CFA Institute®
CFA Program

FIXED INCOME AND EQUITY PORTFOLIO MANAGEMENT

CFA® Program Curriculum
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O indicates an optional segment

How to Use the CFA Program Curriculum

Congratulations on reaching Level III of the Chartered Financial Analyst® (CFA®) Program. This exciting and rewarding program of study reflects your desire to become a serious investment professional. You have embarked on a program noted for its high ethical standards and the breadth of knowledge, skills, and abilities (competencies) it develops. Your commitment to the CFA Program should be educationally and professionally rewarding.

The credential you seek is respected around the world as a mark of accomplishment and dedication. Each level of the program represents a distinct achievement in professional development. Successful completion of the program is rewarded with membership in a prestigious global community of investment professionals. CFA charterholders are dedicated to life-long learning and maintaining currency with the ever-changing dynamics of a challenging profession. The CFA Program represents the first step toward a career-long commitment to professional education.

The CFA examination measures your mastery of the core knowledge, skills, and abilities required to succeed as an investment professional. These core competencies are the basis for the Candidate Body of Knowledge (CBOK™). The CBOK consists of four components:

- A broad outline that lists the major topic areas covered in the CFA Program (https://www.cfainstitute.org/programs/cfa/curriculum/cbok);
- Topic area weights that indicate the relative exam weightings of the top-level topic areas (https://www.cfainstitute.org/programs/cfa/curriculum/overview);
- Learning outcome statements (LOS) that advise candidates about the specific knowledge, skills, and abilities they should acquire from readings covering a topic area (LOS are provided in candidate study sessions and at the beginning of each reading); and
- The CFA Program curriculum that candidates receive upon examination registration.

Therefore, the key to your success on the CFA examinations is studying and understanding the CBOK. The following sections provide background on the CBOK, the organization of the curriculum, features of the curriculum, and tips for designing an effective personal study program.

BACKGROUND ON THE CBOK

The CFA Program is grounded in the practice of the investment profession. Beginning with the Global Body of Investment Knowledge (GBIK), CFA Institute performs a continuous practice analysis with investment professionals around the world to determine the competencies that are relevant to the profession. Regional expert panels and targeted surveys are conducted annually to verify and reinforce the continuous feedback about the GBIK. The practice analysis process ultimately defines the CBOK. The

CBOK reflects the competencies that are generally accepted and applied by investment professionals. These competencies are used in practice in a generalist context and are expected to be demonstrated by a recently qualified CFA charterholder.

The CFA Institute staff, in conjunction with the Education Advisory Committee and Curriculum Level Advisors, who consist of practicing CFA charterholders, designs the CFA Program curriculum in order to deliver the CBOK to candidates. The examinations, also written by CFA charterholders, are designed to allow you to demonstrate your mastery of the CBOK as set forth in the CFA Program curriculum. As you structure your personal study program, you should emphasize mastery of the CBOK and the practical applications of that knowledge. For more information on the practice analysis, CBOK, and development of the CFA Program curriculum, please visit www.cfainstitute.org.

ORGANIZATION OF THE CURRICULUM

The Level III CFA Program curriculum is organized into seven topic areas. Each topic area begins with a brief statement of the material and the depth of knowledge expected. It is then divided into one or more study sessions. These study sessions—16 sessions in the Level III curriculum—should form the basic structure of your reading and preparation. Each study session includes a statement of its structure and objective and is further divided into assigned readings. An outline illustrating the organization of these 16 study sessions can be found at the front of each volume of the curriculum.

The readings are commissioned by CFA Institute and written by content experts, including investment professionals and university professors. Each reading includes LOS and the core material to be studied, often a combination of text, exhibits, and in-text examples and questions. A reading typically ends with practice problems followed by solutions to these problems to help you understand and master the material. The LOS indicate what you should be able to accomplish after studying the material. The LOS, the core material, and the practice problems are dependent on each other, with the core material and the practice problems providing context for understanding the scope of the LOS and enabling you to apply a principle or concept in a variety of scenarios.

The entire readings, including the practice problems at the end of the readings, are the basis for all examination questions and are selected or developed specifically to teach the knowledge, skills, and abilities reflected in the CBOK.

You should use the LOS to guide and focus your study because each examination question is based on one or more LOS and the core material and practice problems associated with the LOS. As a candidate, you are responsible for the entirety of the required material in a study session.

We encourage you to review the information about the LOS on our website (www.cfainstitute.org/programs/cfa/curriculum/study-sessions), including the descriptions of LOS "command words" on the candidate resources page at www.cfainstitute.org.

FEATURES OF THE CURRICULUM

OPTIONAL SEGMENT

Required vs. Optional Segments You should read all of an assigned reading. In some cases, though, we have reprinted an entire publication and marked certain parts of the reading as "optional." The CFA examination is based only on the required segments, and the optional segments are included only when it is determined that they might help you to better understand the required segments (by seeing the required material in its full context). When an optional segment begins, you will see an icon and a dashed vertical bar in the outside margin that will continue until the optional segment ends, accompanied by another icon. *Unless the material is specifically marked as optional, you should assume it is required.* You should rely on the required segments and the reading-specific LOS in preparing for the examination.

END OPTIONAL SEGMENT

Practice Problems/Solutions *All practice problems at the end of the readings as well as their solutions are part of the curriculum and are required material for the examination.* In addition to the in-text examples and questions, these practice problems should help demonstrate practical applications and reinforce your understanding of the concepts presented. Some of these practice problems are adapted from past CFA examinations and/or may serve as a basis for examination questions.

Glossary For your convenience, each volume includes a comprehensive glossary. Throughout the curriculum, a **bolded** word in a reading denotes a term defined in the glossary.

Note that the digital curriculum that is included in your examination registration fee is searchable for key words, including glossary terms.

LOS Self-Check We have inserted checkboxes next to each LOS that you can use to track your progress in mastering the concepts in each reading.

Source Material The CFA Institute curriculum cites textbooks, journal articles, and other publications that provide additional context and information about topics covered in the readings. As a candidate, you are not responsible for familiarity with the original source materials cited in the curriculum.

Note that some readings may contain a web address or URL. The referenced sites were live at the time the reading was written or updated but may have been deactivated since then.

Some readings in the curriculum cite articles published in the *Financial Analysts Journal*®, which is the flagship publication of CFA Institute. Since its launch in 1945, the *Financial Analysts Journal* has established itself as the leading practitioner-oriented journal in the investment management community. Over the years, it has advanced the knowledge and understanding of the practice of investment management through the publication of peer-reviewed practitioner-relevant research from leading academics and practitioners. It has also featured thought-provoking opinion pieces that advance the common level of discourse within the investment management profession. Some of the most influential research in the area of investment management has appeared in the pages of the *Financial Analysts Journal*, and several Nobel laureates have contributed articles.

Candidates are not responsible for familiarity with *Financial Analysts Journal* articles that are cited in the curriculum. But, as your time and studies allow, we strongly encourage you to begin supplementing your understanding of key investment management issues by reading this practice-oriented publication. Candidates have full online access to the *Financial Analysts Journal* and associated resources. All you need is to log in on www.cfapubs.org using your candidate credentials.

Errata The curriculum development process is rigorous and includes multiple rounds of reviews by content experts. Despite our efforts to produce a curriculum that is free of errors, there are times when we must make corrections. Curriculum errata are periodically updated and posted on the candidate resources page at www.cfainstitute.org.

DESIGNING YOUR PERSONAL STUDY PROGRAM

Create a Schedule An orderly, systematic approach to examination preparation is critical. You should dedicate a consistent block of time every week to reading and studying. Complete all assigned readings and the associated problems and solutions in each study session. Review the LOS both before and after you study each reading to ensure that you have mastered the applicable content and can demonstrate the knowledge, skills, and abilities described by the LOS and the assigned reading. Use the LOS self-check to track your progress and highlight areas of weakness for later review.

Successful candidates report an average of more than 300 hours preparing for each examination. Your preparation time will vary based on your prior education and experience, and you will probably spend more time on some study sessions than on others. As the Level III curriculum includes 16 study sessions, a good plan is to devote 15–20 hours per week for 16 weeks to studying the material, and use the final four to six weeks before the examination to review what you have learned and practice with practice questions and mock examinations. This recommendation, however, may underestimate the hours needed for appropriate examination preparation depending on your individual circumstances, relevant experience, and academic background. You will undoubtedly adjust your study time to conform to your own strengths and weaknesses and to your educational and professional background.

You should allow ample time for both in-depth study of all topic areas and additional concentration on those topic areas for which you feel the least prepared.

As part of the supplemental study tools that are included in your examination registration fee, you have access to a study planner to help you plan your study time. The study planner calculates your study progress and pace based on the time remaining until examination. For more information on the study planner and other supplemental study tools, please visit www.cfainstitute.org.

As you prepare for your exam, we will e-mail you important examination updates, testing policies, and study tips. Be sure to read these carefully.

CFA Institute Practice Questions Your examination registration fee includes digital access to hundreds of practice questions that are additional to the practice problems at the end of the readings. These practice questions are intended to help you assess your mastery of individual topic areas as you progress through your studies. After each practice question, you will be able to receive immediate feedback noting the correct responses and indicating the relevant assigned reading so you can identify areas of weakness for further study. For more information on the practice question sets, please visit www.cfainstitute.org.

CFA Institute Mock Examinations Your examination registration fee also includes digital access to three-hour mock examinations that simulate the morning and afternoon sessions of the actual CFA examination. These mock examinations are intended to be taken after you complete your study of the full curriculum and take practice questions so you can test your understanding of the curriculum and your readiness for the examination. You will receive feedback at the end of the mock examination, noting the correct responses and indicating the relevant assigned readings so you can assess areas of weakness for further study during your review period. We recommend that you take mock examinations during the final stages of your preparation for the actual CFA examination. For more information on the mock examinations, please visit www.cfainstitute.org.

Preparatory Providers After you enroll in the CFA Program, you may receive numerous solicitations for preparatory courses and review materials. When considering a prep course, make sure the provider belongs to the CFA Institute Approved Prep Provider Program. Approved Prep Providers have committed to follow CFA Institute guidelines and high standards in their offerings and communications with candidates. For more information on the Approved Prep Providers, please visit www.cfainstitute.org/programs/cfa/exam/prep-providers).

Remember, however, that there are no shortcuts to success on the CFA examinations; reading and studying the CFA curriculum *is* the key to success on the examination. The CFA examinations reference only the CFA Institute assigned curriculum—no preparatory course or review course materials are consulted or referenced.

SUMMARY

Every question on the CFA examination is based on the content contained in the required readings and on one or more LOS. Frequently, an examination question is based on a specific example highlighted within a reading or on a specific practice problem and its solution. To make effective use of the CFA Program curriculum, please remember these key points:

1. All pages of the curriculum are required reading for the examination except for occasional sections marked as optional. You may read optional pages as background, but you will not be tested on them.
2. All questions, problems, and their solutions—found at the end of readings—are part of the curriculum and are required study material for the examination.
3. You should make appropriate use of the practice questions and mock examinations as well as other supplemental study tools and candidate resources available at www.cfainstitute.org.
4. Create a schedule and commit sufficient study time to cover the 16 study sessions, using the study planner. You should also plan to review the materials and take practice questions and mock examinations.
5. Some of the concepts in the study sessions may be superseded by updated rulings and/or pronouncements issued after a reading was published. Candidates are expected to be familiar with the overall analytical framework contained in the assigned readings. Candidates are not responsible for changes that occur after the material was written.

FEEDBACK

At CFA Institute, we are committed to delivering a comprehensive and rigorous curriculum for the development of competent, ethically grounded investment professionals. We rely on candidate and investment professional comments and feedback as we work to improve the curriculum, supplemental study tools, and candidate resources.

Please send any comments or feedback to info@cfainstitute.org. You can be assured that we will review your suggestions carefully. Ongoing improvements in the curriculum will help you prepare for success on the upcoming examinations and for a lifetime of learning as a serious investment professional.

Portfolio Management

STUDY SESSIONS

Study Session 3	Behavioral Finance
Study Session 4	Capital Market Expectations
Study Session 5	Asset Allocation and Related Decisions in Portfolio Management
Study Session 6	Derivatives and Currency Management
Study Session 7	Fixed-Income Portfolio Management (1)
Study Session 8	Fixed-Income Portfolio Management (2)
Study Session 9	Equity Portfolio Management (1)
Study Session 10	Equity Portfolio Management (2)
Study Session 11	Alternative Investments Portfolio Management
Study Session 12	Private Wealth Management (1)
Study Session 13	Private Wealth Management (2)
Study Session 14	Portfolio Management for Institutional Investors
Study Session 15	Trading, Performance Evaluation, and Manager Selection
Study Session 16	Cases in Portfolio Management and Risk Management

This volume includes Study Sessions 7–10.

TOPIC LEVEL LEARNING OUTCOME

The candidate should be able to prepare an appropriate investment policy statement and asset allocation; formulate strategies for managing, monitoring, and rebalancing investment portfolios; and evaluate portfolio performance.

PORTFOLIO MANAGEMENT
STUDY SESSION

7

Fixed-Income Portfolio Management (1)

Fixed-income securities represent a significant portion of all available financial assets and are included in most investor portfolios.

This study session begins by explaining the role played by fixed-income securities in portfolios and then introduces the two primary types of fixed-income mandates (liability-based and total return). A model for decomposing expected bond returns, which identifies the driving forces behind expected returns, is presented. The effects of illiquidity, leverage, and taxes on fixed-income portfolios are discussed. Next, liability-driven and index-based strategies are examined in greater detail. Coverage includes approaches, risks, and challenges associated with both immunization of single and multiple liabilities and the indexation and laddering of a fixed-income portfolio.

READING ASSIGNMENTS

Reading 18	Overview of Fixed-Income Portfolio Management by Bernd Hanke, PhD, CFA, and Brian J. Henderson, PhD, CFA
Reading 19	Liability-Driven and Index-Based Strategies by James F. Adams, PhD, CFA, and Donald J. Smith, PhD

READING

18

Overview of Fixed-Income Portfolio Management

by Bernd Hanke, PhD, CFA, and Brian J. Henderson, PhD, CFA

Bernd Hanke, PhD, CFA, is at Global Systematic Investors LLP (United Kingdom). Brian J. Henderson, PhD, CFA, is at The George Washington University (USA).

LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	**a.** discuss roles of fixed-income securities in portfolios;
☐	**b.** describe how fixed-income mandates may be classified and compare features of the mandates;
☐	**c.** describe bond market liquidity, including the differences among market sub-sectors, and discuss the effect of liquidity on fixed-income portfolio management;
☐	**d.** describe and interpret a model for fixed-income returns;
☐	**e.** discuss the use of leverage, alternative methods for leveraging, and risks that leverage creates in fixed-income portfolios;
☐	**f.** discuss differences in managing fixed-income portfolios for taxable and tax-exempt investors.

1 INTRODUCTION

Globally, fixed-income markets represent the largest asset class in financial markets, and most investors' portfolios include fixed-income investments. Fixed-income markets include publicly traded securities (such as commercial paper, notes, and bonds) and non-publicly traded instruments (such as loans and privately placed securities). Loans may be securitized and become part of the pool of assets supporting an asset-backed security.

This reading discusses why investor portfolios include fixed-income securities and provides an overview of fixed-income portfolio management. Section 2 discusses different roles of fixed-income securities in portfolios, including diversification, regular cash flows, and inflation hedging potential. Section 3 describes the two main types of fixed-income portfolio mandates: liability-based (or structured) mandates and total return mandates. It also describes approaches to implementing these mandates. Section 4 discusses bond market liquidity and its effects on pricing and portfolio construction. Section 5 introduces a model of how a bond position's total expected return can be decomposed. The model provides a better understanding of the driving forces behind expected returns to fixed-income securities. Section 6 discusses the use of leverage in fixed-income portfolios. Section 7 describes considerations in managing fixed-income portfolios for both taxable and tax-exempt investors. A summary of key points completes the reading.

2 ROLES OF FIXED-INCOME SECURITIES IN PORTFOLIOS

Fixed-income securities serve important roles in investment portfolios, including diversification, regular cash flows, and possible inflation hedging. The correlations of fixed-income securities with equity securities vary, but adding fixed-income securities to portfolios that include equity securities is usually an effective way to obtain diversification benefits. Fixed-income securities typically specify schedules for principal repayments and interest payments. The scheduled nature of their cash flows enables investors—both individual and institutional—to fund, with some degree of predictability, known future obligations such as tuition payments or corporate pension obligations. Some fixed-income securities, such as inflation-linked bonds, may also provide a hedge for inflation.

2.1 Diversification Benefits

In a portfolio context, fixed-income investments can provide diversification benefits when combined with other asset classes. Recall that a major reason that portfolios can effectively reduce risk is that combining securities whose returns are not perfectly correlated (i.e., a correlation coefficient of less than +1.0) provides risk diversification. Lower correlations are associated with lower risk. The challenge in diversifying risk is to find assets that have a correlation that is much lower than +1.0.

Exhibit 1 shows the correlation matrix across several bond market sectors and the S&P 500 Index (an index of large-cap US equity securities) for the period January 2003 to September 2015. The bond market sectors in the matrix are represented by indexes of four investment-grade bond sub-sectors of the US bond market:

1 The Bloomberg Barclays US Aggregate (US dollar–denominated bonds with maturity greater than 1 year, including Treasuries, government-related and corporate securities, mortgage-backed securities, asset-backed securities, and commercial mortgage-backed securities);
2 The Bloomberg Barclays US Treasury Bond 10-Year Term (US Treasury bonds with maturities of 7–10 years);
3 The Bloomberg Barclays US Corporate (US dollar–denominated corporate bonds with maturity greater than 1 year); and
4 The Bloomberg Barclays US TIPS (Series-L) (US Treasury Inflation-Protected Securities [TIPS] with maturity greater than 1 year).

In addition to investment-grade bonds, the matrix includes a high-yield (non-investment-grade) bond market index: the Bloomberg Barclays US Corporate High-Yield (US dollar–denominated high-yield corporate bonds with maturity greater than one year). The matrix also includes two international bond indexes: the Bloomberg Barclays Global Aggregate (international investment-grade bonds) and the JP Morgan Government Bond Index–Emerging Markets Global (GBI–EM Global).

Exhibit 1 Correlation Matrix

Index	Bloomberg Barclays US Aggregate	Bloomberg Barclays US Treasury 10-Year Term	Bloomberg Barclays US Corporate	Bloomberg Barclays US TIPS	Bloomberg Barclays Global Aggregate	Bloomberg Barclays US Corporate High Yield	JP Morgan GBI-EM Global	S&P 500
Bloomberg Barclays US Aggregate	1.00	0.95	0.92	0.81	0.54	0.03	–0.01	–0.27
Bloomberg Barclays US Treasury 10-Year Term	0.95	1.00	0.88	0.79	0.50	–0.13	–0.12	–0.35
Bloomberg Barclays US Corporate	0.92	0.88	1.00	0.77	0.50	0.16	0.04	–0.25
Bloomberg Barclays US TIPS	0.81	0.79	0.77	1.00	0.49	0.07	0.08	–0.21
Bloomberg Barclays Global Aggregate	0.54	0.50	0.50	0.49	1.00	0.09	0.46	0.04
Bloomberg Barclays US Corporate High Yield	0.03	–0.13	0.16	0.07	0.09	1.00	0.47	0.32
JP Morgan GBI-EM Global	–0.01	–0.12	0.04	0.08	0.46	0.47	1.00	0.36
S&P 500	–0.27	–0.35	–0.25	–0.21	0.04	0.32	0.36	1.00

Source: Authors' calculations for the period January 2003 to September 2015, based on data from Barclays Risk Analytics and Index Solutions; J.P. Morgan Index Research; S&P Dow Jones Indices.

