus  $H_a: \theta \neq \theta_0$ ,
  2. One-sided alternative (right side):  $H_0: \theta \leq \theta_0$  versus  $H_a: \theta > \theta_0$ ,

3. One-sided alternative (left side):  $H_0: \theta \geq \theta_0$  versus  $H_a: \theta < \theta_0$ , where  $\theta_0$  is a hypothesized value of the population parameter and  $\theta$  is the true value of the population parameter.

- When we have a “suspected” or “hoped-for” condition for which we want to find supportive evidence, we frequently set up that condition as the alternative hypothesis and use a one-sided test. The researcher, however, may select a “not equal to” alternative hypothesis and conduct a two-sided test to emphasize a neutral attitude.
- A test statistic is a quantity, calculated using a sample, whose value is the basis for deciding whether to reject or not reject the null hypothesis. We compare the computed value of the test statistic to a critical value for the same test statistic to decide whether to reject or not reject the null hypothesis.
- In reaching a statistical decision, we can make two possible errors: We may reject a true null hypothesis (a Type I error, or false positive), or we may fail to reject a false null hypothesis (a Type II error, or false negative).
- The level of significance of a test is the probability of a Type I error that we accept in conducting a hypothesis test. The standard approach to hypothesis testing involves specifying only a level of significance (i.e., the probability of a Type I error). The complement of the level of significance is the confidence level.
- The power of a test is the probability of correctly rejecting the null (rejecting the null when it is false). The complement of the power of the test is the probability of a Type II error.
- A decision rule consists of determining the critical values with which to compare the test statistic to decide whether to reject or

not reject the null hypothesis. When we reject the null hypothesis, the result is said to be statistically significant.

- The  $(1 - \alpha)$  confidence interval represents the range of values of the test statistic for which the null hypothesis is not rejected.
- The statistical decision consists of rejecting or not rejecting the null hypothesis. The economic decision takes into consideration all economic issues pertinent to the decision.
- The  $p$ -value is the smallest level of significance at which the null hypothesis can be rejected. The smaller the  $p$ -value, the stronger the evidence against the null hypothesis and in favor of the alternative hypothesis. The  $p$ -value approach to hypothesis testing involves computing a  $p$ -value for the test statistic and allowing the user of the research to interpret the implications for the null hypothesis.
- For hypothesis tests concerning the population mean of a normally distributed population with unknown variance, the theoretically correct test statistic is the  $t$ -statistic.
- When we want to test whether the observed difference between two means is statistically significant, we must first decide whether the samples are independent or dependent (related). If the samples are independent, we conduct a test concerning differences between means. If the samples are dependent, we conduct a test of mean differences (paired comparisons test).
- When we conduct a test of the difference between two population means from normally distributed populations with unknown but equal variances, we use a  $t$ -test based on pooling the observations of the two samples to estimate the common but unknown variance. This test is based on an assumption of independent samples.

- In tests concerning two means based on two samples that are not independent, we often can arrange the data in paired observations and conduct a test of mean differences (a paired comparisons test). When the samples are from normally distributed populations with unknown variances, the appropriate test statistic is  $t$ -distributed.
- In tests concerning the variance of a single normally distributed population, the test statistic is chi-square with  $n - 1$  degrees of freedom, where  $n$  is the sample size.
- For tests concerning differences between the variances of two normally distributed populations based on two random, independent samples, the appropriate test statistic is based on an  $F$ -test (the ratio of the sample variances). The degrees of freedom for this  $F$ -test are  $n_1 - 1$  and  $n_2 - 1$ , where  $n_1$  corresponds to the number of observations in the calculation of the numerator and  $n_2$  is the number of observations in the calculation of the denominator of the  $F$ -statistic.
- A parametric test is a hypothesis test concerning a population parameter or a hypothesis test based on specific distributional assumptions. In contrast, a nonparametric test either is not concerned with a parameter or makes minimal assumptions about the population from which the sample comes.
- A nonparametric test is primarily used when data do not meet distributional assumptions, when there are outliers, when data are given in ranks, or when the hypothesis we are addressing does not concern a parameter.
- In tests concerning correlation, we use a  $t$ -statistic to test whether a population correlation coefficient is different from



zero. If we have  $n$  observations for two variables, this test statistic has a  $t$ -distribution with  $n - 2$  degrees of freedom.

- The Spearman rank correlation coefficient is calculated on the ranks of two variables within their respective samples.
- A chi-square distributed test statistic is used to test for independence of two categorical variables. This nonparametric test compares actual frequencies with those expected on the basis of independence. This test statistic has degrees of freedom of  $(r - 1)(c - 2)$ , where  $r$  is the number of categories for the first variable and  $c$  is the number of categories of the second variable.



# Introduction to Linear Regression

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## Learning Outcomes

The candidate should be able to:

- a. describe a simple linear regression model and the roles of the dependent and independent variables in the model;
- b. describe the least squares criterion, how it is used to estimate regression coefficients, and their interpretation;
- c. explain the assumptions underlying the simple linear regression model, and describe how residuals and residual plots indicate if these assumptions may have been violated;
- d. calculate and interpret the coefficient of determination and the  $F$ -statistic in a simple linear regression;
- e. describe the use of analysis of variance (ANOVA) in regression analysis, interpret ANOVA results, and calculate and interpret the standard error of estimate in a simple linear regression;
- f. formulate a null and an alternative hypothesis about a population value of a regression coefficient, and determine whether the null hypothesis is rejected at a given level of significance;

- g. calculate and interpret the predicted value for the dependent variable, and a prediction interval for it, given an estimated linear regression model and a value for the independent variable; and
- h. describe different functional forms of simple linear regressions.

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## Introduction

Financial analysts often need to examine whether a variable is useful for explaining another variable. For example, the analyst may want to know whether earnings growth, or perhaps cash flow growth, helps explain the company's value in the marketplace. **Regression analysis** is a tool used to examine this type of issue.

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## Summary

- The dependent variable in a linear regression is the variable whose variability the regression model tries to explain. The independent variable is the variable whose variation the researcher uses to explain the variation of the dependent variable.
- If there is one independent variable in a linear regression and there are  $n$  observations of the dependent and independent variables, the regression model is  $Y_i = b_0 + b_1X_i + \varepsilon_i$ ,  $i = 1, \dots, n$ , where  $Y_i$  is the dependent variable,  $X_i$  is the independent variable, and  $\varepsilon_i$  is the error term. In this model, the coefficients  $b_0$  and  $b_1$  are the population intercept and slope, respectively.

- The intercept is the expected value of the dependent variable when the independent variable has a value of zero. The slope coefficient is the estimate of the population slope of the regression line and is the expected change in the dependent variable for a one-unit change in the independent variable.
- The assumptions of the classic simple linear regression model are as follows:
  1. Linearity: A linear relation exists between the dependent variable and the independent variable.
  2. Homoskedasticity: The variance of the error term is the same for all observations.
  3. Independence: The error term is uncorrelated across observations.
  4. Normality: The error term is normally distributed.
- The estimated parameters in a simple linear regression model minimize the sum of the squared errors.
- The coefficient of determination, or  $R^2$ , measures the percentage of the total variation in the dependent variable explained by the independent variable.
- To test the fit of the simple linear regression, we can calculate an  $F$ -distributed test statistic and test the hypotheses  $H_0: b_1 = 0$  versus  $H_a: b_1 \neq 0$ , with 1 and  $n - 2$  degrees of freedom.
- The standard error of the estimate is an absolute measure of the fit of the model calculated as the square root of the mean square error.
- We can evaluate a regression model by testing whether the population value of a regression coefficient is equal to a particular

hypothesized value. We do this by calculating a  $t$ -distributed test statistic that compares the estimated parameter with the hypothesized parameter, dividing this difference by the standard error of the coefficient.