For the period January 2003 to September 2015, the correlation matrix shows the following:

- The US bond market's investment-grade sub-sectors were highly correlated with each other, as evidenced by the correlations ranging from 0.77 to 0.95.
- International investment-grade bonds, which include US investment-grade bonds, show a 0.54 correlation with the overall US investment-grade bond sector. Because the US Aggregate Index and the US Aggregate Index portion of the Global Aggregate Index have a correlation of 1.0, the non-US investment-grade bonds must have had an even lower correlation with US investment-grade bonds. During this period, significant diversification benefits existed for including both US and non-US bonds in portfolios.

- The US investment-grade bond sub-sectors exhibited low (and in some cases, negative) correlations with equities, US high-yield bonds, and emerging market bonds. International investment-grade bonds also exhibited low correlations with equities and US high-yield bonds but were moderately correlated with emerging market bonds. The low or negative correlations indicate that investment-grade bonds would have provided significant diversification benefits if combined with these other, more-volatile asset classes.
- High-yield bonds, emerging market bonds, and equities exhibited positive correlations with each other, ranging from 0.32 to 0.47.

Based on Exhibit 1, it appears that combining investment-grade, high-yield, and emerging market bonds and equities can result in portfolio diversification benefits. Fixed-income investments may also provide diversification benefits through their low correlations with other asset classes, such as real estate and commodities.

Importantly, these correlations are not constant over time. During a long historical period, the average correlation of returns between two asset classes may be low, but in any particular period, the correlation can differ from the average correlation. Correlation estimates can vary based on the capital market dynamics during the period when the correlations are measured. The correlation between the asset classes may increase or decrease, depending on the circumstances. During periods of market stress, investors may exhibit a "flight to quality" by buying safer assets such as government bonds (increasing their prices) and selling riskier assets such as equity securities and high-yield bonds (lowering their prices). These actions may decrease the correlation between government bonds and equity securities, as well as between government bonds and high-yield bonds. At the same time, the correlation between riskier assets such as equity securities and high-yield bonds may increase.

Correlation among assets is the primary determinant of diversification benefits and a reduction in portfolio risk, but volatility of each asset class also affects portfolio risk. Bonds are generally less volatile than other major asset classes such as equity securities. Consider the standard deviation of daily returns to the indexes shown in Exhibit 1, covering the same period (January 2003 to September 2015). The Bloomberg Barclays US Aggregate (Bond) Index exhibited annualized return standard deviations of approximately 4%. The Bloomberg Barclays US Corporate High-Yield Index and the JP Morgan GBI–EM Index, which are higher-risk sectors of the bond market, exhibited 6.3% and 9.8% annualized return standard deviations, respectively. By comparison, the S&P 500 exhibited an annualized return standard deviation of 19.4%. Including diversified fixed-income positions in an investment portfolio, combined with exposure to other major asset classes, may significantly lower portfolio risk.

It is important to note that similar to correlations, volatility (standard deviation) of asset class returns may also vary over time. If interest rate volatility increases, bonds, particularly those with long maturities, can exhibit higher near-term volatility relative to the average volatility during a long historical period. The standard deviation of returns for lower credit quality (high-yield) bonds can rise significantly during times of financial stress, because as credit quality declines and the probability of default increases, investors often view these bonds as being more similar to equities.

2.2 Benefits of Regular Cash Flows

Fixed-income investments typically produce regular cash flows to a portfolio. Regular cash flows allow investors—both individual and institutional—to plan how to meet, with some degree of predictability, known future obligations such as tuition payments, pension obligations, or payouts on life insurance policies. In these cases, future liabilities can be estimated with some reasonable certainty. Fixed-income securities are often acquired and "dedicated" to funding those future liabilities. In dedicated portfolios, fixed-income securities are selected such that the timing and magnitude of their cash flows match the timing and magnitude of the projected future liabilities.

Frequently, investors will "ladder" bond portfolios by staggering the maturity dates of portfolio bonds throughout the investment horizon. This approach can help to balance price risk and reinvestment risk. Buy-and-hold portfolios can also be tailored to fit an investor's specific investment horizon. For example, if an investor seeks regular income over a 10-year horizon, coupon-paying bonds that mature approximately 10 years in the future are good building blocks for such a portfolio.

It is important to note that reliance on regular cash flows assumes that no credit event (such as an issuer missing a scheduled interest or principal payment) or other market event (such as a decrease in interest rates increasing prepayments of mortgages underlying mortgage-backed securities) will occur. These events may cause actual cash flows of fixed-income securities to differ from expected cash flows. If any credit or market event occurs, a portfolio manager may need to adjust the portfolio.

2.3 Inflation Hedging Potential

Some fixed-income securities can provide a hedge for inflation. Bonds with floating-rate coupons protect interest income from inflation because the reference rate should adjust for inflation. The principal payment at maturity is unadjusted for inflation. Inflation-linked bonds provide investors with valuable inflation hedging benefits by paying a return that is directly linked to an index of consumer prices and adjusting the principal for inflation. There are several different structures for inflation-linked bonds, such as zero-coupon bonds with the inflation adjustment made to the principal payment, and capital-indexed bonds where a fixed coupon rate is applied to a principal amount that is adjusted for inflation throughout the bond's life.

The return on inflation-linked bonds includes a real return plus an additional component that is tied directly to the inflation rate. Inflation-linked bonds typically exhibit lower return volatility than conventional bonds and equities because the volatility of the returns on inflation-linked bonds depends on the volatility of *real,* rather than *nominal,* interest rates. The volatility of real interest rates is typically lower than the volatility of nominal interest rates that drive the returns of conventional bonds and equities.

Many governments in developed countries have issued inflation-linked bonds, including the United States, United Kingdom, France, Germany, Sweden, and Canada, as well as some in developing countries such as Brazil, Chile, and Argentina. Corporate issuers of inflation-linked bonds have included both financial and non-financial companies. For investors with long investment horizons, especially institutions facing long-term liabilities (for example, defined benefit pension plans and life insurance companies), inflation-linked bonds are particularly useful.

Exhibit 2 illustrates inflation protection provided by type of bond.

Exhibit 2 Protection against Inflation

	Coupon	Principal
Fixed-coupon bonds	Inflation unprotected	Inflation unprotected
Floating-coupon bonds	Inflation protected	Inflation unprotected
Inflation-linked bonds	Inflation protected	Inflation protected

Adding inflation-indexed bonds to diversified portfolios of bonds and equities typically results in superior risk-adjusted real portfolio returns. This improvement occurs because inflation-linked bonds can effectively represent a separate asset class, as they offer returns that differ from other asset classes and add to market completeness. Introducing inflation-linked bonds to an asset allocation strategy can result in a superior mean-efficient frontier.

EXAMPLE 1

Adding Fixed-Income Securities to a Portfolio

Mary Baker is anxious about the level of risk in her portfolio based on a recent period of increased equity market volatility. Most of her wealth is invested in a diversified global equities portfolio.

Baker contacts two wealth management firms, Atlantic Investments (AI) and West Coast Capital (WCC), for advice. In conversation with each adviser, she expresses her desire to reduce her portfolio's risk and to have a portfolio that generates a cash flow stream with consistent purchasing power over her 15-year investment horizon.

The correlation coefficient of Baker's diversified global equities portfolio with a diversified fixed-coupon bond portfolio is −0.10 and with a diversified inflation-linked bond portfolio is 0.10. The correlation coefficient between a diversified fixed-coupon bond portfolio and a diversified inflation-linked bond portfolio is 0.65.

The adviser from AI suggests diversifying half of her investment assets into nominal fixed-coupon bonds. The adviser from WCC also suggests diversification but recommends that Baker invest 25% of her investment assets into fixed-coupon bonds and 25% into inflation-linked bonds.

Evaluate the advice given to Baker by each adviser based on her stated desires regarding portfolio risk reduction and cash flow stream. Recommend which advice Baker should follow, making sure to discuss the following concepts in your answer:

a Diversification benefits

b Cash flow benefits

c Inflation hedging benefits

Solution:

Advice from AI:

Diversifying into fixed-coupon bonds would offer substantial diversification benefits in lowering overall portfolio volatility (risk) given the negative correlation of −0.10. The portfolio's volatility, measured by standard deviation, would be lower than the weighted standard deviations of the diversified global equities portfolio and the diversified fixed-coupon bond portfolio. The portfolio will generate regular cash flows because it includes fixed-coupon bonds. This advice, however, does not address Baker's desire to have the cash flows maintain purchasing power over time and thus serve as an inflation hedge.

Advice from WCC:

Diversifying into both fixed-coupon bonds and inflation-linked bonds offers additional diversification benefits beyond that offered by fixed-coupon bonds only. The correlation between diversified global equities and inflation-linked bonds is only 0.10. The correlation between nominal fixed-coupon bonds and inflation-linked bonds is 0.65, which is also less than 1.0. The portfolio will generate regular cash flows because of the inclusion of fixed-coupon and inflation-linked bonds. Adding the inflation-linked bonds helps to at least partially address Baker's desire for consistent purchasing power over her investment horizon.

Based on her stated desires and the analysis above, Baker should follow the advice provided by WCC.

3 FIXED-INCOME MANDATES

The previous section discussed the roles of fixed-income securities in portfolios and the benefits these securities provide. When investment mandates include an allocation to fixed income, investors need to decide how to add fixed-income securities to portfolios. Fixed-income mandates can be broadly classified into liability-based mandates and total return mandates. Liability-based mandates are managed to match or cover expected liability payments with future projected cash inflows. As such, they are also referred to as structured mandates, asset/liability management (ALM), or liability-driven investments (LDI). These types of mandates are structured in a way to ensure that a liability or a stream of liabilities (e.g., a company's pension liabilities) can be covered and that any risk of shortfalls or deficient cash inflows is minimized.

Total return mandates are generally managed in an attempt to either track or outperform a market-weighted fixed-income benchmark such as the Bloomberg Barclays Global Aggregate Index. Both liability-based and total return mandates exhibit common features, such as the attempt by investors to achieve the highest risk-adjusted returns (or perhaps highest yields) given a set of constraints. The two types of mandates have fundamentally different objectives, however.

Some fixed-income mandates include a requirement that environmental, social, and governance (ESG) factors are considered during the investment process. When considering these factors, an analyst or portfolio manager may look for evidence on whether the portfolio contains companies whose operations are favorable or unfavorable in the context of ESG, and whether such companies' actions and resource management practices reflect a sustainable business model. For example, the analyst or portfolio manager may consider whether a company experienced incidents involving significant environmental damage, instances of unfair labor practices, or lapses in corporate governance integrity. For companies that do not fare favorably in an ESG analysis, investors may assume that these companies are more likely to encounter future ESG-related incidents that could cause serious reputational and financial damage to the company. Such incidents could impair a company's credit quality and result in a decline in both the price of the company's bonds and the performance of a portfolio containing those bonds.

3.1 Liability-Based Mandates

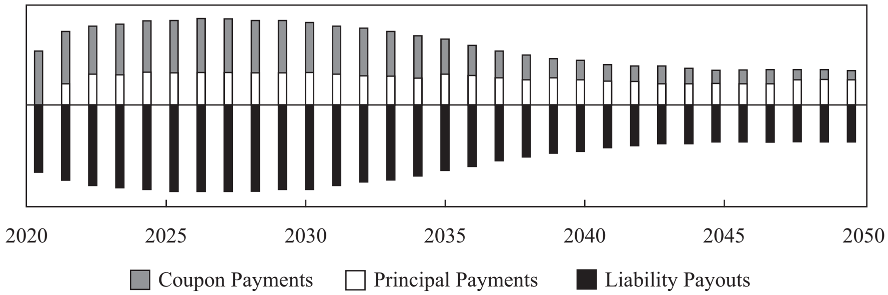
Users of liability-based mandates include individuals funding specific cash flow and lifestyle needs as well as institutions such as banks, insurance companies, and pension funds. These types of institutions have a need to match future liabilities, such as payouts on life insurance policies and pension benefits, with corresponding cash inflows. Pension funds are perhaps the largest users of liability-based mandates based on assets invested. Regulators in many jurisdictions impose minimum funding levels on pension liabilities to ensure the safety of retiree pensions. Insurance companies project future cash outflows based on expected claims from policyholders. Additionally, life insurance companies may offer annuities and guaranteed investment contracts, both of which require cash outflows for extended periods.

There are two main approaches to liability-based mandates: **cash flow matching** and **duration matching**, which are immunization approaches. Immunization is the process of structuring and managing a fixed-income portfolio to minimize the variance in the realized rate of return over a known time horizon. This variance arises from the volatility of future interest rates. Immunization is an asset/liability management approach that structures investments in bonds to reduce or eliminate the risks associated with a change in market interest rates. In addition, several variations use or combine elements of these approaches, including contingent immunization and horizon matching.[1] The following discussion provides an overview of these approaches.

3.1.1 *Cash Flow Matching*

Cash flow matching is an immunization approach that may be the simplest and most intuitive way to match a liability stream and a stream of cash inflows. This approach, unlike duration matching, essentially has no underlying assumptions. Cash flow matching attempts to ensure that all future liability payouts are matched precisely by cash flows from bonds or fixed-income derivatives, such as interest rate futures, options, or swaps. Exhibit 3 shows the results of a cash flow matching approach for a liability stream and a bond portfolio. Future liability payouts are exactly mirrored by coupon and principal payments arising from the bond portfolio. Bond cash inflows coincide with liability cash outflows. Therefore, there is no need for reinvestment of cash inflows.

Exhibit 3 Cash Flow Matching



In practice, perfect matching of cash flows is difficult to achieve. It is rare that a combination of fixed-income securities can be found that exactly matches the timing and amount of the required cash outflows. Further, implementing a cash flow matching approach may result in relatively high transaction costs, even if quantitative optimization techniques are used to construct a cash flow matching portfolio at the lowest possible cost. Timing mismatches, such as some cash inflows preceding corresponding cash outflows, tend to exist because it may be less costly and more practical to not match cash flows precisely. Such a mismatch, however, results in some reinvestment risk.

Although in theory a cash flow matching portfolio does not need to be rebalanced once in place, it is often desirable or necessary to do so. As market conditions change, the lowest-cost cash flow matching portfolio may change because the universe of

1 Leibowitz (1986a and 1986b) provides an insightful summary of the main approaches.

securities eligible for inclusion into the portfolio changes and the characteristics of securities change. A portfolio manager, therefore, has an incentive to rebalance the portfolio periodically despite incurring transaction costs.

For some types of fixed-income securities, the timing or amount of cash flows may change. For example, a corporate bond issuer may default and subsequent cash flows cease, or a bond with an embedded option may be called before maturity. Although these types of "imperfections" can often be avoided by restricting the universe of eligible securities and including only certain types of bonds (e.g., government bonds) in the portfolio, it is usually not optimal to do so. Securities that are not included in a smaller restricted universe might provide better return-to-risk tradeoffs.

3.1.2 *Duration Matching*

Duration matching is an immunization approach that is based on the duration of assets and liabilities. Ideally, the liabilities being matched (the liability portfolio) and the portfolio of assets (the bond portfolio) should be affected similarly by a change in interest rates. Conditions that need to be satisfied to achieve immunization using duration matching include the following: (1) A bond portfolio's duration must equal the duration of the liability portfolio; and (2) the present value of the bond portfolio's assets must equal the present value of the liabilities at current interest rate levels. The idea is that changes in the bond portfolio's market value closely match changes in the liability portfolio, whether interest rates rise or fall.

If interest rates increase or decrease, changes in reinvestment income and changes in bond prices immunize against the effect of interest rate changes. If interest rates decrease, reduced reinvestment income is offset by an increase in bond prices. If interest rates increase, higher reinvestment income offsets the decrease in bond prices. A crucial limitation of immunization is that it protects against only a parallel change in the yield curve—that is, the same yield change across the entire maturity spectrum of the yield curve. In practice, however, changes in the bond market environment may lead to changes in yield curve shape, such as steepening, flattening, or changes in the curvature.[2] Hence immunization remains imperfect, and the strategy design needs to incorporate some margin for error.

It is important to note other considerations for an immunized portfolio:

- A portfolio is an immunized portfolio only at a given point in time. As market conditions change, the immunization conditions will be violated, and the portfolio therefore needs to be rebalanced periodically to continue to achieve its immunization objective.
- The need to rebalance makes liquidity considerations important. Moreover, if bond portfolio cash flows (e.g., scheduled coupon and principal payments) are not perfectly matched with liability cash flows under immunization, bond positions may need to be liquidated in order to satisfy the liability outflows.
- Rebalancing and the need to liquidate positions can result in high portfolio turnover.

2 There are extensions to the classical immunization approach (Redington 1952) that can incorporate non-parallel yield curve shifts (see, for example, Fong and Vasicek 1984). These approaches are more complex, however, and are not discussed here.

- Immunization assumes that bond issuers do not default, and it does not protect against issuer- or bond-specific interest rate changes such as those resulting from an individual bond issuer's change in credit quality.
- Immunization can accommodate bonds with embedded options (such as certain corporate bonds and mortgage-backed securities) to the extent that a bond's duration is replaced by its effective duration as an input to the methodology. Effective duration takes into account that future interest rate changes can affect the expected cash flows for a bond with embedded options.

In summary, the duration matching approach requires that reinvestment risk and the risk of bond price movements in a portfolio are offset. In practice, however, some immunization risk almost always remains. An exception would be a portfolio of zero-coupon bonds that are designed to match liability cash flows. In this case, because the zero-coupon bonds are held to maturity, the effect of interest rate changes on price are irrelevant and there are no interim cash flows to reinvest. In effect, there is no price risk, no reinvestment risk, and therefore no immunization risk, although credit risk remains.

Exhibit 4 gives an overview of key features of duration matching and cash flow matching.

Exhibit 4 Liability-Based Mandates: Key Features

	Duration Matching	Cash Flow Matching
Yield curve assumptions	Parallel yield curve shifts	None
Mechanism	Risk of shortfall in cash flows is minimized by matching duration and present value of liability stream	Bond portfolio cash flows match liabilities
Basic principle	Cash flows come from coupon and principal repayments of the bond portfolio and offset liability cash flows	Cash flows, coupons, and principal repayments of the bond portfolio offset liability cash flows
Rebalancing	Frequent rebalancing required	Not required but often desirable
Complexity	High	Low

3.1.3 *Contingent Immunization*

Variations of both duration and cash flow matching approaches exist. A commonly used hybrid approach is known as **contingent immunization**, which combines immunization with an active management approach when the asset portfolio's value exceeds the present value of the liability portfolio. In other words, there is a surplus. The portfolio manager is allowed to actively manage the asset portfolio, or some portion of the asset portfolio, as long as the value of the actively managed portfolio exceeds a specified value (threshold). The actively managed portfolio can potentially be invested into any asset category, including equity, fixed-income, and alternative investments. If the actively managed portfolio value falls to the specified threshold, active management ceases and a conventional duration matching or a cash flow matching approach is put in place.

3.1.4 *Horizon Matching*

Another hybrid approach, **horizon matching**, combines cash flow and duration matching approaches. Under this approach, liabilities are categorized as short- and long-term liabilities. The short-term liability portion (usually liabilities up to about four or five years) is covered by a cash flow matching approach, whereas the long-term liabilities are covered by a duration matching approach. This approach combines desirable features of both approaches—a portfolio manager has more flexibility over the less certain, longer horizon and can still meet more certain, shorter-term obligations.

EXAMPLE 2

Liability-Based Mandates (1)

Dave Wilson, a fixed-income analyst, has been asked by his manager to analyze different liability-based mandates for a pension fund client. The pension plan currently has a very large surplus of assets over liabilities. Evaluate whether an immunization or contingent immunization approach would be most suitable for the pension fund.

Solution:

Because the pension fund currently has a large surplus of assets over liabilities, a contingent immunization approach would be most suitable. A pure immunization approach would not be appropriate, because a key assumption under this approach is that the present value of the fund's assets equals the present value of its liabilities. The contingent immunization approach allows the pension fund's portfolio manager to follow an active management approach as long as the portfolio remains above a specified value. If the pension fund's portfolio decreases to the specified value, a duration matching or even a cash flow matching approach would be put in place to ensure adequate funding of the pension plan's liabilities.

EXAMPLE 3

Liability-Based Mandates (2)

If the yield curve experiences a one-time parallel shift of 1%, what is the likely effect on the match between a portfolio's assets and liabilities for a duration matching approach and a cash flow matching approach?

Solution:

There should be no effect on the match between assets and liabilities for either a duration matching or cash flow matching portfolio. Duration matching insures against any adverse effects of a one-time parallel shift in the yield curve. By contrast, non-parallel shifts would cause mismatches between assets and liabilities in a duration matching approach. In a cash flow matching approach, asset and liability matching remains in place even if market conditions change.

3.2 Total Return Mandates

In contrast to liability-based mandates, total return mandates do not attempt to match future liabilities. Total return mandates can establish objectives based on a specified absolute return or a relative return. Generally structured to either track or outperform a specified bond index, total return mandates are the focus of this discussion. Total return and risk are both critical considerations for these types of mandates, with **active return** and **active risk** representing key metrics. Active return is defined as the portfolio return minus the benchmark return. Active risk is the annualized standard deviation of active returns, which may also be referred to as **tracking error** (also sometimes called **tracking risk**).

Total return mandates can be classified into different approaches based on their target active return and active risk levels. Approaches range from a pure indexing approach that has targeted active return and active risk (tracking error) of zero to fully active approaches that substantially deviate from the benchmarks and attempt to generate significant excess (or active) returns. Portfolios that attempt to closely match a bond index, as compared with an equity index, are more challenging to construct and monitor.

3.2.1 *Pure Indexing*

A pure indexing approach attempts to replicate a bond index as closely as possible. Under this approach, the targeted active return and active risk are both zero. In practice, even if the tracking error is zero, the portfolio return will almost always be lower than the corresponding index return because of trading costs and management fees. Theoretically, the portfolio should include all of the underlying securities in the same proportions as the index. It is generally very difficult and costly, however, to precisely replicate most bond indexes because many bonds included in standard indexes are illiquid. Illiquidity is typically higher for bonds with small issuance size, less familiarity of the bond issuer among investors, and longer period outstanding. To help deal with bond market illiquidity, portfolio managers are generally allowed some flexibility around index holdings in an attempt to reduce costs and make the portfolio more implementable in practice.

An index manager, who is allowed some flexibility in holdings, is expected to match the risk factor exposures of the benchmark index, such as duration, credit (or quality) risk, sector risk, call risk, and prepayment risk. In this way, all or most of the known systematic risk factors can be matched to the extent possible. The risk that remains is then mostly issuer-specific (or idiosyncratic) risk, which can be largely mitigated if both the benchmark index and the portfolio are sufficiently diversified. Overall, a pure indexing approach that allows some flexibility in holdings is generally less costly and easier to implement than precise replication of an index. Portfolio turnover for pure indexing approaches is normally consistent with benchmark turnover but considerably lower than that of most active management approaches.[3]

3.2.2 *Enhanced Indexing*

An enhanced indexing approach maintains a close link to the benchmark but attempts to generate at least a modest amount of outperformance relative to the benchmark. As with the pure indexing approach in practice, enhanced indexing allows small deviations in portfolio holdings from the benchmark index but tracks the benchmark's primary risk factor exposures very closely (particularly duration). Unlike the pure indexing approach, however, minor risk factor mismatches (e.g., sector or quality bets) are allowed under enhanced indexing. The intent of the mismatches is to generate higher returns than the benchmark. A target active risk or tracking error of less than 50 bps per year is typical. The turnover of this type of approach is generally only marginally higher than that of a pure indexing portfolio. Any potential outperformance of an

3 In general, bond index turnover is considerably higher than equity index turnover. This is true because higher cash flows are received as a result of bonds maturing or being called by issuers and also as a result of coupon payments. Cash flows from equity indexes are typically lower than those of bond indexes, and they mostly come from dividends as well as corporate actions. Bond index turnover depends to a large extent on the index's average maturity as well as its duration. Shorter-term bond indexes incur more-frequent principal repayments as bonds mature, which need to be reinvested in new bonds being added to these indexes. As a result, turnover for shorter-term bond indexes tends to be high.

enhanced indexing approach is likely to be modest. As a result, managers need to monitor turnover and the associated transaction costs closely in order to achieve positive active returns net of fees and costs. Management fees for an enhanced indexing approach are normally higher than those of a pure indexing approach portfolio. The higher fees largely reflect the manager's efforts to outperform the index. Management fees for an enhanced indexing approach are considerably lower than those of a fully active management approach.

3.2.3 *Active Management*

Active management allows larger risk factor mismatches relative to a benchmark index. These mismatches may cause significant return differences between the active portfolio and the underlying benchmark. Most notably, portfolio managers may take views on portfolio duration that differ markedly from the duration of the underlying benchmark. To take advantage of potential opportunities in changing market environments, active managers may incur significant portfolio turnover—often considerably higher than the underlying benchmark's turnover. Active portfolio managers normally charge higher management fees than pure or enhanced index managers. The higher fees and transaction costs increase the rate of return necessary to achieve positive active returns net of fees and costs.

As with enhanced indexing, actively managed portfolios seek to outperform the underlying benchmark. In practice, however, most active managers (in both fixed income and equity) have historically underperformed their benchmarks after fees and transaction costs. Bond index funds have also historically underperformed their benchmark indexes, but to a lesser extent than active fixed-income portfolios, because of lower turnover and management fees in bond index funds. A key challenge for investors is identifying, in advance, portfolio managers that will outperform their benchmarks.

Exhibit 5 summarizes the key features of the total return approaches discussed here.

Exhibit 5 Total Return Approaches: Key Features

	Pure Indexing	Enhanced Indexing	Active Management
Objective	Match benchmark return and risk as closely as possible	Modest outperformance (generally 20 bps to 30 bps) of benchmark while active risk is kept low (typically around 50 bps or lower)	Higher outperformance (generally around 50 bps or more) of benchmark and higher active risk levels
Portfolio weights	Ideally the same as benchmark or only slight mismatches	Small deviations from underlying benchmark	Significant deviations from underlying benchmark
Risk factor matching	Risk factors are matched exactly	Most primary risk factors are closely matched (in particular, duration)	Large risk factor deviations from benchmark (in particular, duration)
Turnover	Similar to underlying benchmark	Slightly higher than underlying benchmark	Considerably higher turnover than the underlying benchmark

EXAMPLE 4

The Characteristics of Different Total Return Approaches

Diane Walker is a consultant for a large corporate pension plan. She is looking at three funds (Funds X, Y, and Z) as part of the pension plan's global fixed-income allocation. All three funds use the Bloomberg Barclays Global Aggregate Index as a benchmark. Exhibit 6 provides characteristics of each fund and the index as of February 2016.

Identify the approach (pure indexing, enhanced indexing, or active management) that is *most likely* used by each fund, and support your choices by referencing the information in Exhibit 6.

Exhibit 6 Characteristics of Funds X, Y, and Z and the Bloomberg Barclays Global Aggregate Index

Risk and Return Characteristics	Fund X	Fund Y	Fund Z	Bloomberg Barclays Global Aggregate Index
Average maturity (years)	8.61	8.35	9.45	8.34
Modified duration (years)	6.37	6.35	7.37	6.34
Average yield (%)	1.49	1.42	1.55	1.43
Convexity	0.65	0.60	0.72	0.60
Quality				
AAA	41.10	41.20	40.11	41.24
AA	15.32	15.13	14.15	15.05
A	28.01	28.51	29.32	28.78
BBB	14.53	14.51	15.23	14.55
BB	0.59	0.55	1.02	0.35
Not rated	0.45	0.10	0.17	0.05
Maturity Exposure				
0–3 Years	21.43	21.67	19.20	21.80
3–5 Years	23.01	24.17	22.21	24.23
5–10 Years	32.23	31.55	35.21	31.67
10+ Years	23.33	22.61	23.38	22.30
Country Exposure				
United States	42.55	39.44	35.11	39.56
Japan	11.43	18.33	13.33	18.36
France	7.10	6.11	6.01	6.08
United Kingdom	3.44	5.87	4.33	5.99
Germany	6.70	5.23	4.50	5.30
Italy	4.80	4.01	4.43	4.07
Canada	4.44	3.12	5.32	3.15
Other	19.54	17.89	26.97	17.49

Notes: Quality, Maturity Exposure, and Country Exposure are shown as a percentage of the total for each fund and the index. Weights do not always sum to 100 because of rounding.
Source: Barclays Research.

Solution:

Fund X most likely uses an enhanced indexing approach. Fund X's modified duration and convexity are very close to those of the benchmark but still differ slightly. The average maturity of Fund X is slightly longer than that of the benchmark, whereas Fund X's average yield is slightly higher than that of the benchmark. Fund X also has deviations in quality, maturity exposure, and country exposures from the benchmark, providing further evidence of an enhanced indexing approach. Some of these deviations are meaningful; for example, Fund X has a relatively strong underweight in Japan.

Fund Y most likely uses a pure indexing approach because it provides the closest match to the Bloomberg Barclays Global Aggregate Index. The risk and return characteristics are almost identical between Fund Y and the benchmark. Furthermore, quality, maturity exposure, and country exposure deviations from the benchmark are very minor.

Fund Z most likely uses an active management approach because risk and return characteristics, quality, maturity exposure, and country exposure differ markedly from the index. The difference can be seen most notably with the mismatch in modified duration (7.37 for Fund Z versus 6.34 for the benchmark). Other differences exist between Fund Z and the index, but a sizable duration mismatch provides the strongest evidence of an active management approach.

BOND MARKET LIQUIDITY

4

A liquid security is one that may be transacted quickly with little effect on the security's price. Fixed-income securities vary greatly in their liquidity. Recently issued "on-the-run" sovereign government bonds may be very liquid and trade frequently at narrow bid–ask spreads. Other bonds, such as corporate and non-sovereign government bonds, may be very illiquid. These bonds may trade infrequently, in small quantities, or possibly never; and bid–ask spreads, if they are available, may be very wide.

Compared with equities, fixed-income markets are generally less liquid. The global fixed-income universe contains a multitude of individual bonds with varying features. Many issuers have multiple bonds outstanding with their own unique maturity dates, coupon rates, early redemption features, and other specific features. In other words, even for a single issuer, bonds are very heterogeneous. In contrast, each share of a single issuing company's common stock has identical features. Investors must understand the implications of varying features on bond values.

An important structural feature affecting liquidity is that fixed-income markets are typically over-the-counter dealer markets. Search costs (the costs of finding a willing counterparty) exist in bond markets because investors may have to locate desired bonds. In addition, when either buying or selling, investors may have to obtain quotes from various dealers to obtain the most advantageous pricing. With limited, although improving, sources for transaction prices and quotes, bond markets are ordinarily less transparent than equity markets. Liquidity, search costs, and price transparency are closely related to the type of issuer and its credit quality. An investor is likely to find that bonds of a highly creditworthy government issuer are more liquid, have greater price transparency, and have lower search costs than bonds of, for example, a corporate issuer with a lower credit quality.

Bond liquidity is typically highest right after issuance. For example, an on-the-run bond issue of a highly creditworthy sovereign entity is typically more liquid than a bond with similar features—including maturity—that was issued previously (an off-the-run bond). This difference in liquidity is typically found even if the off-the-run bond was issued only one or two months earlier. One reason for this phenomenon is that soon after bonds are issued, dealers normally have a supply of the bonds in inventory, but as time goes by and bonds are traded, many are purchased by buy-and-hold investors. Once in the possession of such investors, those bonds are no longer available for trading. Typically, after issuance, the available supply of bonds in an issue is reduced and liquidity is impaired.

Liquidity typically affects bond yields. Bond investors require higher yields for investing in illiquid securities relative to otherwise identical securities that are more liquid. The higher yield compensates investors for the costs they may encounter if they try to sell illiquid bonds prior to maturity. These costs include the opportunity costs associated with the delays in finding trading counterparties, as well as the bid–ask spread (which is a direct loss of wealth). The incremental yield investors require for holding illiquid bonds instead of liquid bonds is referred to as a liquidity premium. The magnitude of the liquidity premium normally varies depending on such factors as the issuer, the issue size, and date of maturity. For example, the off-the-run 10-year US Treasury bond typically trades at several basis points higher yield than the on-the-run bond.

4.1 Liquidity among Bond Market Sub-Sectors

Bond market liquidity varies across sub-sectors. These sub-sectors can be categorized by key features such as issuer type, credit quality, issue size, and maturity. The global bond market includes sovereign government bonds, non-sovereign government bonds, government-related bonds, corporate bonds, and securitized bonds (such as asset-backed securities and commercial mortgage-backed securities). For simplicity, in this section we focus on sovereign government and corporate bonds.

Sovereign government bonds are typically more liquid than corporate and non-sovereign government bonds. Their superior liquidity relates to their large issuance size, use as benchmark bonds, acceptance as collateral in the repo market, and well-recognized issuers. Sovereign government bonds of countries with high credit quality are typically more liquid than bonds of lower-credit-quality countries.

In contrast to sovereign government bonds, corporate bonds are issued by many different companies and represent a wide spectrum of credit quality. For corporate bonds with low credit quality, it can be difficult to find a counterparty dealer with the securities in inventory or willing to take them into inventory. Bonds of infrequent issuers are often less liquid than the bonds of issuers with many outstanding issues because market participants are less familiar with companies that seldom issue debt.

Liquidity among sub-sectors can vary across additional dimensions, such as issue size and maturity. For example, in the corporate bond market, smaller issues are generally less liquid than larger issues because small bond issues are typically excluded from major bond indexes with minimum issue size requirements. Further, market participants generally have less incentive to dedicate resources to monitoring smaller issuers, whose bonds may constitute a small proportion of an investor's portfolio. Bonds with longer maturities tend to be less liquid than nearer-term bonds because investors frequently purchase bonds with the intention to hold them until maturity, so such bonds may be unavailable for trading for a long period.

4.2 The Effects of Liquidity on Fixed-Income Portfolio Management

Liquidity concerns influence fixed-income portfolio management in multiple ways, including pricing, portfolio construction, and consideration of alternatives to bonds (such as derivatives).

4.2.1 *Pricing*

As mentioned earlier, pricing in bond markets is generally less transparent than pricing in equity markets. Sources for recent bond transactions—notably corporate bonds—are not always readily available. It should be noted that price transparency is improving in some bond markets. For example, in the United States, the Financial Industry Regulatory Authority's (FINRA) Trade Reporting and Compliance Engine (TRACE) and the Municipal Securities Rulemaking Board's Electronic Municipal Market Access (EMMA) are electronic systems that help to increase transparency in US corporate and municipal bond markets. Outside the United States, corporate bonds traded on market exchanges serve a similar role as TRACE in increasing pricing transparency. In most bond markets, however, the lack of transparency in corporate bond trading presents a challenge.

Because many bonds do not trade, or trade infrequently, using recent transaction prices to represent current value is not practical. Reliance on last traded prices, which may be out-of-date prices that do not incorporate current market conditions, could result in costly trading decisions. The determinants of corporate bond value, including interest rates, credit spreads, and liquidity premiums, change frequently.

For bonds that trade infrequently, a common investor approach is matrix pricing. Matrix pricing uses the recent transaction prices of comparable bonds to estimate the market discount rate or required rate of return on less frequently traded bonds. The comparable bonds have similar features such as credit quality, time to maturity, and coupon rate to the illiquid bond. A benefit of matrix pricing is that it does not require sophisticated financial modeling of bond market characteristics such as term structure and credit spreads. A disadvantage is that some value-relevant features between different bonds (for example, call features) may be ignored.

4.2.2 *Portfolio Construction*

Investors' liquidity needs directly influence portfolio construction. In constructing a portfolio, investors must consider an important trade-off between yield and liquidity. As mentioned previously, illiquid bonds typically have higher yields; a buy-and-hold investor that seeks yield will likely prefer less liquid bonds for these higher yields. By contrast, investors that emphasize liquidity will likely give up some yield and choose more-liquid bonds. Some investors may restrict their portfolio holdings to bonds within a certain maturity range. This restriction reduces the need to sell bonds to generate needed cash inflows. In such cases, the investors that anticipate their liquidity needs may give up the higher yield typically available to longer-term bonds. In addition to avoiding longer-term bonds, investors that have liquidity concerns may also avoid bonds with generally lower liquidity, such as small issues and private placements of corporate bonds.

A challenge in bond portfolio construction relates to the dealer market. Bond dealers often carry an inventory of bonds because buy and sell orders do not arrive simultaneously. A dealer is not certain how long bonds will remain in its inventory. Less liquid bonds are likely to remain in inventory longer than liquid bonds. A dealer provides bid–ask quotes (prices at which it will buy and sell) on bonds of its choice. Some illiquid bonds will not have quotes, particularly bid quotes, from any dealer. A number of different factors determine the bid–ask spread. Riskier bonds often have higher bid–ask spreads because of dealers' aversion to hold those bonds in inventory. Because bond dealers must finance their inventories, the dealers incur costs in both obtaining funding and holding those bonds. Dealers seek to cover their costs and make a profit through the bid–ask spread, and therefore the spread will be higher on illiquid bonds that are likely to remain in inventory longer.

A bond's bid–ask spread is also a function of the bond's complexity and how easily market participants can analyze the issuer's creditworthiness. Bid–ask spreads in government bonds are generally lower than spreads in corporate bonds or structured financial instruments, such as asset-backed securities. Conventional (plain vanilla) corporate bonds normally have lower spreads than corporate bonds with non-standard or complex features, such as embedded options. Bonds of large, high-credit-quality corporations that have many outstanding bond issues are the most liquid among corporate bonds, and thus they have relatively low bid–ask spreads compared with smaller, less creditworthy companies.

Illiquidity directly increases bid–ask spreads on bonds, which increases the cost of trading. Higher transaction costs reduce the benefits to active portfolio decisions and may decrease portfolio managers' willingness to adjust their portfolios to take advantage of opportunities that present themselves.

4.2.3 *Alternatives to Direct Investment in Bonds*

As we have discussed, transacting in fixed-income securities may present challenges because of low liquidity in many global bond markets. As an alternative, investors can use fixed-income derivatives, which are often more liquid than their underlying bonds. Such fixed-income derivatives include those traded on an exchange (for example, futures and options on futures) and those traded over the counter (for example, interest rate swaps and credit default swaps). In particular, bond futures, which are exchange traded and standardized, provide a liquid alternative for investors to gain exposure to the underlying bond(s).

Based on notional amount outstanding, interest rate swaps are the most widely used over-the-counter derivative worldwide. Some interest rate swaps are liquid, with multiple swaps dealers posting competitive two-way quotes. In addition to interest rate swaps, fixed-income portfolio managers use inflation swaps, total return swaps, and credit swaps to alter their portfolio exposure. Because they trade over the counter, swaps may be tailored to an investor's specific needs.