- An indicator (or dummy) variable takes on only the values 0 or 1 and can be used as the independent variable in a simple linear regression. In such a model, the interpretation of the intercept is the predicted value of the dependent variable if the indicator variable is 0, and when the indicator variable is 1, the slope is the difference in the means if we grouped the observations by the indicator variable.
- We calculate a prediction interval for a regression coefficient using the estimated coefficient, the standard error of the estimated coefficient, and the critical value for the  $t$ -distributed test statistic based on the level of significance and the appropriate degrees of freedom, which are  $n - 2$  for simple regression.
- We can make predictions for the dependent variable using an estimated linear regression by inserting the forecasted value of the independent variable into the estimated model.
- The standard error of the forecast is the product of the standard error of the estimate and a term that reflects the sample size of the regression, the variation of the independent variable, and the deviation between the forecasted value of the independent variable and the mean of the independent variable in the regression.
- The prediction interval for a particular forecasted value of the dependent variable is formed by using the forecasted value of the dependent variable and extending above and below this value a quantity that reflects the critical  $t$ -value corresponding to the

degrees of freedom, the level of significance, and the standard error of the forecast.

- If the relationship between the independent variable and the dependent variable is not linear, we often can transform one or both of these variables to convert this relation to a linear form, which then allows for the use of simple linear regression.

# Probability Concepts

**Richard A. DeFusco, PhD, CFA, Dennis W. McLeavey, DBA, CFA, Jerald E. Pinto, PhD, CFA, and David E. Runkle, PhD, CFA**

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*CFA Institute would like to thank John Stowe, PhD, CFA, for his significant contributions in revising this reading.*

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## Learning Outcomes

The candidate should be able to:

- a. define a random variable, an outcome, and an event;
- b. identify the two defining properties of probability, including mutually exclusive and exhaustive events, and compare and contrast empirical, subjective, and a priori probabilities;
- c. describe the probability of an event in terms of odds for and against the event;
- d. calculate and interpret conditional probabilities;
- e. demonstrate the application of the multiplication and addition rules for probability;
- f. compare and contrast dependent and independent events;

- g. calculate and interpret an unconditional probability using the total probability rule;
- h. calculate and interpret the expected value, variance, and standard deviation of random variables;
- i. explain the use of conditional expectation in investment applications;
- j. interpret a probability tree and demonstrate its application to investment problems;
- k. calculate and interpret the expected value, variance, standard deviation, covariances, and correlations of portfolio returns;
- l. calculate and interpret the covariances of portfolio returns using the joint probability function;
- m. calculate and interpret an updated probability using Bayes' formula; and
- n. identify the most appropriate method to solve a particular counting problem and analyze counting problems using factorial, combination, and permutation concepts.

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## Introduction

Investment decisions are made in a risky environment. The tools that allow us to make decisions with consistency and logic in this setting are based on probability concepts. This reading presents the essential probability tools needed to frame and address many real-world problems involving risk. These tools apply to a variety of issues, such as predicting investment manager performance, forecasting financial



variables, and pricing bonds so that they fairly compensate bondholders for default risk. Our focus is practical. We explore the concepts that are most important to investment research and practice. Among these are independence, as it relates to the predictability of returns and financial variables; expectation, as analysts continually look to the future in their analyses and decisions; and variability, variance, or dispersion around expectation, as a risk concept important in investments. The reader will acquire specific skills and competencies in using these probability concepts to understand risks and returns on investments.

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## Summary

In this reading, we have discussed the essential concepts and tools of probability. We have applied probability, expected value, and variance to a range of investment problems.

- A random variable is a quantity whose outcome is uncertain.
- Probability is a number between 0 and 1 that describes the chance that a stated event will occur.
- An event is a specified set of outcomes of a random variable.
- Mutually exclusive events can occur only one at a time. Exhaustive events cover or contain all possible outcomes.
- The two defining properties of a probability are, first, that  $0 \leq P(E) \leq 1$  (where  $P(E)$  denotes the probability of an event  $E$ ) and, second, that the sum of the probabilities of any set of mutually exclusive and exhaustive events equals 1.

- A probability estimated from data as a relative frequency of occurrence is an empirical probability. A probability drawing on personal or subjective judgment is a subjective probability. A probability obtained based on logical analysis is an a priori probability.
- A probability of an event  $E$ ,  $P(E)$ , can be stated as odds for  $E = P(E)/[1 - P(E)]$  or odds against  $E = [1 - P(E)]/P(E)$ .
- Probabilities that are inconsistent create profit opportunities, according to the Dutch book theorem.
- A probability of an event *not* conditioned on another event is an unconditional probability. The unconditional probability of an event  $A$  is denoted  $P(A)$ . Unconditional probabilities are also called marginal probabilities.
- A probability of an event given (conditioned on) another event is a conditional probability. The probability of an event  $A$  given an event  $B$  is denoted  $P(A | B)$ , and  $P(A | B) = P(AB)/P(B)$ ,  $P(B) \neq 0$ .
- The probability of both  $A$  and  $B$  occurring is the joint probability of  $A$  and  $B$ , denoted  $P(AB)$ .
- The multiplication rule for probabilities is  $P(AB) = P(A | B)P(B)$ .
- The probability that  $A$  or  $B$  occurs, or that both occur, is denoted by  $P(A \text{ or } B)$ .
- The addition rule for probabilities is  $P(A \text{ or } B) = P(A) + P(B) - P(AB)$ .
- When events are independent, the occurrence of one event does not affect the probability of occurrence of the other event. Otherwise, the events are dependent.

- The multiplication rule for independent events states that if  $A$  and  $B$  are independent events,  $P(AB) = P(A)P(B)$ . The rule generalizes in similar fashion to more than two events.
- According to the total probability rule, if  $S_1, S_2, \dots, S_n$  are mutually exclusive and exhaustive scenarios or events, then  $P(A) = P(A | S_1)P(S_1) + P(A | S_2)P(S_2) + \dots + P(A | S_n)P(S_n)$ .
- The expected value of a random variable is a probability-weighted average of the possible outcomes of the random variable. For a random variable  $X$ , the expected value of  $X$  is denoted  $E(X)$ .
- The total probability rule for expected value states that  $E(X) = E(X | S_1)P(S_1) + E(X | S_2)P(S_2) + \dots + E(X | S_n)P(S_n)$ , where  $S_1, S_2, \dots, S_n$  are mutually exclusive and exhaustive scenarios or events.
- The variance of a random variable is the expected value (the probability-weighted average) of squared deviations from the random variable's expected value  $E(X)$ :  $\sigma^2(X) = E\{[X - E(X)]^2\}$ , where  $\sigma^2(X)$  stands for the variance of  $X$ .
- Variance is a measure of dispersion about the mean. Increasing variance indicates increasing dispersion. Variance is measured in squared units of the original variable.
- Standard deviation is the positive square root of variance. Standard deviation measures dispersion (as does variance), but it is measured in the same units as the variable.
- Covariance is a measure of the co-movement between random variables.
- The covariance between two random variables  $R_i$  and  $R_j$  in a forward-looking sense is the expected value of the cross-product of the deviations of the two random variables from their respective

means:  $\text{Cov}(R_i, R_j) = E\{[R_i - E(R_i)][R_j - E(R_j)]\}$ . The covariance of a random variable with itself is its own variance.