Fixed-income exchange-traded funds (ETFs) and pooled investment vehicles (such as mutual funds) have emerged as another alternative to transacting in individual bonds. ETF shares tend to be more liquid than the underlying individual securities and have thus provided new opportunities for investors seeking liquid fixed-income investments. ETFs may allow certain qualified financial institutions (authorized participants) to transact through in-kind deposits and redemptions (delivering and receiving a portfolio of securities, such as a portfolio of bonds). In the more illiquid bond market sectors, such as high-yield corporate bonds, fixed-income portfolio managers may purchase ETF shares and then redeem those shares for the actual underlying portfolio of bonds. In this redemption process, an ETF authorized participant generally acts as the intermediary between the portfolio managers redeeming their ETF shares and the ETF sponsor supplying the portfolio of bonds.

5 A MODEL FOR FIXED-INCOME RETURNS

Investors often have views on future changes in the yield curve and (re)structure their portfolios accordingly. Investment strategies should be evaluated in terms of expected returns rather than just yields. A bond position's yield provides an incomplete measure of its expected return. Instead, expected fixed-income returns consist of a number of different components in addition to yield. Examining these components leads to a better understanding of the driving forces behind expected returns. The focus is on *expected* as opposed to *realized* returns, but realized returns can be decomposed in a similar manner.

5.1 Decomposing Expected Returns[4]

Decomposing expected fixed-income returns allows an investor to differentiate among several important return components. At the most general level, expected returns (denoted as E(R) below) can be decomposed (approximately) in the following manner:

$$\begin{aligned}E(R) \approx\ & \text{Yield income} \\ & + \text{Rolldown return} \\ & + E(\text{Change in price based on investor's views of yields and yield spreads}) \\ & - E(\text{Credit losses}) \\ & + E(\text{Currency gains or losses})\end{aligned}$$

where E(…) represents effects on expected returns based on expectations of the bracketed item. The decomposition holds only approximately and can be a better or worse approximation of reality depending on the type of bond. It has very general applicability for all types of fixed-income securities, however, ranging from high-credit-quality, home currency sovereign government bonds to lower-credit-quality (high-yield) corporate bonds denominated in a currency other than an investor's home currency. The decomposition should help investors better understand their own investment positions and any assumptions reflected in those positions. The following discussion assumes the model is being applied to an annual period, but the same model can be generalized to other periods. In addition, for simplification, the model does not reflect taxes.

Yield income is the income that an investor receives from coupon payments relative to the bond's price as well as interest on reinvestment income. Assuming there is no reinvestment income, yield income equals a bond's annual current yield.

$$\text{Yield income (or Current yield)} = \text{Annual coupon payment/Current bond price}$$

The rolldown return results from the bond "rolling down" the yield curve as the time to maturity decreases, assuming zero interest rate volatility. Bond prices change as time passes even if the market discount rate remains the same. As time passes, a bond's price typically moves closer to par. This price movement is illustrated by the constant-yield price trajectory, which shows the "pull to par" effect on the price of a bond trading at a premium or a discount to par value. If the issuer does not default, the price of a bond approaches par value as its time to maturity approaches zero.

The rolldown return equals the bond's percentage price change assuming an unchanged yield curve over the strategy horizon. Bonds trading at a premium to their par value will experience capital losses during their remaining life, and bonds trading at a discount relative to their par value will experience capital gains during their remaining life.

To compute the rolldown return, the bond has to be revalued at the end of the strategy horizon assuming an unchanged yield curve. Then the annualized rolldown return is as follows:

$$\text{Rolldown Return} = \frac{\left(\text{Bond price}_{\text{End-of-horizon period}} - \text{Bond price}_{\text{Beginning-of-horizon period}}\right)}{\text{Bond price}_{\text{Beginning-of-horizon period}}}$$

4 Some of this material has been adapted from Hanke and Seals (2010). A more detailed analysis of expected returns of US government bonds can be found in Ilmanen (1995a, 1995b, and 2011).

The sum of the yield income and the rolldown return may be referred to as the bond's rolling yield.

The expected change in price based on investor's views of yields and yield spreads reflects an investor's expectation of changes in yields and yield spreads over the investment horizon. This expected change is zero if the investor expects yield curves and yield spreads to remain unchanged. Assuming the investor does expect a change in the yield curve, this expected return component is computed as follows:

E(Change in price based on investor's views of yields and yield spreads) = $[-\text{MD} \times \Delta\text{Yield}] + [\tfrac{1}{2} \times \text{Convexity} \times (\Delta\text{Yield})^2]$

where MD is the modified duration of a bond, ΔYield is the expected change in yield based on expected changes to both the yield curve and yield spread, and convexity estimates the effect of the non-linearity of the yield curve.[5] It should be noted that for bonds with embedded options, the duration and convexity measures used in the expected return decomposition need to be effective duration and effective convexity. Also, in contrast to fixed-coupon bonds, floating-rate notes have modified duration near zero.

Expected credit losses represent the expected percentage of par value lost to default for a bond. The expected credit loss equals the bond's probability of default (also called expected default rate) multiplied by its expected loss severity (also known as loss given default). Expected credit losses may be low based on past experience of default rates and resulting credit losses. For example, US investment-grade bonds experienced an average annual default rate of around 0.1% from 1980 to 2015.[6]

If an investor holds bonds denominated in a currency other than her home currency, she also needs to factor in any expected fluctuations in the currency exchange rate or expected currency gains or losses over the investment horizon. This quantity could simply be a reflection of her own views, or it could be based on survey information or some kind of quantitative model. It could also be based on the exchange rate that can be locked in over the investment horizon using currency forwards.

The following discussion shows an application of the fixed-income model described here. Expected return and its components are on an annualized basis, and any potential coupons are assumed to be paid annually.

EXAMPLE 5

Decomposing Expected Returns

Ann Smith works for a US investment firm in its London office. She manages the firm's British pound–denominated corporate bond portfolio. Her department head in New York has asked Smith to make a presentation on the next year's total expected return of her portfolio in US dollars and the components of this return. Exhibit 7 shows information on the portfolio and Smith's expectations for the next year. Calculate the total expected return of Smith's bond portfolio, assuming no reinvestment income.

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5 Leibowitz, Krasker, and Nozari (1990) offer a detailed analysis of spread duration.

6 As reported by Vazza and Kraemer (2016), for the period 1981 to 2015, the average one-year cumulative global corporate default rates were 0.10% for investment-grade issues, 3.80% for speculative-grade (high-yield) issues, and 1.49% for all rated issues. Yearly default rates vary, however, and during the period 1981 to 2015, one-year cumulative global corporate default rates ranged between 0.14% (1981) and 4.18% (2009) for all rated issues.

Exhibit 7 Portfolio Characteristics and Expectations

Notional principal of portfolio (in millions)	£100
Average bond coupon payment (per £100)	£2.75
Coupon frequency	Annual
Investment horizon	1 year
Current average bond price	£97.11
Expected average bond price in one year (assuming an unchanged yield curve)	£97.27
Average bond convexity	18
Average bond modified duration	3.70
Expected average yield and yield spread change	0.26%
Expected credit losses	0.10%
Expected currency losses (£ depreciation versus US$)	0.50%

Solution:

The portfolio's yield income is 2.83%. The portfolio has an average coupon of £2.75 on a £100 notional principal and currently trades at £97.11. The yield income over a one-year horizon is 2.83% = £2.75/£97.11.

In one year's time, assuming an unchanged yield curve and zero interest rate volatility, the rolldown return is 0.16% = (£97.27 – £97.11)/£97.11.

The rolling yield, which is the sum of the yield income and the rolldown return, is 2.99% = 2.83% + 0.16%.

The expected change in price based on Smith's views of yields and yield spreads is –0.96%. The bond portfolio has a modified duration of 3.70 and a convexity statistic of 0.18. Smith expects an average yield and yield spread change of 0.26%. Smith expects to incur a decrease in prices and a reduction in return based on her yield view. The expected change in price based on Smith's views of yields and yield spreads is thus $-0.0096 = [-3.70 \times 0.0026] + [½ \times 18 \times (0.0026)^2]$. So the expected reduction in return based on Smith's yield view is 0.96%.

Smith expects 0.1% of credit losses in her well-diversified investment-grade bond portfolio.

Smith expects the British pound, the foreign currency in which her bond position is denominated, to depreciate by an annualized 50 bps (or 0.5%) over the investment horizon against the US dollar, the home country currency. The expected currency loss to the portfolio is thus 0.50%.

After combining the foregoing return components, the total expected return on Smith's bond position is 1.43%. For ease of reference, Exhibit 8 summarizes the calculations.

Exhibit 8 Return Component Calculations

Return Component	Formula	Calculation
Yield income	Annual coupon payment/Current bond price	£2.75/£97.11 = 2.83%
+ Rolldown return	$\frac{(\text{Bond price}_{\text{End-of-horizon period}} - \text{Bond price}_{\text{Beginning-of-horizon period}})}{\text{Bond price}_{\text{Beginning-of-horizon period}}}$	(£97.27 – £97.11)/£97.11 = 0.16%
= Rolling yield	Yield income + Rolldown return	2.83% + 0.16% = 2.99%

(continued)

Exhibit 8 (Continued)

Return Component	Formula	Calculation
+ E(Change in price based on Smith's yield and yield spread view)	[−MD × ΔYield] + [½ × Convexity × $(\Delta\text{Yield})^2$]	[−3.70 × 0.0026] + [½ × 18 × $(0.0026)^2$] = −0.96%
− E(Credit losses)	given	−0.10%
+ E(Currency gains or losses)	given	−0.50%
= Total expected return		**1.43%**

5.2 Estimation of the Inputs

In the model for fixed-income returns discussed earlier, some of the individual expected return components can be more easily estimated than others. The easiest component to estimate is the yield income. The rolldown return, although still relatively straightforward to estimate, depends on the curve-fitting technique used.

The return model's most uncertain individual components are the investor's views of changes in yields and yield spreads, expected credit losses, and expected currency movements. These components are normally based on purely qualitative (subjective) criteria, on survey information, or on a quantitative model. Although a quantitative approach may seem more objective, the choice of quantitative model is largely subjective given the multitude of such models available.

5.3 Limitations of the Expected Return Decomposition

The return decomposition described in Section 5.1 is an approximation; only duration and convexity are used to summarize the price–yield relationship. In addition, the model implicitly assumes that all intermediate cash flows of the bond are reinvested at the yield to maturity, which results in different coupon reinvestment rates for different bonds.

The model also ignores other factors, such as local richness/cheapness effects as well as potential financing advantages. Local richness/cheapness effects are deviations of individual maturity segments from the fitted yield curve, which was obtained using a curve estimation technique. Yield curve estimation techniques produce relatively smooth curves, and there are likely slight deviations from the curve in practice. There may be financing advantages to certain maturity segments in the repo market. The repo market provides a form of short-term borrowing for dealers in government securities who sell government bonds to other market participants overnight and buy them back, typically on the following day. In most cases, local richness/cheapness effects and financing advantages tend to be relatively small and are thus not included in the expected return decomposition model.

EXAMPLE 6

Components of Expected Return

Kevin Tucker manages a global bond portfolio. At a recent investment committee meeting, Tucker discussed his portfolio's domestic (very high credit quality) government bond allocation with another committee member. The other committee member argued that if the yield curve is expected to remain unchanged, the only determinants of a domestic government bond's expected return are its coupon payment and its price.

Explain why the other committee member is incorrect, including a description of the additional expected return components that need to be included.

Solution:

A bond's coupon payment and its price allow only its yield income to be computed. Yield income is an incomplete measure of a bond's expected return. For domestic government bonds, in addition to yield income, the rolldown return needs to be considered. The rolldown return results from the fact that bonds are pulled to par as the time to maturity decreases, even if the yield curve is expected to remain unchanged over the investment horizon. Currency gains and losses would also need to be considered in a global portfolio. Because the portfolio consists of government bonds with very high credit quality, the view on credit spreads and expected credit losses are less relevant for Tucker's analysis. For government and corporate bonds with lower credit quality, however, credit spreads and credit losses would also need to be considered as additional return components.

LEVERAGE

6

Leverage is the use of borrowed capital to increase the magnitude of portfolio positions, and it is an important tool for fixed-income portfolio managers. By using leverage, fixed-income portfolio managers may be able to increase portfolio returns relative to what they can achieve in unleveraged portfolios.

Managers often have mandates that place limits on the types of securities they may hold. Simultaneously, managers may have return objectives that are difficult to achieve, especially during low interest rate environments. Through the use of leverage, a manager can increase his investment exposure and may be able to increase the returns to fixed-income asset classes that typically have low returns. The increased return potential, however, comes at the cost of increased risk: If losses occur, these would be higher than in unleveraged positions.

6.1 Using Leverage

Leverage increases portfolio returns if the securities in the portfolio have higher returns than the cost of borrowing. In an unleveraged portfolio, the return on the portfolio (r_p) equals the return on invested funds (r_I). When the manager uses leverage, however, the invested funds exceed the portfolio's equity by the amount that is borrowed.

The leveraged portfolio return, r_p, can be expressed as the total investment gains per unit of invested capital:

$$r_P = \frac{\text{Portfolio return}}{\text{Portfolio equity}} = \frac{\left[r_I \times \left(V_E + V_B\right) - \left(V_B \times r_B\right)\right]}{V_E}$$

where

V_E = value of the portfolio's equity
V_B = borrowed funds
r_B = borrowing rate (cost of borrowing)
r_I = return on the invested funds (investment returns)
r_p = return on the levered portfolio

The numerator represents the total return on the portfolio assets, $r_I \times (V_E + V_B)$, minus the cost of borrowing, $V_B \times r_B$, divided by the portfolio's equity.

The leveraged portfolio return can be decomposed further to better identify the effect of leverage on returns:

$$\begin{aligned} r_P &= \frac{\left[r_I \times (V_E + V_B) - (V_B \times r_B)\right]}{V_E} \\ &= \frac{(r_I \times V_E) + \left[V_B \times (r_I - r_B)\right]}{V_E} \\ &= r_I + \frac{V_B}{V_E}(r_I - r_B) \end{aligned}$$

This expression decomposes the leveraged portfolio return into the return on invested funds and a portion that accounts for the effect of leverage. If $r_I > r_B$, then the second term is positive because the rate of return on invested funds exceeds the borrowing rate—in this case, leverage increases the portfolio's return. If $r_I < r_B$, then the second term is negative because the rate of return on invested funds is less than the borrowing rate—in this case, the use of leverage decreases the portfolio's return. The degree to which the leverage increases or decreases portfolio returns is proportional to the use of leverage (amount borrowed), V_B/V_E, and the amount by which investment return differs from the cost of borrowing, $(r_I - r_B)$.

6.2 Methods for Leveraging Fixed-Income Portfolios

Fixed-income portfolio managers have a variety of tools available to create leveraged portfolio exposures, notably the use of financial derivatives as well as borrowing via collateralized money markets. Derivatives or borrowing are explicit forms of leverage. Other forms of leverage, such as the use of structured financial instruments, are more implicit.

6.2.1 *Futures Contracts*

Futures contracts embed significant leverage because they permit the counterparties to gain exposure to a large quantity of the underlying asset without having to actually transact in the underlying. Futures contracts can be obtained for a modest investment that comes in the form of a margin deposit. A futures contract's notional value equals the current value of the underlying asset multiplied by the multiplier, or the quantity of the underlying asset controlled by the contract.

The futures leverage is the ratio of the futures exposure (in excess of the margin deposit) normalized by the amount of margin required to control the notional amount. We can calculate the futures leverage using the following equation:

$$\text{Leverage}_{\text{Futures}} = \frac{\text{Notional value} - \text{Margin}}{\text{Margin}}$$

6.2.2 *Swap Agreements*

Interest rate swaps can be viewed as a portfolio of bonds. In an interest rate swap, the fixed-rate payer is effectively short a fixed-rate bond and long a floating-rate bond. When interest rates increase, the value of the swap to the fixed-rate payer increases because the present value of the fixed-rate liability decreases and the floating-rate payments received increase. The fixed-rate receiver in the interest rate swap agreement effectively has a long position in a fixed-rate bond and a short position in a floating-rate bond. If interest rates decline, the value of the swap to the fixed-rate receiver increases because the present value of the fixed-rate asset increases and the floating-rate payments made decrease.

Because interest rate swaps are economically equivalent to a long–short bond portfolio, they provide leveraged exposure to bonds; the only capital required to enter into swap agreements is collateral required by the counterparties. Collateral for interest rate swap agreements has historically occurred between the two (or more) counterparties in the transaction. Increasingly, collateral for interest rate and other swaps occurs through central clearinghouses. The most significant driver of this shift has been regulation enacted after the 2008–2009 global financial crisis. Clearing of interest rate swaps through central clearinghouses has increased standardization and has reduced counterparty risk.

6.2.3 *Structured Financial Instruments*

Structured financial instruments (or structured products) are designed to repackage and redistribute risks. Many structured financial instruments have embedded leverage. An example of such a structured financial instrument is an inverse floating-rate note, also known as an inverse floater. An inverse floater's defining feature is that its coupon has an inverse relationship to a market interest rate such as Libor. As an example, the coupon rate for an inverse floater may be as follows:

$$\text{Coupon rate} = 15\% - (1.5 \times \text{Libor}_{\text{3-month}})$$

The inverse floater exacerbates the magnitude of the inverse relationship between bond prices and interest rates. The coupon rate in the example above can range from 0% to 15%. If three-month Libor increases to at least 10%, the coupon rate is 0%. At the other extreme, if three-month Libor decreases to 0%, the coupon rate is 15%. It should be noted that the inverse floater's structure would specify that the coupon rate cannot be less than 0%. A long position in an inverse floater is ideal for a fixed-income manager looking to express a strong view that interest rates will remain low or possibly decline over the life of the bond. However, the embedded leverage adds an additional source of price volatility to a fixed-income investor's portfolio.

6.2.4 *Repurchase Agreements*

Repurchase agreements (repos) are an important source of short-term financing for fixed-income securities dealers and other financial institutions, as evidenced by the trillions of dollars of repo transactions that take place annually. In a repurchase agreement, a security owner agrees to sell a security for a specific cash amount while simultaneously agreeing to repurchase the security at a specified future date (typically one day later) and price. Repos are thus effectively collateralized loans. When referring to a repo, the transaction normally refers to the borrower's standpoint; from the standpoint of the lender, these agreements are referred to as **reverse repos**.

The interest rate on a repurchase agreement, called the **repo rate**, is the difference between the security's selling price and its repurchase price. For example, consider a dealer wishing to finance a $15 million bond position with a repurchase agreement.

The dealer enters into an overnight repo at a repo rate of 5%. We can compute the price at which she agrees to repurchase this bond after one day as the $15 million value today plus one day of interest. The interest amount is computed as follows:

Dollar interest = Principal amount × Repo rate × (Term of repo in days/360)

Continuing with the example, the dollar interest = $2,083.33 = $15 million × 5% × (1/360). Thus, the dealer will repurchase the bond the next day for $15,002,083.33.

The term, or length, of a repurchase agreement is measured in days. Overnight repos are common, although they are often rolled over to create longer-term funding. A repo agreement may be cash driven or security driven. Cash-driven transactions feature one party that owns bonds and wants to borrow cash, as in the foregoing example. Cash-driven transactions usually feature "general collateral," which are securities commonly accepted by investors and dealers, such as Treasury bonds. In a security-driven transaction, the lender typically seeks a particular security. The motives may be for hedging, arbitrage, or speculation.

Credit risk is a concern in a repo agreement, in particular for the counterparty that lends capital. Protection against a default by the borrower is provided by the underlying collateral bonds. Additional credit protection comes from the "haircut," the amount by which the collateral's value exceeds the repo principal amount. For example, haircuts for high-quality government bonds typically range from 1% to 3% and are higher for other types of bonds. The size of the haircut serves to not only protect the lender against a potential default by the borrower but also to limit the borrower's net leverage capacity. Generally, the size of the haircut increases as the price volatility of the underlying collateral increases.

Repos are categorized as bilateral repos or tri-party repos based on the way they are settled. Bilateral repos are conducted directly between two institutions, and settlement is typically conducted as "delivery versus payment," meaning that the exchanges of cash and collateral occur simultaneously through a central custodian (for example, the Depository Trust Company in the United States). Bilateral repos are usually used for security-driven transactions. Tri-party repo transactions involve a third party that provides settlement and collateral management services. Most cash-motivated repo transactions against general collateral are conducted as tri-party repo transactions.

6.2.5 *Securities Lending*

Securities lending is another form of collateralized lending, and is closely linked to the repo market. The primary motive of securities lending transactions is to facilitate short sales, which involve the sale of securities the seller does not own. A short seller must borrow the securities he has sold short in order to deliver them upon trade settlement. Another motive for securities lending transactions is financing, or collateralized borrowing. In a financing-motivated security loan, a bond owner lends the bond to another investor in exchange for cash.

Security lending transactions are collateralized by cash or high-credit-quality bonds. In the United States, most transactions feature cash collateral, although in many other countries, highly rated bonds are used as collateral. Typically, security lenders require collateral valued in excess of the value of the borrowed securities when bonds are used as collateral. For example, if high-quality government bonds are used as collateral, the lender may require bonds valued at 102% of the value of the borrowed securities. The extra 2% functions in the same way as the haircut in the repo market, providing extra protection against borrower default. The collateral required will increase if lower-quality bonds are used as collateral.

In security lending transactions with cash collateral, the security borrower typically pays the security lender a fee equal to a percentage of the value of the securities loaned. For securities that are readily available for lending, that fee is small. The security lender earns an additional return by reinvesting the cash collateral. In cases where the securities loan is initiated for financing purposes, the lending fee is typically negative, indicating that the security lender pays the security borrower a fee in exchange for its use of the cash.

When bonds are posted as collateral, the income earned on the collateral usually exceeds the security lending rate; the security lender (who is in possession of the bonds as collateral) usually repays the security borrower a portion of the interest earned on the bond collateral. The term **rebate rate** refers to the portion of the collateral earnings rate that is repaid to the security borrower by the security lender. This relationship can be expressed as follows:

Rebate rate = Collateral earnings rate − Security lending rate

When securities are difficult to borrow, the rebate rate may be negative, which means the fee for borrowing the securities is greater than the return earned on the collateral. In this case, the security borrower pays a fee to the security lender in addition to forgoing the interest earned on the collateral.

There are important differences between repurchase agreements and securities lending transactions. Unlike repurchase agreements, security lending transactions are typically open-ended. The securities lender may recall the securities at any time, forcing the borrower to deliver the bonds by buying them back or borrowing from another lender. Similarly, the borrower may deliver the borrowed securities back to the lender at any time, forcing the lender, or its agent, to return the collateral (cash or bonds) and search for another borrower.

6.3 Risks of Leverage

Leverage alters the risk–return properties of an investment portfolio. A heavily leveraged portfolio may incur significant losses even when portfolio assets suffer only moderate valuation declines.

Leverage can lead to forced liquidations. If the value of the portfolio decreases, the portfolio's equity relative to borrowing levels is reduced and the portfolio's leverage increases. Portfolio assets may be sold in order to pay off borrowing and reduce leverage. If portfolio assets are not liquidated, then the overall leverage increases, corresponding to higher levels of risk. Decreases in portfolio value can lead to forced liquidations even if market conditions are unfavorable for selling—for example, during crisis periods. The term "fire sale" refers to forced liquidations at prices that are below fair value as a result of the seller's need for immediate liquidation. Reducing leverage, declining asset values, and forced sales have the potential to create spiraling effects that can result in severe declines in values and reduction in market liquidity.

Additionally, reassessments of counterparty risk typically occur during extreme market conditions, such as occurred in the 2008–2009 financial crisis. During periods of financial crisis, counterparties to short-term financing arrangements, such as credit lines, repurchase agreements, and securities lending agreements, may withdraw their financing. These withdrawals undermine the ability of leveraged market participants to maintain their investment exposures. Thus, the leveraged investor may be forced to reduce their investment exposure at exactly the worst time—that is, when prices are depressed.

7 FIXED-INCOME PORTFOLIO TAXATION

A tax-exempt investor's objective is to achieve the highest possible risk-adjusted returns net of fees and transaction costs. A taxable investor needs to also consider the effects of taxes on both expected and realized net investment returns. Taxes typically complicate investment decisions.

The investment management industry has traditionally made investment decisions based on pretax returns as though investors are tax exempt (such as pension funds in many countries).[7] The majority of the world's investable assets, however, is owned by taxable investors, who are concerned with after-tax rather than pretax returns.

Taxes may differ across investor types, among countries, and based on income source, such as interest or capital gains. In many countries, pension funds are exempt from taxes but corporations generally have to pay tax on their investments. Many countries make some allowance for tax-sheltered investments that individuals can use (up to certain limits). These types of tax shelters generally offer either an exemption from tax on investment income or a deferral of taxes until an investor draws money from the shelter (usually after retirement). Such shelters allow returns to accrue on a pretax basis until retirement, which can provide substantial benefits. In a fixed-income context for taxable investors, coupon payments (interest income) are typically taxed at the investor's normal income tax rate. Capital gains, however, may be taxed at a lower effective rate than an investor's normal income tax rate. In some countries, income from special types of fixed-income securities, such as bonds issued by the sovereign government, a non-sovereign government, or various government agencies, may be taxed at a lower effective rate or even not taxed.

It is beyond the scope of this reading to discuss specific tax rules because these vary across countries. Any discussion of the effect of taxes on investor returns—and therefore on how portfolios should optimally be managed for taxable investors—is especially challenging if it needs to apply on a global level. Although accounting standards have become more harmonized globally, any kind of tax harmonization among countries is not likely to occur anytime soon. An investor should consider how taxes affect investment income in the country where the income is earned and how the investment income is treated when it is repatriated to the investor's home country. Treaties between countries may affect tax treatment of investment income. Taxes are complicated and can make investment decisions difficult. Portfolio managers who manage assets for taxable individual investors, as opposed to tax-exempt investors, need to consider a number of issues.

7.1 Principles of Fixed-Income Taxation

Although tax codes differ across countries, there are certain principles that most tax codes have in common with regard to taxation of fixed-income investments:

- The two primary sources of investment income that affect taxes for fixed-income securities are coupon payments (interest income) and capital gains or losses.
- In general, tax is payable only on capital gains and interest income that have actually been received. In some countries, an exception to this rule applies to zero-coupon bonds. Imputed interest may be calculated that is taxed

7 See, for example, Rogers (2006).

throughout a zero-coupon bond's life. This method of taxation ensures that tax is paid over the bond's life and that the return on a zero-coupon bond is not taxed entirely as a capital gain.

- Capital gains are frequently taxed at a lower effective tax rate than interest income.
- Capital losses generally cannot be used to reduce sources of income other than capital gains. Capital losses reduce capital gains in the tax year in which they occur. If capital losses exceed capital gains in the year, they can often be "carried forward" and applied to gains in future years; in some countries, losses may also be "carried back" to reduce capital gains taxes paid in prior years. Limits typically exist on the number of years that capital losses can be carried forward or back.
- In some countries, short-term capital gains are taxed at a different (usually higher) rate than long-term capital gains.

An investor or portfolio manager generally has no control over the timing of when coupon income is received and the related income tax must be paid. However, he or she can generally decide the timing of sale of investments and therefore has some control over the timing of realized capital gains and losses. This control can be valuable for a taxable investor because it may be optimal to delay realizing gains and related tax payments and to realize losses as early as possible. This type of tax-driven strategic behavior is referred to as tax-loss harvesting.

Key points for managing taxable fixed-income portfolios include the following:

- Selectively offset capital gains and losses for tax purposes.
- If short-term capital gains tax rates are higher than long-term capital gains tax rates, then be judicious when realizing short term gains.
- Realize losses taking into account tax consequences. They may be used to offset current or future capital gains for tax purposes.
- Control turnover in the fund. In general, the lower the turnover, the longer capital gains tax payments can be deferred.
- Consider the trade-off between capital gains and income for tax purposes.

7.2 Investment Vehicles and Taxes

The choice of investment vehicle often affects how investments are taxed at the final investor level. In a pooled investment vehicle (sometimes referred to as a collective investment scheme) such as a mutual fund, interest income is generally taxed at the final investor level when it occurs—regardless of whether the fund reinvests interest income or pays it out to investors. In other words, for tax purposes the fund is considered to have distributed interest income for tax purposes in the year it is received even if it does not actually pay it out to investors. Taxation of capital gains arising from the individual investments within a fund is often treated differently in different countries.

Some countries, such as the United States, use what is known as *pass-through treatment* of capital gains in mutual funds. Realized net capital gains in the underlying securities of a fund are treated as if distributed to investors in the year that they arise, and investors need to include the gains on their tax returns. Other countries, such as the United Kingdom, do not use pass-through treatment. Realized capital gains arising within a fund increase the net asset value of the fund shares that investors hold. Investors pay taxes on the net capital gain when they sell their fund shares. This tax treatment leads to a deferral in capital gains tax payments. The UK portfolio manager's decisions on when to realize capital gains or losses do not affect the timing of tax payments on capital gains by investors.

In a separately managed account, an investor typically pays tax on realized gains in the underlying securities at the time they occur. The investor holds the securities directly rather than through shares in a fund. For separately managed accounts, the portfolio manager needs to consider tax consequences for the investor when making investment decisions.

Tax-loss harvesting, which we defined earlier as deferring the realization of gains and realizing capital losses early, allows investors to accumulate gains on a pretax basis. The deferral of taxes increases the present value of investments to the investor.

EXAMPLE 7

Managing Taxable and Tax-Exempt Portfolios

A bond portfolio manager needs to raise €10,000,000 in cash to cover outflows in the portfolio she manages. To satisfy her cash demands, she considers one of two corporate bond positions for potential liquidation: Position A and Position B. For tax purposes, capital gains receive pass-through treatment; realized net capital gains in the underlying securities of a fund are treated as if distributed to investors in the year that they arise. Assume that the capital gains tax rate is 28% and the income tax rate for interest is 45%. Exhibit 9 provides relevant data for the two bond positions.

Exhibit 9 Selected Data for Two Bonds

	Position A		Position B
Current market value	€10,000,000		€10,000,000
Capital gain/loss	€1,000,000		–€1,000,000
Coupon rate	5.00%		5.00%
Remaining maturity	10 years		10 years
Income tax rate		45%	
Capital gains tax rate		28%	

The portfolio manager considers Position A to be slightly overvalued and Position B to be slightly undervalued. Assume that the two bond positions are identical with regard to all other relevant characteristics. How should the portfolio manager optimally liquidate bond positions if she manages a portfolio for:

1 tax-exempt investors?

2 taxable investors?

Solution to 1:

The taxation of capital gains and capital losses has minimal consequences to tax-exempt investors. Consistent with the portfolio manager's investment views, the portfolio manager would likely liquidate Position A, which she considers slightly overvalued rather than liquidating Position B, which she considers slightly undervalued.

Solution to 2:

All else equal, portfolio managers for taxable investors should have an incentive to defer capital gains taxes and realize capital losses early (tax-loss harvesting) so that losses can be used to offset current or future capital gains. Despite the slight undervaluation of the position, the portfolio manager might want to liquidate Position B because of its embedded capital loss, which will result in a lower realized net capital gain being distributed to investors. This decision is based on the assumption that there are no other capital losses in the portfolio that can be used to offset other capital gains. Despite the slight overvaluation of Position A, its liquidation would be less desirable for a taxable investor because of the required capital gains tax.

SUMMARY

This reading describes the roles of fixed-income securities in an investment portfolio and introduces fixed-income portfolio management. Key points of the reading include the following:

- Fixed-income investments provide diversification benefits in a portfolio context. These benefits arise from the generally low correlations of fixed-income investments with other major asset classes such as equities.
- Fixed-income investments have regular cash flows, which is beneficial for the purposes of funding future liabilities.
- Floating-rate and inflation-linked bonds can be used to hedge inflation risk.
- Liability-based fixed-income mandates are managed to match or cover expected liability payments with future projected cash inflows.
- For liability-based fixed-income mandates, portfolio construction follows two main approaches—cash flow matching and duration matching—to match fixed-income assets with future liabilities.
- Cash flow matching is an immunization approach based on matching bond cash flows with liability payments.
- Duration matching is an immunization approach based on matching the duration of assets and liabilities.
- Hybrid forms of duration and cash flow matching include contingent immunization and horizon matching.
- Total return mandates are generally structured to either track or outperform a benchmark.
- Total return mandates can be classified into different approaches based on their target active return and active risk levels. Approaches range from pure indexing to enhanced indexing to active management.
- Liquidity is an important consideration in fixed-income portfolio management. Bonds are generally less liquid than equities, and liquidity varies greatly across sectors.
- Liquidity affects pricing in fixed-income markets because many bonds either do not trade or trade infrequently.
- Liquidity affects portfolio construction because there is a trade-off between liquidity and yield. Less liquid bonds have higher yields, all else being equal, and may be more desirable for buy-and-hold investors. Investors anticipating liquidity needs may forgo higher yields for more-liquid bonds.

- Fixed-income derivatives, as well as fixed-income exchange-traded funds and pooled investment vehicles, are often more liquid than their underlying bonds and provide investment managers with an alternative to trading in illiquid underlying bonds.
- When evaluating fixed-income investment strategies, it is important to consider expected returns and to understand the different components of expected returns.
- Decomposing expected fixed-income returns allows investors to understand the different sources of returns given expected changes in bond market conditions.
- A model for expected fixed-income returns can decompose them into the following components: yield income, rolldown return, expected change in price based on investor's views of yields and yield spreads, expected credit losses, and expected currency gains or losses.
- Leverage is the use of borrowed capital to increase the magnitude of portfolio positions. By using leverage, fixed-income portfolio managers may be able to increase portfolio returns relative to what they can achieve in unleveraged portfolios. The potential for increased returns, however, comes with increased risk.
- Methods for leveraging fixed-income portfolios include the use of futures contracts, swap agreements, structured financial instruments, repurchase agreements, and securities lending.
- Taxes can complicate investment decisions in fixed-income portfolio management. Complications result from the difference in taxation across investor types, countries, and income sources (interest income or capital gains).

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PRACTICE PROBLEMS

The following information relates to Questions 1–6

Cécile Perreaux is a junior analyst for an international wealth management firm. Her supervisor, Margit Daasvand, asks Perreaux to evaluate three fixed-income funds as part of the firm's global fixed-income offerings. Selected financial data for the funds Aschel, Permot, and Rosaiso are presented in Exhibit 1. In Perreaux's initial review, she assumes that there is no reinvestment income and that the yield curve remains unchanged.

Exhibit 1 Selected Data on Fixed-Income Funds

	Aschel	Permot	Rosaiso
Current average bond price	$117.00	$91.50	$94.60
Expected average bond price in one year (end of Year 1)	$114.00	$96.00	$97.00
Average modified duration	7.07	7.38	6.99
Average annual coupon payment	$3.63	$6.07	$6.36
Present value of portfolio's assets (millions)	$136.33	$68.50	$74.38
Bond type*			
Fixed-coupon bonds	95%	38%	62%
Floating-coupon bonds	2%	34%	17%
Inflation-linked bonds	3%	28%	21%
Quality*			
AAA	65%	15%	20%
BBB	35%	65%	50%
B	0%	20%	20%
Not rated	0%	0%	10%
Value of portfolio's equity (millions)	$94.33		
Value of borrowed funds (millions)	$42.00		
Borrowing rate	2.80%		
Return on invested funds	6.20%		

* Bond type and Quality are shown as a percentage of total for each fund.

After further review of the composition of each of the funds, Perreaux notes the following.

Note 1 Aschel is the only fund of the three that uses leverage.

Note 2 Rosaiso is the only fund of the three that holds a significant number of bonds with embedded options.

Daasvand asks Perreaux to analyze immunization approaches to liability-based mandates for a meeting with Villash Foundation. Villash Foundation is a tax-exempt client. Prior to the meeting, Perreaux identifies what she considers to be two key features of a cash flow–matching approach.

Feature 1	It requires no yield curve assumptions.
Feature 2	Cash flows come from coupons and liquidating bond portfolio positions.

Two years later, Daasvand learns that Villash Foundation needs $5,000,000 in cash to meet liabilities. She asks Perreaux to analyze two bonds for possible liquidation. Selected data on the two bonds are presented in Exhibit 2.

Exhibit 2 Selected Data for Bonds 1 and 2

	Bond 1	Bond 2
Current market value	$5,000,000	$5,000,000
Capital gain/loss	400,000	–400,000
Coupon rate	2.05%	2.05%
Remaining maturity	8 years	8 years
Investment view	Overvalued	Undervalued
Income tax rate	39%	
Capital gains tax rate	30%	

1 Based on Exhibit 1, which fund provides the highest level of protection against inflation for coupon payments?

A Aschel

B Permot

C Rosaiso

2 Based on Exhibit 1, the rolling yield of Aschel over a one-year investment horizon is *closest* to:

A –2.56%.

B 0.54%.

C 5.66%.

3 The levered portfolio return for Aschel is *closest* to:

A 7.25%.

B 7.71%.

C 8.96%.

4 Based on Note 2, Rosaiso is the only fund for which the expected change in price based on the investor's views of yields and yield spreads should be calculated using:

A convexity.

B modified duration.

C effective duration

5 Is Perreaux correct with respect to key features of cash flow matching?

A Yes.

B No, only Feature 1 is correct.

C No, only Feature 2 is correct.

6 Based on Exhibit 2, the optimal strategy to meet Villash Foundation's cash needs is the sale of:

A 100% of Bond 1.

B 100% of Bond 2.

C 50% of Bond 1 and 50% of Bond 2.

The following information relates to Questions 7–12

Celia Deveraux is chief investment officer for the Topanga Investors Fund, which invests in equities and fixed income. The clients in the fund are all taxable investors. The fixed-income allocation includes a domestic (US) bond portfolio and an externally managed global bond portfolio.

The domestic bond portfolio has a total return mandate, which specifies a long-term return objective of 25 basis points (bps) over the benchmark index. Relative to the benchmark, small deviations in sector weightings are permitted, such risk factors as duration must closely match, and tracking error is expected to be less than 50 bps per year.

The objectives for the domestic bond portfolio include the ability to fund future liabilities, protect interest income from short-term inflation, and minimize the correlation with the fund's equity portfolio. The correlation between the fund's domestic bond portfolio and equity portfolio is currently 0.14. Deveraux plans to reduce the fund's equity allocation and increase the allocation to the domestic bond portfolio. She reviews two possible investment strategies.

Strategy 1 Purchase AAA rated fixed-coupon corporate bonds with a modified duration of two years and a correlation coefficient with the equity portfolio of –0.15.

Strategy 2 Purchase US government agency floating-coupon bonds with a modified duration of one month and a correlation coefficient with the equity portfolio of –0.10.

Deveraux realizes that the fund's return may decrease if the equity allocation of the fund is reduced. Deveraux decides to liquidate $20 million of US Treasuries that are currently owned and to invest the proceeds in the US corporate bond sector. To fulfill this strategy, Deveraux asks Dan Foster, a newly hired analyst for the fund, to recommend Treasuries to sell and corporate bonds to purchase.