- The historical or sample covariance between two random variables  $R_i$  and  $R_j$  based on a sample of past data of size  $n$  is the average value of the product of the deviations of observations on two random variables from their sample means:

$$\text{Cov}(R_i, R_j) = \frac{\sum_{t=1}^n (R_{i,t} - \bar{R}_i)(R_{j,t} - \bar{R}_j)}{n-1}$$

- Correlation is a number between  $-1$  and  $+1$  that measures the co-movement (linear association) between two random variables:  $\rho(R_i, R_j) = \text{Cov}(R_i, R_j) / [\sigma(R_i) \sigma(R_j)]$ .
- If two variables have a very strong (inverse) linear relation, then the absolute value of their correlation will be close to 1 ( $-1$ ). If two variables have a weak linear relation, then the absolute value of their correlation will be close to 0.
- If the correlation coefficient is positive, the two variables are positively related; if the correlation coefficient is negative, the two variables are inversely related.
- To calculate the variance of return on a portfolio of  $n$  assets, the inputs needed are the  $n$  expected returns on the individual assets,  $n$  variances of return on the individual assets, and  $n(n-1)/2$  distinct covariances.
- Portfolio variance of return is  $\sigma^2(R_p) = \sum_{i=1}^n \sum_{j=1}^n w_i w_j \text{Cov}(R_i, R_j)$ .
- The calculation of covariance in a forward-looking sense requires the specification of a joint probability function, which gives the probability of joint occurrences of values of the two random variables.

- When two random variables are independent, the joint probability function is the product of the individual probability functions of the random variables.
- Bayes' formula is a method for updating probabilities based on new information.
- Bayes' formula is expressed as follows: Updated probability of event given the new information = [(Probability of the new information given event)/(Unconditional probability of the new information)]  $\times$  Prior probability of event.
- The multiplication rule of counting says, for example, that if the first step in a process can be done in 10 ways, the second step, given the first, can be done in 5 ways, and the third step, given the first two, can be done in 7 ways, then the steps can be carried out in  $(10)(5)(7) = 350$  ways.
- The number of ways to assign every member of a group of size  $n$  to  $n$  slots is  $n! = n(n-1)(n-2)(n-3) \dots 1$ . (By convention,  $0! = 1$ .)
- The number of ways that  $n$  objects can be labeled with  $k$  different labels, with  $n_1$  of the first type,  $n_2$  of the second type, and so on, with  $n_1 + n_2 + \dots + n_k = n$ , is given by  $n!/(n_1!n_2! \dots n_k!)$ . This expression is the multinomial formula.
- A special case of the multinomial formula is the combination formula. The number of ways to choose  $r$  objects from a total of  $n$  objects, when the order in which the  $r$  objects are listed does not matter, is as follows:

$${}_n C_r = \binom{n}{r} = \frac{n!}{(n-r)!r!}$$

- The number of ways to choose  $r$  objects from a total of  $n$  objects, when the order in which the  $r$  objects are listed does matter, is as follows:

$${}_n P_r = \frac{n!}{(n-r)!}$$

- This expression is the permutation formula.

# Common Probability Distributions

**Richard A. DeFusco, PhD, CFA, Dennis W. McLeavey, DBA, CFA, Jerald E. Pinto, PhD, CFA, and David E. Runkle, PhD, CFA**

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*CFA Institute would like to thank Adam Kobor, PhD, CFA, at New York University Investment Office (USA), for this major revision of “Common Probability Distributions,” including new visuals, graphics, Microsoft Excel functions, code snippets, and related text content throughout the reading.*

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## Learning Outcomes

The candidate should be able to:

- a. define a probability distribution and compare and contrast discrete and continuous random variables and their probability functions;
- b. calculate and interpret probabilities for a random variable given its cumulative distribution function;
- c. describe the properties of a discrete uniform random variable, and calculate and interpret probabilities given the discrete uniform distribution function;

- d. describe the properties of the continuous uniform distribution, and calculate and interpret probabilities given a continuous uniform distribution;
- e. describe the properties of a Bernoulli random variable and a binomial random variable, and calculate and interpret probabilities given the binomial distribution function;
- f. explain the key properties of the normal distribution;
- g. contrast a multivariate distribution and a univariate distribution, and explain the role of correlation in the multivariate normal distribution;
- h. calculate the probability that a normally distributed random variable lies inside a given interval;
- i. explain how to standardize a random variable;
- j. calculate and interpret probabilities using the standard normal distribution;
- k. define shortfall risk, calculate the safety-first ratio, and identify an optimal portfolio using Roy's safety-first criterion;
- l. explain the relationship between normal and lognormal distributions and why the lognormal distribution is used to model asset prices;
- m. calculate and interpret a continuously compounded rate of return, given a specific holding period return;
- n. describe the properties of the Student's  $t$ -distribution, and calculate and interpret its degrees of freedom;
- o. describe the properties of the chi-square distribution and the  $F$ -distribution, and calculate and interpret their degrees of freedom;
- p. describe Monte Carlo simulation.



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## Introduction

Probabilities play a critical role in investment decisions. Although we cannot predict the future, informed investment decisions are based on some kind of probabilistic thinking. An analyst may put probability estimates behind the success of her high-conviction or low-conviction stock recommendations. Risk managers would typically think in probabilistic terms: What is the probability of not achieving the target return, or what kind of losses are we facing with high likelihood over the relevant time horizon? Probability distributions also underpin validating trade signal-generating models: For example, does earnings revision play a significant role in forecasting stock returns?

In nearly all investment decisions, we work with random variables. The return on a stock and its earnings per share are familiar examples of random variables. To make probability statements about a random variable, we need to understand its probability distribution. A **probability distribution** specifies the probabilities associated with the possible outcomes of a random variable.

In this reading, we present important facts about seven probability distributions and their investment uses. These seven distributions—the uniform, binomial, normal, lognormal, Student's  $t$ -, chi-square, and  $F$ -distributions—are used extensively in investment analysis. Normal and binomial distributions are used in such basic valuation models as the Black–Scholes–Merton option pricing model, the binomial option pricing model, and the capital asset pricing model. Student's  $t$ -, chi-square, and  $F$ -distributions are applied in validating statistical significance and in hypothesis testing. With the working knowledge of probability distributions provided in this reading, you will be better prepared to study and use other quantitative methods, such as regression analysis, time-series analysis, and hypothesis testing. After discussing probability distributions, we end

with an introduction to Monte Carlo simulation, a computer-based tool for obtaining information on complex investment problems.

We start by defining basic concepts and terms, then illustrate the operation of these concepts through the simplest distribution, the uniform distribution, and then address probability distributions that have more applications in investment work but also greater complexity.

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## Summary

In this reading, we have presented the most frequently used probability distributions in investment analysis and Monte Carlo simulation.

- A probability distribution specifies the probabilities of the possible outcomes of a random variable.
- The two basic types of random variables are discrete random variables and continuous random variables. Discrete random variables take on at most a countable number of possible outcomes that we can list as  $x_1, x_2, \dots$ . In contrast, we cannot describe the possible outcomes of a continuous random variable  $Z$  with a list  $z_1, z_2, \dots$ , because the outcome  $(z_1 + z_2)/2$ , not in the list, would always be possible.
- The probability function specifies the probability that the random variable will take on a specific value. The probability function is denoted  $p(x)$  for a discrete random variable and  $f(x)$  for a continuous random variable. For any probability function  $p(x)$ ,  $0 \leq p(x) \leq 1$ , and the sum of  $p(x)$  over all values of  $X$  equals 1.
- The cumulative distribution function, denoted  $F(x)$  for both continuous and discrete random variables, gives the probability that the random variable is less than or equal to  $x$ .

- The discrete uniform and the continuous uniform distributions are the distributions of equally likely outcomes.
- The binomial random variable is defined as the number of successes in  $n$  Bernoulli trials, where the probability of success,  $p$ , is constant for all trials and the trials are independent. A Bernoulli trial is an experiment with two outcomes, which can represent success or failure, an up move or a down move, or another binary (twofold) outcome.
- A binomial random variable has an expected value or mean equal to  $np$  and variance equal to  $np(1 - p)$ .
- A binomial tree is the graphical representation of a model of asset price dynamics in which, at each period, the asset moves up with probability  $p$  or down with probability  $(1 - p)$ . The binomial tree is a flexible method for modeling asset price movement and is widely used in pricing options.
- The normal distribution is a continuous symmetric probability distribution that is completely described by two parameters: its mean,  $\mu$ , and its variance,  $\sigma^2$ .
- A univariate distribution specifies the probabilities for a single random variable. A multivariate distribution specifies the probabilities for a group of related random variables.
- To specify the normal distribution for a portfolio when its component securities are normally distributed, we need the means, the standard deviations, and all the distinct pairwise correlations of the securities. When we have those statistics, we have also specified a multivariate normal distribution for the securities.
- For a normal random variable, approximately 68% of all possible outcomes are within a one standard deviation interval about the

mean, approximately 95% are within a two standard deviation interval about the mean, and approximately 99% are within a three standard deviation interval about the mean.

- A normal random variable,  $X$ , is standardized using the expression  $Z = (X - \mu)/\sigma$ , where  $\mu$  and  $\sigma$  are the mean and standard deviation of  $X$ . Generally, we use the sample mean,  $\bar{X}$ , as an estimate of  $\mu$  and the sample standard deviation,  $s$ , as an estimate of  $\sigma$  in this expression.
- The standard normal random variable, denoted  $Z$ , has a mean equal to 0 and variance equal to 1. All questions about any normal random variable can be answered by referring to the cumulative distribution function of a standard normal random variable, denoted  $N(x)$  or  $N(z)$ .
- Shortfall risk is the risk that portfolio value or portfolio return will fall below some minimum acceptable level over some time horizon.
- Roy's safety-first criterion, addressing shortfall risk, asserts that the optimal portfolio is the one that minimizes the probability that portfolio return falls below a threshold level. According to Roy's safety-first criterion, if returns are normally distributed, the safety-first optimal portfolio  $P$  is the one that maximizes the quantity  $[E(R_p) - R_L]/s_p$ , where  $R_L$  is the minimum acceptable level of return.
- A random variable follows a lognormal distribution if the natural logarithm of the random variable is normally distributed. The lognormal distribution is defined in terms of the mean and variance of its associated normal distribution. The lognormal distribution is bounded below by 0 and skewed to the right (it has a long right tail).

- The lognormal distribution is frequently used to model the probability distribution of asset prices because it is bounded below by zero.
- Continuous compounding views time as essentially continuous or unbroken; discrete compounding views time as advancing in discrete finite intervals.
- The continuously compounded return associated with a holding period is the natural log of 1 plus the holding period return, or equivalently, the natural log of ending price over beginning price.
- If continuously compounded returns are normally distributed, asset prices are lognormally distributed. This relationship is used to move back and forth between the distributions for return and price. Because of the central limit theorem, continuously compounded returns need not be normally distributed for asset prices to be reasonably well described by a lognormal distribution.
- Student's  $t$ -, chi-square, and  $F$ -distributions are used to support statistical analyses, such as sampling, testing the statistical significance of estimated model parameters, or hypothesis testing.
- The standard  $t$ -distribution is a symmetrical probability distribution defined by degrees of freedom (df) and characterized by fat tails. As df increase, the  $t$ -distribution approaches the standard normal distribution.
- The chi-square distribution is asymmetrical, defined by degrees of freedom, and with  $k$  df is the distribution of the sum of the squares of  $k$  independent standard normally distributed random variables, so it does not take on negative values. A different distribution exists for each value of df,  $n - 1$ .

- The  $F$ -distribution is a family of asymmetrical distributions bounded from below by 0. Each  $F$ -distribution is defined by two values of degrees of freedom, the numerator df and the denominator df. If  $\chi_1^2$  is one chi-square random variable with  $m$  df and  $\chi_2^2$  is another chi-square random variable with  $n$  df, then  $F = (\chi_1^2/m) / (\chi_2^2/n)$  follows an  $F$ -distribution with  $m$  numerator df and  $n$  denominator df.
- Monte Carlo simulation involves the use of a computer to represent the operation of a complex financial system. A characteristic feature of Monte Carlo simulation is the generation of a large number of random samples from specified probability distributions to represent the operation of risk in the system. Monte Carlo simulation is used in planning, in financial risk management, and in valuing complex securities. Monte Carlo simulation is a complement to analytical methods but provides only statistical estimates, not exact results.
- Random observations from any distribution can be produced using the uniform random variable with endpoints 0 and 1 via the inverse transformation method. The randomly generated uniform random number is mapped onto the inverted cdf of any distribution from which random observations are desired. The point on the given distribution's cdf is then mapped onto its pdf, and the random observation is identified.

# Sampling and Estimation

**Richard A. DeFusco, PhD, CFA, Dennis W. McLeavey, DBA, CFA, Jerald E. Pinto, PhD, CFA, and David E. Runkle, PhD, CFA**

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*CFA Institute would like to thank Jian Wu, PhD, at State Street (USA), for this major revision of *Sampling and Estimation*, including new visuals, graphics, Excel functions and related text content throughout the reading.*

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## Learning Outcomes

The candidate should be able to:

- a. compare and contrast probability samples with non-probability samples and discuss applications of each to an investment problem;
- b. explain sampling error;
- c. compare and contrast simple random, stratified random, cluster, convenience, and judgmental sampling;
- d. explain the central limit theorem and its importance;
- e. calculate and interpret the standard error of the sample mean;
- f. identify and describe desirable properties of an estimator;

- g. contrast a point estimate and a confidence interval estimate of a population parameter;
- h. calculate and interpret a confidence interval for a population mean, given a normal distribution with 1) a known population variance, 2) an unknown population variance, or 3) an unknown population variance and a large sample size;
- i. describe the use of resampling (bootstrap, jackknife) to estimate the sampling distribution of a statistic;
- j. describe the issues regarding selection of the appropriate sample size, data snooping bias, sample selection bias, survivorship bias, look-ahead bias, and time-period bias.