Foster recommends Treasuries from the existing portfolio that he believes are overvalued and will generate capital gains. Deveraux asks Foster why he chose only overvalued bonds with capital gains and did not include any bonds with capital losses. Foster responds with two statements.

Statement 1 Taxable investors should prioritize selling overvalued bonds and always sell them before selling bonds that are viewed as fairly valued or undervalued.

Statement 2 Taxable investors should never intentionally realize capital losses.

Regarding the purchase of corporate bonds, Foster collects relevant data, which are presented in Exhibit 1.

Exhibit 1 Selected Data on Three US Corporate Bonds

Bond Characteristics	Bond 1	Bond 2	Bond 3
Credit quality	AA	AA	A
Issue size ($ millions)	100	75	75
Maturity (years)	5	7	7
Total issuance outstanding ($ millions)	1,000	1,500	1,000
Months since issuance	New issue	3	6

Deveraux and Foster review the total expected 12-month return (assuming no reinvestment income) for the global bond portfolio. Selected financial data are presented in Exhibit 2.

Exhibit 2 Selected Data on Global Bond Portfolio

Notional principal of portfolio (in millions)	€200
Average bond coupon payment (per €100 par value)	€2.25
Coupon frequency	Annual
Current average bond price	€98.45
Expected average bond price in one year (assuming an unchanged yield curve)	€98.62
Average bond convexity	22
Average bond modified duration	5.19
Expected average yield and yield spread change	0.15%
Expected credit losses	0.13%
Expected currency gains (€ appreciation vs. $)	0.65%

Deveraux contemplates adding a new manager to the global bond portfolio. She reviews three proposals and determines that each manager uses the same index as its benchmark but pursues a different total return approach, as presented in Exhibit 3.

Exhibit 3 New Manager Proposals Fixed-Income Portfolio Characteristics

Sector Weights (%)	Manager A	Manager B	Manager C	Index
Government	53.5	52.5	47.8	54.1
Agency/quasi-agency	16.2	16.4	13.4	16.0

Exhibit 3 (Continued)

Sector Weights (%)	Manager A	Manager B	Manager C	Index
Corporate	20.0	22.2	25.1	19.8
MBS	10.3	8.9	13.7	10.1

Risk and Return Characteristics	Manager A	Manager B	Manager C	Index
Average maturity (years)	7.63	7.84	8.55	7.56
Modified duration (years)	5.23	5.25	6.16	5.22
Average yield (%)	1.98	2.08	2.12	1.99
Turnover (%)	207	220	290	205

7 Which approach to its total return mandate is the fund's domestic bond portfolio *most likely* to use?

A Pure indexing

B Enhanced indexing

C Active management

8 Strategy 2 is *most likely* preferred to Strategy 1 for meeting the objective of:

A protecting inflation.

B funding future liabilities.

C minimizing the correlation of the fund's domestic bond portfolio and equity portfolio.

9 Are Foster's statements to Deveraux supporting Foster's choice of bonds to sell correct?

A Only Statement 1 is correct.

B Only Statement 2 is correct.

C Neither Statement 1 nor Statement 2 is correct.

10 Based on Exhibit 1, which bond *most likely* has the highest liquidity premium?

A Bond 1

B Bond 2

C Bond 3

11 Based on Exhibit 2, the total expected return of the fund's global bond portfolio is *closest* to:

A 0.90%.

B 2.20%.

C 3.76%.

12 Based on Exhibit 3, which manager is *most likely* to have an active management total return mandate?

A Manager A

B Manager B

C Manager C

SOLUTIONS

1 B is correct. Permot has the highest percentage of floating-coupon bonds and inflation-linked bonds. Bonds with floating coupons protect interest income from inflation because the reference rate should adjust for inflation. Inflation-linked bonds protect against inflation by paying a return that is directly linked to an index of consumer prices and adjusting the principal for inflation. Inflation-linked bonds protect both coupon and principal payments against inflation.

The level of inflation protection for coupons = % portfolio in floating-coupon bonds + % portfolio in inflation-linked bonds:

Aschel = 2% + 3% = 5%

Permot = 34% + 28% = 62%

Rosaiso = 17% + 21% = 38%

Thus, Permot has the highest level of inflation protection with 62% of its portfolio in floating-coupon and inflation-linked bonds.

2 B is correct. The rolling yield is the sum of the yield income and the rolldown return. Yield income is the sum of the bond's annual current yield and interest on reinvestment income. Perreaux assumes that there is no reinvestment income for any of the three funds, and the yield income for Aschel will be calculated as follows:

$$\begin{aligned}\text{Yield income} &= \text{Annual average coupon payment/Current bond price}\\ &= \$3.63/\$117.00\\ &= 0.0310\text{, or } 3.10\%.\end{aligned}$$

The rolldown return is equal to the bond's percentage price change assuming an unchanged yield curve over the horizon period. The rolldown return will be calculated as follows:

$$\begin{aligned}\text{Rolldown return} &= \frac{\left(\text{Bond price}_{\text{End-of-horizon period}} - \text{Bond price}_{\text{Beginning-of-horizon period}}\right)}{\text{Bond price}_{\text{Beginning-of-horizon period}}}\\ &= \frac{(\$114.00 - \$117.00)}{\$117.00}\\ &= -0.0256\text{, or } -2.56\%\end{aligned}$$

Rolling yield = Yield income + Rolldown return = 3.10% – 2.56% = 0.54%

3 B is correct. The return for Aschel is 7.71%, calculated as follows.

$$\begin{aligned}r_p &= \frac{\left(r_l \times (V_E + V_B) - V_B \times r_B\right)}{V_E}\\ &= r_l + \frac{V_B}{V_E}(r_l - r_B)\\ &= 6.20\% + \frac{\$42.00\text{ million}}{\$94.33\text{ million}}(6.20\% - 2.80\%)\\ &= 7.71\%\end{aligned}$$

4 C is correct. Rosaiso is the only fund that holds bonds with embedded options. Effective duration should be used for bonds with embedded options. For bonds with embedded options, the duration and convexity measures used to calculate the expected change in price based on the investors's views of yields and yield spreads are effective duration and effective convexity. For bonds without embedded options, convexity and modified duration are used in this calculation.

5 B is correct. Cash flow matching has no yield curve or interest rate assumptions. With this immunization approach, cash flows come from coupon and principal repayments that are expected to match and offset liability cash flows. Because bond cash inflows are scheduled to coincide with liability cash payouts, there is no need for reinvestment of cash flows. Thus, cash flow matching is not affected by interest rate movements. Cash flows coming from coupons and liquidating bond portfolio positions is a key feature of a duration-matching approach.

6 A is correct. The optimal strategy for Villash is the sale of 100% of Bond 1, which Perreaux considers to be overvalued. Because Villash is a tax-exempt foundation, tax considerations are not relevant and Perreaux's investment views drive her trading recommendations.

7 B is correct. The domestic bond portfolio's return objective is to modestly outperform the benchmark. Its risk factors, such as duration, are to closely match the benchmark. Small deviations in sector weights are allowed, and tracking error should be less than 50 bps year. These features are typical of enhanced indexing.

8 A is correct. Floating-coupon bonds provide inflation protection for the interest income because the reference rate should adjust for inflation. The purchase of fixed-coupon bonds as outlined in Strategy 1 provides no protection against inflation for either interest or principal. Strategy 1 would instead be superior to Strategy 2 in funding future liabilities (better predictability as to the amount of cash flows) and reducing the correlation between the fund's domestic bond portfolio and equity portfolio (better diversification).

9 C is correct. Since the fund's clients are taxable investors, there is value in harvesting tax losses. These losses can be used to offset capital gains within the fund that will otherwise be distributed to the clients and cause them higher tax payments, which decreases the total value of the investment to clients. The fund has to consider the overall value of the investment to its clients, including taxes, which may result in the sale of bonds that are not viewed as overvalued. Tax-exempt investors' decisions are driven by their investment views without regard to offsetting gains and losses for tax purposes.

10 C is correct. Bond 3 is most likely to be the least liquid of the three bonds presented in Exhibit 2 and will thus most likely require the highest liquidity premium. Low credit ratings, longer time since issuance, smaller issuance size, smaller issuance outstanding, and longer time to maturity typically are associated with a lower liquidity (and thus a higher liquidity premium). Bond 3 has the lowest credit quality and the longest time since issuance of the three bonds. Bond 3 also has a smaller issue size and longer time to maturity than Bond 1. The total issuance outstanding for Bond 3 is smaller than that of Bond 2 and equal to that of Bond 1.

11 B is correct. The total expected return is calculated as:

Total expected return = Rolling yield + *E*(Change in price based on investor's yield and yield spread view) – *E*(Credit losses) + *E*(Currency gains or losses)

Rolling yield = Yield income + Rolldown return

Return Component	**Formula**	**Calculation**
Yield income	Annual coupon payment/Current bond price	€2.25/€98.45 = 2.29%
+ Rolldown return	$\frac{\left(\text{Bond price}_{\text{End-of-horizon period}} - \text{Bond price}_{\text{Beginning-of-horizon period}}\right)}{\text{Bond price}_{\text{Beginning-of-horizon period}}}$	(€98.62 – €98.45)/ €98.45 = 0.17%
= Rolling yield	Yield income + Rolldown return	2.29% + 0.17% = 2.46%
+ *E*(Change in price based on investor's yield and yield spread view)	[–MD × ΔYield] + [½ × Convexity × $(\text{Yield})^2$]	[–5.19 × 0.0015] + [½ × 22 × $(0.0015)^2$] = –0.78%
– *E*(Credit losses)	Given	–0.13%
+ *E*(Currency gains or losses)	Given	0.65%
= Total expected return		**2.20%**

12 C is correct. The sector weights, risk and return characteristics, and turnover for Manager C differ significantly from those of the index, which is typical of an active management mandate. In particular, Manager C's modified duration of 6.16 represents a much larger deviation from the benchmark index modified duration of 5.22 than that of the other managers, which is a characteristic unique to an active management mandate.

READING

19

Liability-Driven and Index-Based Strategies

by James F. Adams, PhD, CFA, and Donald J. Smith, PhD

James F. Adams, PhD, CFA, is at J.P. Morgan (USA). Donald J. Smith, PhD, is at Boston University Questrom School of Business (USA).

LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	**a.** describe liability-driven investing;
☐	**b.** evaluate strategies for managing a single liability;
☐	**c.** compare strategies for a single liability and for multiple liabilities, including alternative means of implementation;
☐	**d.** evaluate liability-based strategies under various interest rate scenarios and select a strategy to achieve a portfolio's objectives;
☐	**e.** explain risks associated with managing a portfolio against a liability structure;
☐	**f.** discuss bond indexes and the challenges of managing a fixed-income portfolio to mimic the characteristics of a bond index;
☐	**g.** compare alternative methods for establishing bond market exposure passively;
☐	**h.** discuss criteria for selecting a benchmark and justify the selection of a benchmark;
☐	**i.** describe construction, benefits, limitations, and risk–return characteristics of a laddered bond portfolio.

INTRODUCTION

1

Fixed-income instruments make up nearly three-quarters of all global financial assets available to investors, so it is not surprising that bonds are a critical component of most investment portfolios. This reading focuses on structured and passive total return fixed-income investment strategies. "Passive" does not necessarily mean "buy

James F. Adams is a contributing author and his contributions solely represent his views and can in no way be taken to reflect the views of JPMorgan Chase & Co.

and hold" because the primary strategies discussed—immunization and indexation—can entail frequent rebalancing of the bond portfolio. "Passive" stands in contrast to "active" fixed-income strategies that are based on the asset manager's particular view on interest rate and credit market conditions.

Sections 2 through 6 address how to best structure a fixed-income portfolio when considering both the asset and liability sides of the investor's balance sheet. It is first important to have a thorough understanding of both the timing and relative certainty of future financial obligations. Because it is rare to find a bond investment whose characteristics perfectly match one's obligations, we introduce the idea of structuring a bond portfolio to match the future cash flows of one or more liabilities that have bond-like characteristics. Asset–liability management (ALM) strategies are based on the concept that investors incorporate both rate-sensitive assets and liabilities into the portfolio decision-making process. When the liabilities are given and assets are managed, liability-driven investing (LDI) may be used to ensure adequate funding for an insurance portfolio, a pension plan, or an individual's budget after retirement.[1] The techniques and risks associated with LDI are introduced using a single liability, and then expanded to cover both cash flow and duration matching techniques and multiple liabilities. This strategy, known as immunization, may be viewed simply as a special case of interest rate hedging. It is important to note that when funds exceed a predetermined threshold, investors can also use interest rate derivatives as a tool to manage their liabilities in addition to choosing a specific asset portfolio to achieve the management of their liabilities. This contingent form of immunization involves active management above a pre-specified funding threshold while retaining a more passive approach at lower funding levels. Section 5 reviews these concepts in detail using the example of a defined benefit pension plan. Section 6 reviews risks associated with these strategies, such as model risk and measurement risk.

Investors often use an index-based investment strategy to gain a broader exposure to fixed-income markets rather than tailoring investments to match a specific liability profile. Sections 7 through 9 cover this approach. Advantages of index-based investing include greater diversification and lower cost when compared with active management. That said, the depth and breadth of bond markets make both creating and tracking an index more challenging than in the equity markets. Fixed-income managers face a variety of alternatives in matching a bond index, from full replication to enhanced indexing using primary risk factors. We describe how portfolio managers and investors in general can gain fixed-income exposure through mutual funds or exchange-traded funds, as well as via synthetic means. Given the wide variety of fixed-income instruments available, it is critical to select a benchmark that is most relevant to a specific investor based on factors such as the targeted duration profile and risk appetite. In the area of private wealth management, establishing a laddered portfolio of bonds is often an effective strategy to match an individual investor's duration and risk preferences. The final section discusses this approach.

2 LIABILITY-DRIVEN INVESTING

Let us start with the example of a 45-year-old investor who plans to retire at age 65 and would like to secure a stable stream of income thereafter. It is quite probable that he currently has a diversified portfolio that includes bonds, equities, and possibly other asset classes. Our focus here is on the fixed-income portion of his overall portfolio. We will assume that the investor builds the bond portfolio and adds to it year by year.

1 In this reading, we use the terms "liability driven" and "liability based" interchangeably.

Upon retirement, he plans to sell the bonds and buy an annuity that will pay a fixed benefit for his remaining lifetime. This investor's initial 20-year time horizon is critical to identifying and measuring the impact on retirement income arising from future interest rate volatility, and it forms the initial frame of reference for understanding and dealing with interest rate risk.

More generally, the frame of reference is in the form of a balance sheet of rate-sensitive assets and liabilities. In the example of the 45-year-old investor, the asset is the growing bond portfolio and the liability is the present value of the annuity that the investor requires to satisfy the fixed lifetime benefit. Asset–liability management strategies consider both assets and liabilities in the portfolio decision-making process. ALM strategies became popular in the 1970s following the surge in oil prices and inflation. As rising inflation led to US interest rate volatility, bank managers began to implement ALM strategies in order to better balance the interest rate exposure of assets and liabilities. Before ALM, bank managers often made loans and deposit rate decisions independently, leading to unexpected gaps between the maturity profiles of loan assets and deposit liabilities. Managers realized that coordinated rate decisions and measurement of gaps between asset and liability maturities would reduce interest rate risk. These institutions set up asset–liability committees (ALCOs) to monitor and manage the maturity gaps and set rates in a coordinated manner. For example, if the bank acquired long-term fixed-rate assets, it would raise rates on long-term deposits so as to make such deposits attractive to savers, allowing the bank to maintain a balance in the maturities. The use of derivatives such as interest rate swaps to manage these maturity gaps through synthetic ALM strategies became widespread in the 1980s.

Liability-driven investing (LDI) and asset-driven liabilities (ADL) are special cases of ALM. The key difference is that with ADL, the assets are given and the liabilities are structured to manage interest rate risk; whereas with LDI, the liabilities are given and the assets are managed. As an example of LDI, a life insurance company acquires a liability portfolio based on the insurance policies underwritten by its sales force. Another example involves the future employee benefits promised by a defined benefit pension plan, which create a portfolio of rate-sensitive liabilities. In each circumstance, the liabilities are defined and result from routine business and financial management decisions. The present value of those liabilities depends on current interest rates. A life insurance or pension manager will use the estimated interest rate sensitivity of plan liabilities as a starting point when making investment portfolio decisions. This process often requires building a model for the liabilities, as discussed in Section 5 of this reading.

With ADL, the asset side of the balance sheet results from a company's underlying businesses, and the debt manager seeks a liability structure to reduce interest rate risk. One example might be a leasing company with short-term contracts that chooses to finance itself with short-term debt. The company is aiming to match the maturities of its assets and liabilities to minimize risk. Alternatively, a manufacturing company might identify that its operating revenues are highly correlated with the business cycle. Monetary policy is typically managed so there is positive correlation between interest rates and the business cycle. Central banks lower policy rates when the economy is weak and raise them when it is strong. Therefore, this company has a natural preference for variable-rate liabilities so that operating revenue and interest expense rise and fall together.[2]

An LDI strategy starts with analyzing the size and timing of the entity's liabilities. Exhibit 1 shows a classification scheme for this analysis.[3]

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2 See Adams and Smith (2013) for further examples and the use of interest rate swaps to transform fixed-rate debt into a synthetic-floating rate liability.

3 This classification scheme is taken from Fabozzi (2013).

Exhibit 1 Classification of Liabilities

Liability Type	Amount of Cash Outlay	Timing of Cash Outlay
I	Known	Known
II	Known	Uncertain
III	Uncertain	Known
IV	Uncertain	Uncertain

The same scheme also applies to financial assets, but our focus here is on liabilities and on LDI, which is much more common than ADL. Type I liabilities arise from financial contracts that specify certain amounts due on scheduled future dates. An example is a traditional fixed-income bond having no embedded options. How much one pays (or receives) in coupon interest and principal redemption, as well as the timing of the payments, are known in advance. The next two sections assume Type I liabilities, first for only a single payment and then for multiple bonds. An advantage to knowing the size and timing of cash flows is that yield duration statistics—that is, Macaulay duration, modified duration, money duration, and the present value of a basis point (PVBP)—can be used to measure the interest rate sensitivity of the liabilities.

Type II liabilities have known amounts, but the timing of those payments is uncertain. Examples of this type of liability are callable and putable bonds. The call price payable upon exercise of the option is known in advance, but when or if the bond will be called is uncertain. Similarly, the issuer of a putable bond does not know when or if the investor will exercise the option. Another example is a term life insurance policy. Although the timing of the insured's death is unknown, a life insurance company holding a large portfolio of policies can benefit from the "law of large numbers." This means that the insurance company can use actuarial science to predict, on average, the amount of total liabilities due for each year and so can gain a very good sense of the amount of cash flow it will have to pay out in a given year.

Type III liabilities have known payment dates but an uncertain amount. A floating-rate note is an obvious example because the interest payments depend on future money market rates. Moreover, some structured notes have principal redemption amounts tied to a commodity price or interest rate index. Inflation-indexed bonds issued by many governments are another example. In the United States, the US Treasury issues Treasury inflation-protected securities (TIPS). The principal redemption amount is adjusted for the changes in the Consumer Price Index realized over the security's lifetime, making interest and principal payment amounts uncertain.

Type IV liabilities present the most difficult setting for an LDI strategy because both the amount and timing of the future obligations are uncertain. A property and casualty insurance company offers a good example. Although the amount and timing of some claims might follow a known pattern (for instance, automobile insurance), others such as damages from catastrophic weather events (e.g., tornados, cyclones, and floods) are inherently difficult to predict.