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## Introduction

Each day, we observe the high, low, and close of stock market indexes from around the world. Indexes such as the S&P 500 Index and the Nikkei 225 Stock Average are samples of stocks. Although the S&P 500 and the Nikkei do not represent the populations of US or Japanese stocks, we view them as valid indicators of the whole population's behavior. As analysts, we are accustomed to using this sample information to assess how various markets from around the world are performing. Any statistics that we compute with sample information, however, are only estimates of the underlying population parameters. A sample, then, is a subset of the population—a subset studied to infer conclusions about the population itself.

We introduce and discuss **sampling**—the process of obtaining a sample. In investments, we continually make use of the mean as a measure of central tendency of random variables, such as return and



earnings per share. Even when the probability distribution of the random variable is unknown, we can make probability statements about the population mean using the central limit theorem. We discuss and illustrate this key result. Following that discussion, we turn to statistical estimation. Estimation seeks precise answers to the question “What is this parameter’s value?”

The central limit theorem and estimation, the core of the body of methods presented in the sections that follow, may be applied in investment applications. We often interpret the results for the purpose of deciding what works and what does not work in investments. We will also discuss the interpretation of statistical results based on financial data and the possible pitfalls in this process.

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## Summary

In this reading, we have presented basic concepts and results in sampling and estimation. We have also emphasized the challenges faced by analysts in appropriately using and interpreting financial data. As analysts, we should always use a critical eye when evaluating the results from any study. The quality of the sample is of the utmost importance: If the sample is biased, the conclusions drawn from the sample will be in error.

- To draw valid inferences from a sample, the sample should be random.
- In simple random sampling, each observation has an equal chance of being selected. In stratified random sampling, the population is divided into subpopulations, called strata or cells, based on one or more classification criteria; simple random samples are then drawn from each stratum.

- Stratified random sampling ensures that population subdivisions of interest are represented in the sample. Stratified random sampling also produces more-precise parameter estimates than simple random sampling.
- Convenience sampling selects an element from the population on the basis of whether or not it is accessible to a researcher or how easy it is to access. Because convenience sampling presents the advantage of collecting data quickly at a low cost, it is a suitable sampling plan for small-scale pilot studies.
- Judgmental sampling may yield skewed results because of the bias of researchers, but its advantages lie in the fact that in some circumstances, the specialty of researchers and their judgmental can lead them directly to the target population of interest within time constraints.
- The central limit theorem states that for large sample sizes, for any underlying distribution for a random variable, the sampling distribution of the sample mean for that variable will be approximately normal, with mean equal to the population mean for that random variable and variance equal to the population variance of the variable divided by sample size.
- Based on the central limit theorem, when the sample size is large, we can compute confidence intervals for the population mean based on the normal distribution regardless of the distribution of the underlying population. In general, a sample size of 30 or larger can be considered large.
- An estimator is a formula for estimating a parameter. An estimate is a particular value that we calculate from a sample by using an estimator.

- Because an estimator or statistic is a random variable, it is described by some probability distribution. We refer to the distribution of an estimator as its sampling distribution. The standard deviation of the sampling distribution of the sample mean is called the standard error of the sample mean.
- The desirable properties of an estimator are *unbiasedness* (the expected value of the estimator equals the population parameter), *efficiency* (the estimator has the smallest variance), and *consistency* (the probability of accurate estimates increases as sample size increases).
- The two types of estimates of a parameter are point estimates and interval estimates. A point estimate is a single number that we use to estimate a parameter. An interval estimate is a range of values that brackets the population parameter with some probability.
- A confidence interval is an interval for which we can assert with a given probability  $1 - \alpha$ , called the degree of confidence, that it will contain the parameter it is intended to estimate. This measure is often referred to as the  $100(1 - \alpha)\%$  confidence interval for the parameter.
- A  $100(1 - \alpha)\%$  confidence interval for a parameter has the following structure: Point estimate  $\pm$  Reliability factor  $\times$  Standard error, where the reliability factor is a number based on the assumed distribution of the point estimate and the degree of confidence ( $1 - \alpha$ ) for the confidence interval and where standard error is the standard error of the sample statistic providing the point estimate.
- A  $100(1 - \alpha)\%$  confidence interval for population mean  $\mu$  when sampling from a normal distribution with known variance  $\sigma^2$  is

given by  $\bar{X} \pm z_{\alpha/2}(\sigma/\sqrt{n})$ , where  $z_{\alpha/2}$  is the point of the standard normal distribution such that  $\alpha/2$  remains in the right tail.

- A random sample of size  $n$  is said to have  $n - 1$  degrees of freedom for estimating the population variance, in the sense that there are only  $n - 1$  independent deviations from the mean on which to base the estimate.
- A  $100(1 - \alpha)\%$  confidence interval for the population mean  $\mu$  when sampling from a normal distribution with unknown variance (a  $t$ -distribution confidence interval) is given by  $\bar{X} \pm t_{\alpha/2}(s/\sqrt{n})$ , where  $t_{\alpha/2}$  is the point of the  $t$ -distribution such that  $\alpha/2$  remains in the right tail and  $s$  is the sample standard deviation. This confidence interval can also be used, because of the central limit theorem, when dealing with a large sample from a population with unknown variance that may not be normal.
- We may use the confidence interval  $\bar{X} \pm z_{\alpha/2}(s/\sqrt{n})$  as an alternative to the  $t$ -distribution confidence interval for the population mean when using a large sample from a population with unknown variance. The confidence interval based on the  $z$ -statistic is less conservative (narrower) than the corresponding confidence interval based on a  $t$ -distribution.
- Bootstrap and jackknife are simple but powerful methods for statistical inference, and they are particularly useful when no analytical formula is available. Bootstrap constructs the sampling distribution of an estimator by repeatedly drawing samples from the original sample to find standard error and confidence interval. Jackknife draws repeated samples while leaving out one observation at a time from the set, without replacing it.

- Three issues in the selection of sample size are the need for precision, the risk of sampling from more than one population, and the expenses of different sample sizes.
- **Data snooping bias** comes from finding models by repeatedly searching through databases for patterns.
- **Sample selection bias** occurs when data availability leads to certain assets being excluded from the analysis, we call the resulting problem
- **Survivorship bias** is a subset of sample selection bias and occurs if companies are excluded from the analysis because they have gone out of business or because of reasons related to poor performance.
- **Self-selection** bias reflects the ability of entities to decide whether or not they wish to report their attributes or results and be included in databases or samples. **Implicit selection bias** is one type of selection bias introduced through the presence of a threshold that filters out some unqualified members. A subset of selection bias is **backfill bias**, in which past data, not reported or used before, is backfilled into an existing database.
- **Look-ahead bias** exists if the model uses data not available to market participants at the time the market participants act in the model.
- **Time-period bias** is present if the period used makes the results period specific or if the period used includes a point of structural change.