With Types II, III, and IV liabilities, a curve duration statistic known as effective duration is needed to estimate interest rate sensitivity.[4] This statistic is calculated using a model for the uncertain amount and/or timing of the cash flows and an initial assumption about the yield curve. Then the yield curve is shifted up and down to obtain

4 In this reading, we discuss only the use of yield and curve duration statistics for a fixed-income bond. In academic literature, duration is often calculated by discounting each cash flow with the spot (or zero-coupon) rate corresponding with the date. The resulting duration statistic is known as Fisher–Weil duration. Although theoretically correct, it is difficult to calculate in practice because of the lack of observable spot rates for risky bonds.

new estimates for the present value of the liabilities. We demonstrate this process in Section 5 for the sponsor of a defined benefit pension plan, which is another example of an entity with Type IV liabilities.

EXAMPLE 1

Modern Mortgage, a savings bank, decides to establish an ALCO to improve risk management and coordination of its loan and deposit rate-setting processes. Modern's primary assets are long-term, fixed-rate, monthly payment, fully amortizing residential mortgage loans. The mortgage loans are prime quality and have loan-to-value ratios that average 80%. The loans are pre-payable at par value by the homeowners at no fee. Modern also holds a portfolio of non-callable, fixed-income government bonds (considered free of default risk) of varying maturities to manage its liquidity needs. The primary liabilities are demand and time deposits that are fully guaranteed by a government deposit insurance fund. The demand deposits are redeemable by check or debit card. The time deposits have fixed rates and maturities ranging from 90 days to three years and are redeemable before maturity at a small fee. The banking-sector regulator in the country in which Modern operates has introduced a new capital requirement for savings banks. In accordance with the requirement, contingent convertible long-term bonds are issued by the savings bank and sold to institutional investors. The key feature is that if defaults on the mortgage loans reach a certain level or the savings bank's capital ratio drops below a certain level, as determined by the regulator, the bonds convert to equity at a specified price per share.

As a first step, the ALCO needs to identify the types of assets and liabilities that comprise its balance sheet using the classification scheme in Exhibit 1. Type I has certain amounts and dates for its cash flows; Type II has known amounts but uncertain dates; Type III has specified dates but unknown amounts; and Type IV has uncertain amounts and dates.

Specify and explain the classification scheme for the following:

1 Residential mortgage loans
2 Government bonds
3 Demand and time deposits
4 Contingent convertible bonds

Solution to 1:

Residential mortgage loans are Type IV assets to the savings bank. The timing of interest and principal cash flows is uncertain because of the prepayment option held by the homeowner. This type of call option is complex. Homeowners might elect to prepay for many reasons, including sale of the property as well as the opportunity to refinance if interest rates come down. Therefore, a prepayment model is needed to project the timing of future cash flows. Default risk also affects the projected amount of the cash flow for each date. Even if the *average* loan-to-value ratio is 80%, indicating high-quality mortgages, some loans could have higher ratios and be more subject to default, especially if home prices decline.

Solution to 2:

Fixed-rate government bonds are Type I assets because the coupon and principal payment dates and amounts are determined at issuance.

Solution to 3:

Demand and time deposits are Type II liabilities from the savings bank's perspective. The deposit amounts are known, but the depositor can redeem the deposits prior to maturity, creating uncertainty about timing.

Solution to 4:

The contingent convertible bonds are Type IV liabilities. The presence of the conversion option makes both the amount and timing of cash flows uncertain.

3 INTEREST RATE IMMUNIZATION—MANAGING THE INTEREST RATE RISK OF A SINGLE LIABILITY

Liability-driven investing in most circumstances is used to manage the interest rate risk on multiple liabilities. In this section, we focus on only a single liability to demonstrate the techniques and risks of the classic investment strategy known as interest rate **immunization**.[5] Immunization is the process of structuring and managing a fixed-income bond portfolio to minimize the variance in the realized rate of return over a known time horizon.[6] This variance arises from the volatility of future interest rates. Default risk is neglected at this point because the portfolio bonds are assumed to have default probabilities that approach zero.

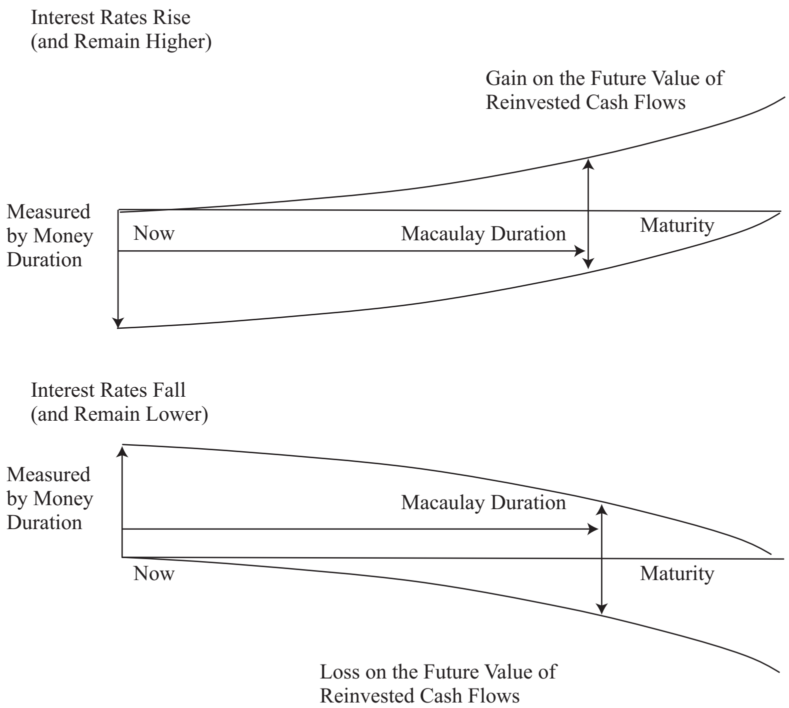
The most obvious way to immunize the interest rate risk on a single liability is to buy a zero-coupon bond that matures on the obligation's due date. The bond's face value matches the liability amount. There is no cash flow reinvestment risk because there are no coupon payments to reinvest, and there is no price risk because the bond is held to maturity. Any interest rate volatility over the bond's lifetime is irrelevant in terms of the asset's ability to pay off the liability. The problem is that in many financial markets, zero-coupon bonds are not available. Nevertheless, the perfect immunization provided by a zero-coupon bond sets a standard to measure the performance of immunizing strategies using coupon-bearing bonds.

Exhibit 2 illustrates the connection between immunization and the duration of a traditional coupon-bearing fixed-income bond.

5 This section is based on Smith (2014, ch. 9–10).

6 The British actuary F.M. Redington coined the term "immunization" in his article, "Review of the Principles of Life-Office Valuations," *Journal of the Institute of Actuaries*, 1952.

Exhibit 2 Interest Rate Immunization with a Single Fixed-Income Bond



Assume that the bond is currently priced at par value. Then, an instantaneous, one-time, upward shift occurs in the yield curve. The bond's value falls, as shown in the upper panel. That drop in value is estimated by the money duration of the bond. The money duration is the bond's modified duration statistic multiplied by the price. Subsequently, the bond price will be "pulled to par" as the maturity date nears (assuming no default, of course). But there is another factor at work. Assuming that interest rates remain higher, the future value of reinvested coupon payments goes up. It is a rising line as more and more payments are received and reinvested at the higher interest rates.

The key detail to note in Exhibit 2 is that at some point in time, the two effects—the price effect and the coupon reinvestment effect—cancel each other. The lower panel shows the same cancellation for an immediate downward shift in interest rates. The remarkable result is that this point in time turns out to be the bond's Macaulay duration (for a zero-coupon bond, its Macaulay duration is its maturity). Therefore, an investor having an investment horizon equal to the bond's Macaulay duration is effectively protected, or immunized, from interest rate risk in that price, and coupon reinvestment effects offset for either higher or lower rates.

A numerical example is useful to show that the strategy of matching the Macaulay duration to the investment horizon works for a bond portfolio as well as for an individual security. Suppose that some entity has a single liability of EUR 250 million due 15 February 2023. The current date is 15 February 2017, so the investment horizon is six years. The asset manager for the entity seeks to build a three-bond portfolio to earn a rate of return sufficient to pay off the obligation.

Exhibit 3 reports the prices, yields, risk statistics (Macaulay duration and convexity), and par values for the chosen portfolio. The portfolio's current market value is EUR 200,052,250 (= EUR 47,117,500 + EUR 97,056,750 + EUR 55,878,000). The semi-annual coupon payments on the bonds occur on 15 February and 15 August of each year. The price is per 100 of par value, and the yield to maturity is on a street-convention semi-annual bond basis (meaning an annual percentage rate having a periodicity of two). Both the Macaulay duration and the convexity are annualized. (Note that in practice, some bond data vendors [such as Bloomberg] report the convexity statistic divided by 100.)

Exhibit 3 The Bond Portfolio to Immunize the Single Liability

	2.5-Year Bond	7-Year Bond	10-Year Bond
Coupon rate	1.50%	3.25%	5.00%
Maturity date	15 August 2019	15 February 2024	15 February 2027
Price	100.25	99.75	100.50
Yield to maturity	1.3979%	3.2903%	4.9360%
Par value	47,000,000	97,300,000	55,600,000
Market value	47,117,500	97,056,750	55,878,000
Macaulay duration	2.463	6.316	7.995
Convexity	7.253	44.257	73.747
Allocation	23.55%	48.52%	27.93%

Exhibit 4 shows the cash flows and calculations used to obtain the relevant portfolio statistics. The third column aggregates the coupon and principal payments received for each date from the three bonds.

Exhibit 4 Portfolio Statistics

Time	Date	Cash Flow	PV of Cash Flow	Weight	Time × Weight	Dispersion	Convexity
0	15-Feb-17	−200,052,250					
1	15-Aug-17	3,323,625	3,262,282	0.0163	0.0163	1.9735	0.0326
2	15-Feb-18	3,323,625	3,202,071	0.0160	0.0320	1.6009	0.0960
3	15-Aug-18	3,323,625	3,142,971	0.0157	0.0471	1.2728	0.1885
4	15-Feb-19	3,323,625	3,084,962	0.0154	0.0617	0.9871	0.3084
5	15-Aug-19	50,323,625	45,847,871	0.2292	1.1459	11.2324	6.8754
6	15-Feb-20	2,971,125	2,656,915	0.0133	0.0797	0.4782	0.5578
7	15-Aug-20	2,971,125	2,607,877	0.0130	0.0913	0.3260	0.7300
8	15-Feb-21	2,971,125	2,559,744	0.0128	0.1024	0.2048	0.9213
9	15-Aug-21	2,971,125	2,512,500	0.0126	0.1130	0.1131	1.1303
10	15-Feb-22	2,971,125	2,466,127	0.0123	0.1233	0.0493	1.3560
11	15-Aug-22	2,971,125	2,420,610	0.0121	0.1331	0.0121	1.5972
12	15-Feb-23	2,971,125	2,375,934	0.0119	0.1425	0.0000	1.8527
13	15-Aug-23	2,971,125	2,332,082	0.0117	0.1515	0.0116	2.1216
14	15-Feb-24	100,271,125	77,251,729	0.3862	5.4062	1.5434	81.0931
15	15-Aug-24	1,390,000	1,051,130	0.0053	0.0788	0.0473	1.2610
16	15-Feb-25	1,390,000	1,031,730	0.0052	0.0825	0.0825	1.4028
17	15-Aug-25	1,390,000	1,012,688	0.0051	0.0861	0.1265	1.5490
18	15-Feb-26	1,390,000	993,997	0.0050	0.0894	0.1788	1.6993
19	15-Aug-26	1,390,000	975,651	0.0049	0.0927	0.2389	1.8533
20	15-Feb-27	56,990,000	39,263,380	0.1963	3.9253	12.5585	82.4316
			200,052,250	1.0000	12.0008	33.0378	189.0580

For instance, EUR 3,323,625 is the sum of the coupon payments for the first four dates:

(1.50% × 0.5 × EUR 47,000,000) + (3.25% × 0.5 × EUR 97,300,000) + (5.00% × 0.5 × EUR 55,600,000) = EUR 352,500 + EUR 1,581,125 + EUR 1,390,000 = EUR 3,323,625

On 15 August 2019, the principal of EUR 47,000,000 is redeemed so that the total cash flow is EUR 50,323,625. The next eight cash flows represent the coupon payments on the second and third bonds, and so forth.

The internal rate of return on the cash flows in column 3 for the 20 semi-annual periods, including the portfolio's initial market value on 15 February 2017, is 1.8804%. Annualized on a semi-annual bond basis, the portfolio's cash flow yield is 3.7608% (= 2 × 1.8804%). This yield is significantly higher than the market value weighted average of the individual bond yields presented in Exhibit 3, which equals 3.3043%.

(1.3979% × 0.2355) + (3.2903% × 0.4852) + (4.9360% × 0.2793) = 3.3043%

This difference arises because of the steepness in the yield curve. The key point is that the goal of the immunization strategy is to achieve a rate of return close to 3.76%, not 3.30%.

The fourth column in Exhibit 4 shows the present values for each of the aggregate cash flows, calculated using the internal rate of return per period (1.8804%) as the discount rate. For example, the combined payment of EUR 100,271,125 due on 15 February 2024 has a present value of EUR 77,251,729. [*Note: Calculations in this reading are carried out on a spreadsheet that preserves precision. For readability and to avoid clutter, the exhibits and text report rounded results. For example, the following calculation gives 77,251,498 with the numbers shown on the left hand-side, but it gives 77,251,729, the amount shown on the right hand-side, when the precise semi-annual cash flow yield, 1.0188037819%, is used.*]

$$\frac{100{,}271{,}125}{(1.018804)^{14}} = 77{,}251{,}729$$

The sum of the present values in column 4 is EUR 200,052,250, the current market value for the bond portfolio.

The sixth column is used to obtain the portfolio's Macaulay duration. This duration statistic is the weighted average of the times to the receipt of cash flow, whereby the share of total market value for each date is the weight. Column 5 shows the weights, which are the PV of each cash flow divided by the total PV of EUR 200,052,250. The times to receipt of cash flow (the times from column 1) are multiplied by the weights and then summed. For example, the contribution to total portfolio duration for the second cash flow on 15 February 2018 is 0.0320 (= 2 × 0.0160). The sum of column 6 is 12.0008. That is the Macaulay duration for the portfolio in terms of semi-annual periods. Annualized, it is 6.0004 (= 12.0008/2). It is now clear why the asset manager for the entity chose this portfolio: The portfolio Macaulay duration matches the investment horizon of six years.

In practice, it is common to estimate the portfolio duration using the market value weighted average of the individual durations for each bond.[7] Exhibit 3 shows those individual durations and the allocation percentages for each bond. The average Macaulay duration is (2.463 × 0.2355) + (6.316 × 0.4852) + (7.995 × 0.2793) = 5.8776.

7 Another, and more theoretically correct, way to obtain the portfolio duration would be to discount the cash flows using spot (or zero-coupon) rates. As mentioned in Footnote 4, this duration calculation is difficult to implement in practice.

The difference, as with the cash flow yield and the market value weighted average yield, arises because the yield curve is not flat. When the yield curve is upwardly sloped, average duration (5.8776) is less than the portfolio duration (6.0004). This difference in duration statistics is important because using the average duration in building the immunizing portfolio instead of the portfolio duration would introduce model risk to the strategy. Section 6 of this reading discusses model risk.

The sum of the seventh column in Exhibit 4 is the portfolio **dispersion** statistic. Whereas Macaulay duration is the weighted *average* of the times to receipt of cash flow, dispersion is the weighted *variance*. It measures the extent to which the payments are spread out around the duration. For example, the contribution to total portfolio dispersion for the fifth cash flow on 15 August 2019 is 11.2324: $(5 - 12.0008)^2 \times 0.2292 = 11.2324$.

This portfolio's dispersion is 33.0378 in terms of semi-annual periods. Annualized, it is 8.2594 (= 33.0378/4). The Macaulay duration statistic is annualized by dividing by the periodicity of the bonds (two payments per year); dispersion (and convexity, which follows) is annualized by dividing by the periodicity squared.

The portfolio convexity is calculated with the eighth column. It is the sum of the times to the receipt of cash flow, multiplied by those times plus one, multiplied by the shares of market value for each date (weight), and all divided by one plus the cash flow yield squared. For example, the contribution to the sum for the 14th payment on 15 February 2024 is 81.0931 (= 14 × 15 × 0.3862). The sum of the column is 189.0580. The convexity in semi-annual periods is 182.1437:

$$\frac{189.0580}{(1.018804)^2} = 182.1437$$

The annualized convexity for the portfolio is 45.5359 (= 182.1437/4). This result is slightly higher than the market value weighted average of the individual convexity statistics reported in Exhibit 3:

$$(7.253 \times 0.2355) + (44.257 \times 0.4852) + (73.747 \times 0.2793) = 43.7786$$

As with the average yield and duration, this difference results from the slope of the yield curve. The convexity statistic can be used to improve the estimate for the change in portfolio market value following a change in interest rates than is provided by duration alone. That is, convexity is the second-order effect, whereas duration is the first-order effect.

There is an interesting connection among the portfolio convexity, Macaulay duration, dispersion, and cash flow yield.[8]

$$\text{Convexity} = \frac{\text{Macaulay duration}^2 + \text{Macaulay duration} + \text{Dispersion}}{(1 + \text{Cash flow yield})^2} \tag{1}$$

In terms of semi-annual periods, the Macaulay duration for this portfolio is 12.0008, the dispersion is 33.0378, and the cash flow yield is 1.8804%.

$$\text{Convexity} = \frac{12.0008^2 + 12.0008 + 33.0378}{(1.018804)^2} = 182.1437$$

The portfolio dispersion and convexity statistics are used to assess the structural risk to the interest rate immunization strategy. Structural risk arises from the potential for shifts and twists to the yield curve. This risk is discussed later in this section.

Exhibit 5 demonstrates how matching the Macaulay duration for the portfolio to the investment horizon leads to interest rate immunization.

8 The derivation of Equation 1, as well as additional examples of calculating dispersion and convexity for fixed-income bonds, are included in Smith (2014).