# Fixed Income

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## Applicable Readings

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### **Yield Curve Strategies (Level III)**

By Robert W. Kopprasch, PhD, CFA, and Steven V. Mann, PhD

2 PL credits

Access the full reading: [cfainst.is/yieldcurve](https://cfainst.is/yieldcurve)

### **Fixed-Income Active Management: Credit Strategies (Level III)**

By Campe Goodman, CFA, and Oleg Melentyev, CFA

2.5 PL credits

Access the full reading: [cfainst.is/creditstrategies](https://cfainst.is/creditstrategies)

### **The Term Structure and Interest Rate Dynamics (Level II)**

By Thomas S. Y. Ho, PhD, Sang Bin Lee, PhD, and Stephen E. Wilcox, PhD, CFA

2 PL credits

Access the full reading: [cfainst.is/termstructure](https://cfainst.is/termstructure)

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## What Is Changing in the 2022 Curriculum?

A comprehensive treatment of fixed-income portfolio positioning is exhibited in the new reading “Yield Curve Strategies.” The reading explores how primary yield curve risk factors (such as level, slope, and shape), interest rate volatility, and currencies all influence portfolio positioning. Fixed-income strategies are presented as capitalizing on both static and dynamic yield curve environments, as well as an interest rate view that either coincides with or diverges from the market view.

Meanwhile, the new reading “Fixed-Income Active Management: Credit Strategies” builds on what we learn about yield curve strategies through an examination of credit spread curves across the credit spectrum and an analysis of how they change over the credit cycle. This includes detailed discussion of credit spread measures for fixed-rate bonds and floating-rate notes, as well as how changes in those measures translate into expected price changes. The reading explores how credit portfolio positioning strategies aim to capitalize on expected static and dynamic credit spread curve environments, alongside an active credit spread view.

Finally, a new section within the reading “Term Structure and Interest Rate Dynamics” introduces bond risk premium drivers and explains how they translate into yield curve changes, setting the stage for positioning fixed-income portfolios.





## Why Does It Matter to Members?

Members will want to know how fixed-income portfolios are managed by their peers to obtain yield in an era of historically low interest rates.

“Yield Curve Strategies” incorporates both cash and derivative-based fixed-income strategies and uses intuitive illustrations and exhibits to promote understanding. It also provides real-world examples, such as negative rates and absolute and relative yield curve changes based on specific market scenarios.

Meanwhile, “Fixed-Income Active Management: Credit Strategies” shows how active managers of spread-based fixed-income portfolios take positions in credit and other risk factors to generate excess return versus passive index replication.

Finally, “The Term Structure and Interest Rate Dynamics” explains how analysts can use key economic factors to establish a view on benchmark rates, spreads, and yield curve changes.



# Yield Curve Strategies

**Robert W. Koppasch, PhD, CFA, and Steven V. Mann, PhD**

*Robert W. Koppasch, PhD, CFA, is at Bates Group, LLC (USA). Steven V. Mann, PhD, is at the University of South Carolina (USA).*

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## Learning Outcomes

The candidate should be able to:

- a. describe the factors affecting fixed-income portfolio returns resulting from a change in benchmark yields;
- b. formulate a portfolio positioning strategy given forward interest rates and an interest rate view that coincides with the market view;
- c. formulate a portfolio positioning strategy given forward interest rates and an interest rate view that diverges from the market view in terms of rate level, slope, and shape;
- d. formulate a portfolio positioning strategy based on expected changes in interest rate volatility;
- e. evaluate a portfolio's sensitivity using key rate durations of the portfolio and its benchmark;
- f. discuss yield curve strategies across currencies; and
- g. evaluate the expected return and risks of a yield curve strategy.

## Introduction

The size and breadth of global fixed-income markets, as well as the term structure of interest rates within and across countries, lead investors to consider numerous factors when creating and managing a bond portfolio. Fixed-income index replication and bond portfolios that consider both an investor's assets and liabilities were addressed earlier in the curriculum, and we now turn our attention to active bond portfolio management. In contrast to a passive index strategy, active fixed-income management involves taking positions in primary risk factors that deviate from those of an index to generate excess return. Financial analysts who can successfully apply fixed-income concepts and tools to evaluate yield curve changes and position a portfolio based on an interest rate view find this to be a valuable skill throughout their careers.

Prioritizing fixed-income risk factors is a key first step. In what follows, we focus on the yield curve, which represents the term structure of interest rates for government or benchmark securities, with the assumption that all promised principal and interest payments take place. Fixed-income securities, which trade at a spread above the benchmark to compensate investors for credit and liquidity risk, will be addressed later in the curriculum. The starting point for active portfolio managers is the current term structure of benchmark interest rates and an interest rate view established using the macroeconomic variables introduced earlier. In what follows, we demonstrate how managers may position a fixed-income portfolio to capitalize on expectations regarding the level, slope, or shape (curvature) of yield curves using both long and short cash positions, derivatives, and leverage.

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## Summary

This reading addresses active fixed-income yield curve management using cash- and derivative-based strategies to generate returns that exceed those of a benchmark index resulting from yield curve changes. The following are the main points in the reading:

- A par yield curve is a stylized representation of yields-to-maturity available to investors at various maturities, which often does not consist of traded securities but must be extracted from available bond yields using a model.
- Primary yield curve risk factors may be categorized by changes in level (or a parallel “shift”), slope (a flatter or steeper yield curve), and shape or curvature.
- Yield curve slope measures the difference between the yield-to-maturity on a long-maturity bond and the yield-to-maturity on a short-maturity bond. Curvature is the relationship between short-, intermediate-, and long-term yields-to-maturity.
- Fixed-income portfolio managers can approximate actual and anticipated bond portfolio value changes using portfolio duration and convexity measures. Duration measures the linear relationship between bond prices and yield-to-maturity. Convexity is a second-order effect describing a bond’s price behavior for larger rate movements and is affected by cash flow dispersion.
- A barbell portfolio combining short- and long-term bond positions will have greater convexity than a bullet portfolio concentrated in a single maturity for a given duration.
- Active managers seeking excess return in an expected static yield curve environment that is upward-sloping can use a

buy-and-hold strategy to increase duration, roll down the yield curve, or use leverage through a carry trade in cash markets. Receive-fixed swaps and long futures positions replicate this exposure in the derivatives market.

- Derivatives offer the opportunity to synthetically change exposure with a far smaller initial cash outlay than cash strategies but require managers to maintain sufficient cash or eligible securities to fulfill margin or collateral requirements.
- Active fixed-income managers with a divergent rate level view increase duration exposure above a target if yields-to-maturity are expected to decline and reduce duration if expecting higher yields-to-maturity to minimize losses.
- Yield curve steepeners seek to gain from a greater spread between short- and long-term yields-to-maturity by combining a long short-dated bond position with a short long-dated bond position, while a flattener involves sale of short-term bonds and purchase of long-term bonds.
- Steepener and flattener strategies may be net duration neutral or net long or short duration depending on a manager's view of how the yield curve slope will change—that is, the relative contribution of short- and long-term yield-to-maturity changes to the expected yield curve slope change.
- The butterfly strategy combining a long bullet with a short barbell portfolio (or vice versa) is commonly used to capitalize on expected yield curve shape changes.
- Active managers capitalize on a view as to whether future realized interest rate volatility will be greater or less than implied volatility by purchasing or selling bonds with embedded options or by using stand-alone interest rate options.

- Stand-alone interest rate put–call options generally are based on a bond’s price, not yield-to-maturity.
- Interest rate swaptions and options on bond futures are among the common tools used by active managers to alter portfolio duration and convexity subject to yield-to-maturity changes. An interest rate swaption involves the right to enter into an interest rate swap at a specific strike price in the future, while an option on a bond future involves the right, not the obligation, to buy or sell a futures contract.
- Key rate durations can be used in active fixed-income management to identify a bond portfolio’s sensitivity to changes in the shape of the benchmark yield curve, allowing an active manager to quantify exposures along the curve.
- Fixed-income managers engaged in active yield curve strategies across currencies measure excess return from active management in functional currency terms—that is, considering domestic currency returns on foreign currency assets within a portfolio.
- Interest rate parity establishes the fundamental relationship between spot and forward exchange rates, with a higher-yielding currency trading at a forward discount and a lower-yielding currency trading at a premium.
- Covered interest rate parity involves the use of a forward contract to lock in domestic currency proceeds, while uncovered interest rate parity suggests that over time, the returns on unhedged foreign currency exposure will be the same as on a domestic currency investment.
- Active investors use the carry trade across currencies to take advantage of divergence from interest rate parity by borrowing in a lower-yield currency and investing in a higher-yield currency.

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- A cross-currency swap enables investors to fully hedge the domestic currency value of cash flows associated with foreign currency bonds.
- Active managers deviate from fully hedged foreign currency bond cash flows by entering overweight and underweight bond positions denominated in different currencies, often using an underweight position in one currency to fund an overweight position in another.
- Investors evaluate the expected return on an active fixed-income portfolio strategy by combining coupon income and rolldown return with expected portfolio changes based on benchmark yield-to-maturity, credit, and currency value changes over the investment horizon.
- Unexpected market changes or risks to portfolio value are frequently evaluated using scenario analysis.



# Fixed-Income Active Management: Credit Strategies

**Campe Goodman, CFA, and Oleg Melentyev, CFA**

*Campe Goodman, CFA, is at Wellington Management (USA). Oleg Melentyev, CFA, is at Bank of America Merrill Lynch (USA).*

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## Learning Outcomes

The candidate should be able to:

- a. describe risk considerations for spread-based fixed-income portfolios;
- b. discuss the advantages and disadvantages of credit spread measures for spread-based fixed-income portfolios, and explain why option-adjusted spread is considered to be the most appropriate measure;
- c. discuss bottom-up approaches to credit strategies;
- d. discuss top-down approaches to credit strategies;
- e. discuss liquidity risk in credit markets and explain how liquidity risk can be managed in a credit portfolio;
- f. describe how to assess and manage tail risk in credit portfolios;



- g. discuss the use of credit default swap strategies in active fixed-income portfolio management;
- h. discuss various portfolio positioning strategies that managers can use to implement a specific credit spread view;
- i. discuss considerations in constructing and managing portfolios across international credit markets;
- j. describe the use of structured financial instruments as an alternative to corporate bonds in credit portfolios; and
- k. describe key inputs, outputs, and considerations in using analytical tools to manage fixed-income portfolios.

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## Introduction

Most fixed-income instruments trade at a nominal yield-to-maturity (YTM) that lies above that for an equivalent government or benchmark bond of similar maturity. This **yield spread** or difference compensates investors for the risk that they might not receive interest and principal cash flows as expected, whether as a result of a financially distressed corporate borrower, a sovereign issuer unable (or unwilling) to meet scheduled payments, or a deterioration in credit quality in an underlying pool of assets of a structured instrument, such as an asset-backed security. A portion of the yield spread reflects the bid-offer cost of buying or selling a particular bond versus a government security, a liquidity premium that varies based on market conditions. Active managers of spread-based fixed-income portfolios take positions in credit and other risk factors that vary from those of an index to generate excess return versus passive index replication. Financial

analysts who build on their foundational knowledge by mastering these more advanced fixed-income concepts and tools will broaden their career opportunities in the investment industry.

We begin by reviewing expected fixed-income portfolio return components with a particular focus on credit spreads. These spreads are not directly observable but rather are derived from market information. Similar to benchmark yield curves, credit-spread curves are often defined by spread level and slope and usually are grouped by credit rating to gauge relative risk as well as to anticipate and act on expected changes in these relationships over the business cycle. We outline credit spread measures for fixed- and floating-rate bonds and quantify the effect of spread changes on portfolio value. Building blocks for active credit management beyond individual bonds include exchange-traded funds (ETFs), structured financial instruments, and derivative products, such as credit default swaps (CDS). These tools are used to describe bottom-up and top-down active credit management approaches as well as how managers position spread-based fixed-income portfolios to capitalize on a market view.

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## Summary

Active spread-based, fixed-income portfolio management involves taking positions in credit and other risk factors that differ from those of an index to generate excess return. The main points of the reading are as follows:

- Yield spreads compensate investors for the risk that they will not receive expected interest and principal cash flows and for the bid–offer cost of buying or selling a bond under current market conditions.

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- Two key components of a bond's credit risk are the probability of default (POD) and the loss given default (LGD).
- Credit spread changes are driven by the credit cycle, or the expansion and contraction of credit over the business cycle, which causes asset prices to change based on default and recovery expectations.
- High-yield issuers experience greater changes in the POD over the credit cycle than investment-grade issuers, with bond prices approaching the recovery rate for distressed debt.
- Fixed-rate bond yield spread measures use actual, interpolated, or zero curve-based benchmark rates to capture relative credit risk, whereas option-adjusted spread (OAS) allows for comparison between risky option-free bonds and bonds with embedded options.
- Floating-rate notes (FRNs) pay periodic interest based on a monthly recurring revenue (MRR) plus a yield spread.
- Spread duration measures the change in a bond's price for a given change in yield spread, while spread changes for lower-rated bonds tend to be proportional on a percentage rather than an absolute basis.
- Bottom-up credit strategies include the use of financial ratio analysis, reduced form credit models (such as the Z-score model), and structural credit models, including Bloomberg's Default Risk (DRSK) model.
- Top-down credit strategies are often based on macro factors and group investment choices by credit rating and industry sector categories.

- Fixed-income factor investing incorporates such factors as size, value, and momentum to target active returns and also increasingly include environmental, social, and governance (ESG) factors.
- Liquidity risk in credit markets is higher than in equities because of market structure differences and is often addressed using liquid bonds for short-term tactical positioning, less liquid positions for buy-and-hold strategies, and liquid alternatives in cases in which active management adds little value.
- Credit market tail risk is usually quantified using value at risk (VaR) or expected shortfall measures and is frequently managed using position limits, risk budgeting, or derivative strategies.
- Credit derivative strategies offer a synthetic liquid alternative to active portfolio managers as a means of over- or underweighting issuers, sectors, or maturities across the credit spectrum.
- Credit spread levels and curve slopes change over the credit cycle, with a credit curve steepening usually indicating low near-term default expectations and higher growth expectations, whereas curve flattening, or inversion, suggests rising default expectations and lower future growth.
- Active credit managers can benefit under a stable credit curve scenario by adding spread duration for existing exposures or by increasing average portfolio credit risk and can capitalize on divergent market views using cash- or derivative-based strategies related to specific issuers, sectors, or the overall credit market.
- Investors in international credit markets distinguish between developed and emerging markets. Developed markets face common macro factors, with market and credit cycle differences affecting relative interest rates, foreign exchange rates, and

## *Fixed Income*

credit spreads. Emerging markets usually exhibit higher growth combined with greater sovereign and geopolitical risk, currency restrictions, and capital controls.

- Structured financial instruments offer active credit managers access to liquid bond portfolios, fixed-income cash flows derived from real estate and consumer loans, and enhanced returns by adding volatility or debt exposure through tranching across the credit spectrum.
- Key considerations for fixed-income analytical tools include the accuracy of model inputs and assumptions as well as alignment between model outputs and fixed-income manager objectives.



# The Term Structure and Interest Rate Dynamics

**Thomas S.Y. Ho, PhD, Sang Bin Lee, PhD, and Stephen E. Wilcox, PhD, CFA**

*Thomas S. Y. Ho, PhD, is at Thomas Ho Company Ltd (USA). Sang Bin Lee, PhD, is at Hanyang University (South Korea). Stephen E. Wilcox, PhD, CFA, is at Minnesota State University, Mankato (USA).*

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## Learning Outcomes

The candidate should be able to:

- a. describe relationships among spot rates, forward rates, yield-to-maturity, expected and realized returns on bonds, and the shape of the yield curve;
- b. describe how zero-coupon rates (spot rates) may be obtained from the par curve by bootstrapping;
- c. describe the assumptions concerning the evolution of spot rates in relation to forward rates implicit in active bond portfolio management;
- d. describe the strategy of rolling down the yield curve;
- e. explain the swap rate curve and why and how market participants use it in valuation;
- f. calculate and interpret the swap spread for a given maturity;

- g. describe short-term interest rate spreads used to gauge economy-wide credit risk and liquidity risk;
- h. explain traditional theories of the term structure of interest rates and describe the implications of each theory for forward rates and the shape of the yield curve;
- i. explain how a bond's exposure to each of the factors driving the yield curve can be measured and how these exposures can be used to manage yield curve risks;
- j. explain the maturity structure of yield volatilities and their effect on price volatility; and
- k. explain how key economic factors are used to establish a view on benchmark rates, spreads, and yield curve changes.

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## Introduction

Interest rates are both a barometer of the economy and an instrument for its control. The term structure of interest rates—market interest rates at various maturities—is a vital input into the valuation of many financial products. The quantification of interest rate risk is of critical importance to risk managers. Understanding the determinants of interest rates, and thus the drivers of bond returns, is imperative for fixed-income market participants. We explore the tools necessary to understand the term structure and interest rate dynamics—that is, the process by which bond yields and prices evolve over time.

Section 1 explains how spot (or current) rates and forward rates, which are set today for a period starting in the future, are related, as well as how their relationship influences yield curve shape.

Section 2 builds on this foundation to show how forward rates affect the yield-to-maturity and expected bond returns. Section 3 explains how these concepts are put into practice by active fixed-income portfolio managers.

The swap curve is the term structure of interest rates derived from a periodic exchange of payments based on fixed rates versus short-term market reference rates rather than default-risk-free government bonds. Sections 4 and 5 describe the swap curve and its relationship to government yields, known as the swap spread, and explains their use in valuation.

Section 6 describes traditional theories of the term structure of interest rates. These theories outline several qualitative perspectives on economic forces that may affect the shape of the term structure.

Section 7 describes yield curve factor models. The focus is a popular three-factor term structure model in which the yield curve changes are described in terms of three independent movements: level, steepness, and curvature. These factors can be extracted from the variance-covariance matrix of historical interest rate movements.

Section 8 builds on the factor model and describes how to manage the risk of changing rates over different maturities. Section 9 concludes with a discussion of key variables known to influence interest rates, the development of interest rate views based on forecasts of those variables, and common trades tailored to capitalize on an interest rate view. A summary of key points concludes the reading.

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## Summary

- The spot rate for a given maturity can be expressed as a geometric average of the short-term rate and a series of forward rates.



- Forward rates are above (below) spot rates when the spot curve is upward (downward) sloping, whereas forward rates are equal to spot rates when the spot curve is flat.
- If forward rates are realized, then all bonds, regardless of maturity, will have the same one-period realized return, which is the first-period spot rate.
- If the spot rate curve is upward sloping and is unchanged, then each bond “rolls down” the curve and earns the forward rate that rolls out of its pricing (i.e., an  $N$ -period zero-coupon bond earns the  $N$ -period forward rate as it rolls down to be a  $N - 1$  period security). This dynamic implies an expected return in excess of short-maturity bonds (i.e., a **term premium**) for longer-maturity bonds if the yield curve is upward sloping.
- Active bond portfolio management is consistent with the expectation that today’s forward curve does not accurately reflect future spot rates.
- The swap curve provides another measure of the time value of money.
- Swaps are an essential tool frequently used by investors to hedge, take a position in, or otherwise modify interest rate risk.
- Bond quote conventions often use measures of spreads. Those quoted spreads can be used to determine a bond’s price.
- Swap curves and Treasury curves can differ because of differences in their credit exposures, liquidity, and other supply/demand factors.
- Market participants often use interest rate spreads between short-term government and risky rates as a barometer to evaluate relative credit and liquidity risk.

- The local expectations theory, liquidity preference theory, segmented markets theory, and preferred habitat theory provide traditional explanations for the shape of the yield curve.
- Historical yield curve movements suggest that they can be explained by a linear combination of three principal movements: level, steepness, and curvature.
- The volatility term structure can be measured using historical data and depicts yield curve risk.
- The sensitivity of a bond value to yield curve changes may make use of effective duration, key rate durations, or sensitivities to parallel, steepness, and curvature movements. Using key rate durations or sensitivities to parallel, steepness, and curvature movements allows one to measure and manage shaping risk.
- The term bond risk premium refers to the expected excess return of a default-free long-term bond less that of an equivalent short-term bond or the one-period risk-free rate
- Several macroeconomic factors influence bond pricing and required returns, such as inflation, economic growth, and monetary policy, among others.
- During highly uncertain market periods, investors flock to government bonds in a flight to quality that is often associated with bullish flattening, in which long-term rates fall by more than short-term rates.
- Investors expecting rates to fall generally will extend (shorten) portfolio duration to take advantage of expected bond price increases (decreases)

*Fixed Income*

- When investors expect a steeper (flatter) curve under which long-term rates rise (fall) relative to short-term rates, they will sell (buy) long-term bonds and purchase (sell) short-term bonds.

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