Exhibit 5 Interest Rate Immunization

Time	Date	Cash Flow	Total Return at 3.7608%	Total Return at 2.7608%	Total Return at 4.7608%
0	15-Feb-17	−200,052,250			
1	15-Aug-17	3,323,625	4,079,520	3,864,613	4,305,237
2	15-Feb-18	3,323,625	4,004,225	3,811,992	4,205,138
3	15-Aug-18	3,323,625	3,930,319	3,760,088	4,107,366
4	15-Feb-19	3,323,625	3,857,777	3,708,891	4,011,868
5	15-Aug-19	50,323,625	57,333,230	55,392,367	59,332,093
6	15-Feb-20	2,971,125	3,322,498	3,225,856	3,421,542
7	15-Aug-20	2,971,125	3,261,175	3,181,932	3,341,989
8	15-Feb-21	2,971,125	3,200,984	3,138,607	3,264,286
9	15-Aug-21	2,971,125	3,141,904	3,095,871	3,188,390
10	15-Feb-22	2,971,125	3,083,914	3,053,718	3,114,258
11	15-Aug-22	2,971,125	3,026,994	3,012,138	3,041,850
12	15-Feb-23	2,971,125	2,971,125	2,971,125	2,971,125
13	15-Aug-23	2,971,125	2,916,287	2,930,670	2,902,045
14	15-Feb-24	100,271,125	96,603,888	97,559,123	95,662,614
15	15-Aug-24	1,390,000	1,314,446	1,333,991	1,295,282
16	15-Feb-25	1,390,000	1,290,186	1,315,827	1,265,166
17	15-Aug-25	1,390,000	1,266,373	1,297,911	1,235,750
18	15-Feb-26	1,390,000	1,242,999	1,280,238	1,207,018
19	15-Aug-26	1,390,000	1,220,058	1,262,806	1,178,955
20	15-Feb-27	56,990,000	49,099,099	51,070,094	47,213,270
			250,167,000	250,267,858	250,265,241

The fourth column shows the values of the cash flows as of the horizon date of 15 February 2023, assuming that the cash flow yield remains unchanged at 3.7608%. For instance, the future value of the EUR 3,323,625 in coupon payments received on 15 August 2017 is EUR 4,079,520.

$$3{,}323{,}625 \times \left(1 + \frac{0.037608}{2}\right)^{11} = 4{,}079{,}520$$

The value of the last cash flow for EUR 56,990,000 on 15 February 2027 is EUR 49,099,099 as of the horizon date of 15 February 2023.

$$\frac{56{,}990{,}000}{\left(1 + \frac{0.037608}{2}\right)^{8}} = 49{,}099{,}099$$

All of the payments received before the horizon date are reinvested at the cash flow yield. All of the payments received after the horizon date are sold at their discounted values. The sum of the fourth column is EUR 250,167,000, which is more than enough to pay off the EUR 250 million liability. The six-year holding period rate of return (ROR), also called the horizon yield, is 3.7608%. It is based on the original market value and the total return and is the solution for ROR:

$$200{,}052{,}250 = \frac{250{,}167{,}000}{\left(1+\frac{\text{ROR}}{2}\right)^{12}},\ \text{ROR} = 0.037608$$

The holding period rate of return equals the cash flow yield for the portfolio. This equivalence is the multi-bond version of the well-known result for a single bond: The realized rate of return matches the yield to maturity only if coupon payments are reinvested at that same yield and if the bond is held to maturity or sold at a point on the constant-yield price trajectory.

The fifth column in Exhibit 5 repeats the calculations for the assumption of an instantaneous, one-time, 100 bp drop in the cash flow yield on 15 February 2017. The future values of all cash flows received are now lower because they are reinvested at 2.7608% instead of 3.7608%. For example, the payment of EUR 50,323,625 on 15 August 2019, which contains the principal redemption on the 2.5-year bond, grows to only EUR 55,392,367.

$$50{,}323{,}625 \times \left(1+\frac{0.027608}{2}\right)^{7} = 55{,}392{,}367$$

The value of the last cash flow is now higher because it is discounted at the lower cash flow yield.

$$\frac{56{,}990{,}000}{\left(1+\frac{0.027608}{2}\right)^{8}} = 51{,}070{,}094$$

The important result is that the total return as of the horizon date is EUR 250,267,858, demonstrating that the cash flow reinvestment effect is balanced by the price effect, as illustrated for a single bond in Exhibit 2. The holding-period rate of return is 3.7676%.

$$200{,}052{,}250 = \frac{250{,}267{,}858}{\left(1+\frac{\text{ROR}}{2}\right)^{12}},\ \text{ROR} = 0.037676$$

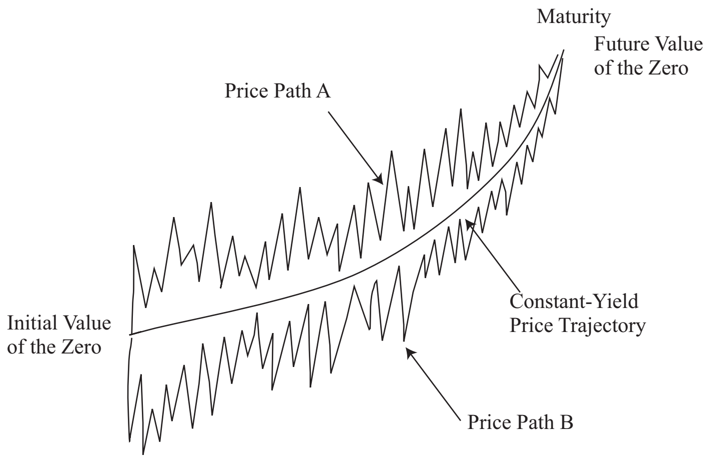
To complete the example, the sixth column reports the results for an instantaneous, one-time, 100 bp jump in the cash flow yield, up to 4.7608% from 3.7608%. In this case, the future values of the reinvested cash flows are higher and the discounted values of cash flows due after the horizon date are lower. Nevertheless, the total return of EUR 250,265,241 for the six-year investment horizon is enough to pay off the liability. The horizon yield is 3.7674%.

$$200{,}052{,}250 = \frac{250{,}265{,}241}{\left(1+\frac{\text{ROR}}{2}\right)^{12}},\ \text{ROR} = 0.037674$$

This numerical exercise demonstrates interest rate immunization using a portfolio of fixed-income bonds. The total returns and holding period rates of return are virtually the same—in fact, slightly higher because of convexity—whether the cash flow yield goes up or down. Exhibit 4 is somewhat misleading, however, because it suggests that immunization is a buy-and-hold passive investment strategy. It suggests that the entity will (a) hold on the horizon date of 15 February 2023 the same positions in what then will be one-year, 3.25% and four-year, 5% bonds and (b) sell the bonds on that date. This suggestion is misleading because the portfolio must be frequently rebalanced to stay on its target duration. As time passes, the portfolio's Macaulay duration changes but not in line with the change in the remainder of the investment horizon. For example, after five years, the investment horizon as of 15 February 2022 is just one remaining year. The portfolio Macaulay duration at that time needs to be 1.000. The asset manager will have had to execute some trades by then, substantially reducing the holdings in what is then the five-year, 5% bond.

Exhibit 6 offers another way to illustrate interest rate immunization. An immunization strategy is essentially "zero replication." We know that the perfect bond to lock in the six-year holding period rate of return is a six-year zero-coupon bond having a face value that matches the EUR 250 million liability. The idea is to originally structure and then manage over time a portfolio of coupon-bearing bonds that replicates the period-to-period performance of the zero-coupon bond. Therefore, immunization is essentially just an interest rate hedging strategy. As the yield on the zero-coupon bond rises and falls, there will be unrealized losses and gains. In Exhibit 6, this is illustrated by the zero-coupon bond's value moving below and above the constant-yield price trajectory. Two paths for the zero-coupon yield are presented: Path A for generally lower rates (and higher values) and Path B for higher rates (and lower values). Regardless, the market value of the zero-coupon bond will be "pulled to par" as maturity nears.

Exhibit 6 Interest Rate Immunization as Zero Replication



Immunizing with coupon-bearing bonds entails continuously matching the portfolio Macaulay duration with the Macaulay duration of the zero-coupon bond over time and as the yield curve shifts, even though the zero-coupon bond could be hypothetical and not exist in reality. Also, the bond portfolio's initial market value has to match or exceed the present value of the zero-coupon bond. The Macaulay duration of that, perhaps hypothetical, zero-coupon bond always matches the investment horizon. Immunization will be achieved if any ensuing change in the cash flow yield on the bond portfolio is equal to the change in the yield to maturity on the zero-coupon bond. That equivalence will ensure that the change in the bond portfolio's market value is close to the change in the market value of the zero-coupon bond. Therefore, at the end of the six-year investment horizon, the bond portfolio's market value should meet or exceed the face value of the zero-coupon bond, regardless of the path for interest rates over the six years.

The key assumption to achieve immunization is the statement that "any ensuing change in the cash flow yield on the bond portfolio is equal to the change in the yield to maturity on the zero-coupon bond." A *sufficient*, but not *necessary*, condition for that statement is a parallel (or shape-preserving) shift to the yield curve whereby all yields change by the same amount. *Sufficient* means that if the yield curve shift is parallel, the change in the bond portfolio's cash flow yield will equal the change in yield to maturity of the zero-coupon bond, which is enough to ensure immunization. To achieve immunization, however, it is not *necessary* that the yield curve shifts in a parallel manner. That is, in some cases, the immunization property can prevail even with non-parallel yield curve movements such as an upward and steepening shift (sometimes called a "bear steepener"), an upward and flattening shift (a "bear flattener"), a downward and steepening shift (a "bull steepener"), or a downward and flattening shift (a "bull flattener").

Exhibit 7 demonstrates this observation. Panel A of Exhibit 7 presents three different upward yield curve shifts. The first is a parallel shift of 102.08 bps for each of the three bond yields. The second is a steepening shift of 72.19 bps for the 2.5-year bond, 94.96 bps for the 7-year bond, and 120.82 bps for the 10-year bond. The third is a flattening shift whereby the yields on the three bonds increase by 145.81 bps, 109.48 bps, and 79.59 bps, respectively. The key point is that each of these yield curve shifts results in the same 100 bp increase in the cash flow yield from 3.7608% to 4.7608%. Moreover, each shift in the yield curve produces virtually the same reduction in the portfolio's market value.

Panel B of Exhibit 7 shows the results for three downward shifts in the yield curve. The first is a parallel shift of 102.06 bps. The second and third are downward and steepening (–129.00 bps, –104.52 bps, and –92.00 bps for the 2.5-year, 7-year, and 10-year bonds) and downward and flattening (–55.76 bps, –86.32 bps, and –134.08 bps). Each shift results in the same 100 bp decrease in the cash flow yield from 3.7608% to 2.7608% and virtually the same increase in the market value of the portfolio.

Exhibit 7 Some Yield Curve Shifts That Achieve Interest Rate Immunization

Panel A Yield Curve Shift

	Change in 2.5-Year Yield	Change in 7-Year Yield	Change in 10-Year Yield	Change in Cash Flow Yield	Change in Market Value
Upward and parallel	+102.08 bps	+102.08 bps	+102.08 bps	+100 bps	–11,340,537
Upward and steepening	+72.19 bps	+94.96 bps	+120.82 bps	+100 bps	–11,340,195
Upward and flattening	+145.81 bps	+109.48 bps	+79.59 bps	+100 bps	–11,340,183

Panel B Yield Curve Shift

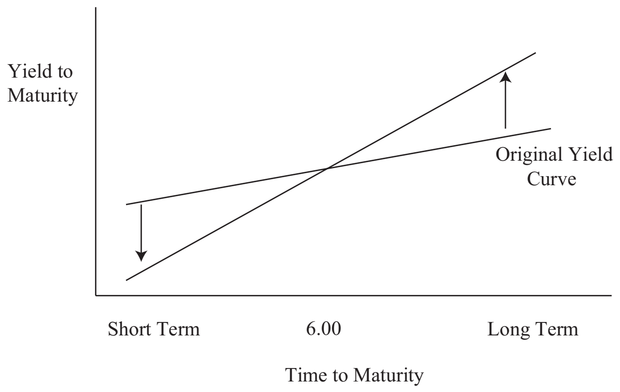
	Change in 2.5-Year Yield	Change in 7-Year Yield	Change in 10-Year Yield	Change in Cash Flow Yield	Change in Market Value
Downward and parallel	–102.06 bps	–102.06 bps	–102.06 bps	–100 bps	12,251,212
Downward and steepening	–129.00 bps	–104.52 bps	–92.00 bps	–100 bps	12,251,333
Downward and flattening	–55.76 bps	–86.32 bps	–134.08 bps	–100 bps	12,251,484

Notice that the interest rate immunization property shown in Exhibit 5 rests only on the change in the cash flow yield going up or down by 100 bps. It is not necessary to assume that the change in the value of the immunizing portfolio arises only from a parallel shift in the yield curve. In the same manner, the immunization property illustrated in Exhibit 6 requires only that the change in the value of the immunizing portfolio, one that has a Macaulay duration matching the investment horizon, is close to the change in the value of the zero-coupon bond that provides perfect immunization. Exhibit 7 demonstrates that non-parallel as well as parallel shifts can satisfy those conditions. Of course, there are many other non-parallel shifts for which those conditions are not met.

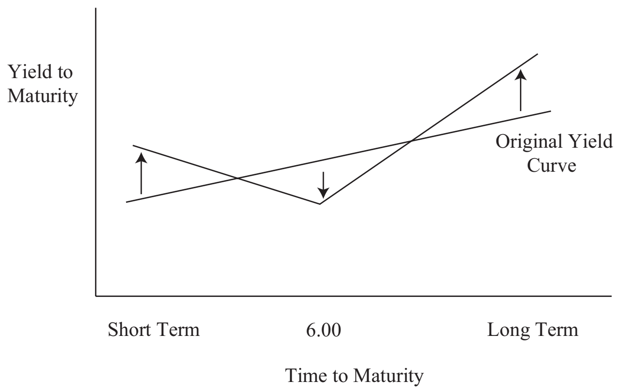
In general, the interest rate risk to an immunization strategy is that the change in the cash flow yield on the portfolio is not the same as on the ideal zero-coupon bond. This difference can occur with twists to the shape of the yield curve, in addition to some non-parallel shifts.[9] Exhibit 8 portrays two such twists. To exaggerate the risk, assume that the immunizing portfolio has a "barbell" structure in that it is composed of half short-term bonds and half long-term bonds. The portfolio Macaulay duration for the barbell is six years. The zero-coupon bond that provides perfect immunization has a maturity (and Macaulay duration) also of six years.

Exhibit 8 Immunization Risk and Twists to the Yield Curve

A. Steepening Twist



B. Positive Butterfly Twist



9 In this reading, we distinguish "non-parallel shift" and "twist" to the yield curve. With a non-parallel shift, all yields rise or fall to varying degrees. With a twist to the yield curve, some yields rise while others fall.

The upper panel of Exhibit 8 shows a steepening twist to the yield curve. The twist is assumed to occur at the six-year point to indicate that the value of the zero-coupon bond does not change. Short-term yields go down and long-term yields go up by approximately the same amount. The value of the barbell portfolio goes down because the losses on the long-term positions exceed the gains on the short-term holdings as a result of the difference in duration between the holdings and the equivalence in the assumed changes in yield. Therefore, this portfolio does not track the value of the zero-coupon bond.

The lower panel of Exhibit 8 illustrates a dramatic twist in the shape of the yield curve. Short-term and long-term yields go up while the six-year yields go down. This type of twist is named a "positive butterfly." (In a "negative butterfly" twist, short-term and long-term yields go down and intermediate-term yields go up.) The immunizing portfolio decreases in value as its yields go up and the zero-coupon bond goes up in value. Again, the portfolio does not track the change in the value of the bond that provides perfect immunization. Fortunately for those entities that pursue interest rate immunization, these types of twists are rare. Most yield curve shifts are generally parallel, with some steepening and flattening, especially for maturities beyond a few years.

Exhibit 8 also illustrates how to reduce **structural risk** to an immunizing strategy. Structural risk arises from portfolio design, particularly the choice of the portfolio allocations. The risk is that yield curve twists and non-parallel shifts lead to changes in the cash flow yield that do not match the yield to maturity of the zero-coupon bond that provides for perfect immunization. Structural risk is reduced by minimizing the dispersion of the bond positions, going from a barbell design to more of a bullet portfolio that concentrates the component bonds' durations around the investment horizon. At the limit, a zero-coupon bond that matches the date of the single obligation has, by design, no structural risk.

Equation 1 indicates that minimizing portfolio dispersion is the same as minimizing the portfolio convexity for a given Macaulay duration and cash flow yield. An advantage to using convexity to measure the extent of structural risk is that the portfolio statistic can be approximated by the market value weighted average of the individual bonds' convexities. A problem with estimating portfolio dispersion using the dispersion statistics for individual bonds is that it can be misleading. Consider a portfolio of all zero-coupon bonds of varying maturities. Each individual bond has zero dispersion (because it has only one payment), so the market value weighted average is also zero. Clearly, the portfolio overall can have significant (non-zero) dispersion.

In summary, the characteristics of a bond portfolio structured to immunize a single liability are that it (1) has an initial market value that equals or exceeds the present value of the liability; (2) has a portfolio Macaulay duration that matches the liability's due date; and (3) minimizes the portfolio convexity statistic. This portfolio must be regularly rebalanced over the horizon to maintain the target duration, because the portfolio Macaulay duration changes as time passes and as yields change. The portfolio manager needs to weigh the trade-off between incurring transactions costs from rebalancing and allowing some duration gap. This and other risks to immunization—for instance, those arising from the use of interest rate derivatives to match the duration of assets to the investment horizon—are covered in Section 6.

EXAMPLE 2

An institutional client asks a fixed-income investment adviser to recommend a portfolio to immunize a single 10-year liability. It is understood that the chosen portfolio will need to be rebalanced over time to maintain its target duration. The adviser proposes two portfolios of coupon-bearing government bonds because zero-coupon bonds are not available. The portfolios have the same market value.

The institutional client's objective is to minimize the variance in the realized rate of return over the 10-year horizon. The two portfolios have the following risk and return statistics:

	Portfolio A	Portfolio B
Cash flow yield	7.64%	7.65%
Macaulay duration	9.98	10.01
Convexity	107.88	129.43

These statistics are based on aggregating the interest and principal cash flows for the bonds that constitute the portfolios; they are not market value weighted averages of the yields, durations, and convexities of the individual bonds. The cash flow yield is stated on a semi-annual bond basis, meaning an annual percentage rate having a periodicity of two; the Macaulay durations and convexities are annualized.

Indicate the portfolio that the investment adviser should recommend, and explain the reasoning.

Solution:

The adviser should recommend Portfolio A. First, notice that the cash flow yields of both portfolios are virtually the same and that both portfolios have Macaulay durations very close to 10, the horizon for the liability. It would be wrong and misleading to recommend Portfolio B because it has a "higher yield" and a "duration closer to the investment horizon of 10 years." In practical terms, a difference of 1 bp in yield is not likely to be significant, nor is the difference of 0.03 in annual duration.

Given the fact that the portfolio yields and durations are essentially the same, the choice depends on the difference in convexity. The difference between 129.43 and 107.88, however, is meaningful. In general, convexity is a desirable property of fixed-income bonds. All else being equal (meaning the same yield and duration), a more convex bond gains more if the yield goes down and loses less if the yield goes up than a less convex bond.

The client's objective, however, is to minimize the variance in the realized rate of return over the 10-year horizon. That objective indicates a conservative immunization strategy achieved by building the duration matching portfolio and minimizing the portfolio convexity. Such an approach minimizes the dispersion of cash flows around the Macaulay duration and makes the portfolio closer to the zero-coupon bond that would provide perfect immunization; see Equation 1.

The structural risk to the immunization strategy is the potential for non-parallel shifts and twists to the yield curve, which lead to changes in the cash flow yield that do not track the change in the yield on the zero-coupon bond. This risk is minimized by selecting the portfolio with the lower convexity (and dispersion of cash flows).

Note that default risk is neglected in this discussion because the portfolio consists of government bonds that presumably have default probabilities approaching zero.

4 INTEREST RATE IMMUNIZATION—MANAGING THE INTEREST RATE RISK OF MULTIPLE LIABILITIES

The principle of interest rate immunization applies to multiple liabilities in addition to a single liability. For now, we continue to assume that these are Type I cash flows in that the scheduled amounts and payment dates are known to the asset manager. In particular, we assume that the same three bonds from Exhibits 3 and 4, which were assets in the single-liability immunization, are now themselves liabilities to be immunized. This assumption allows us to use the same portfolio statistics as in the previous section. The entity in the examples that follow seeks to immunize the cash flows in column 3 (the cash flow column) of Exhibit 4 from Dates 1 through 20, and so needs to build a portfolio of assets that will allow it to pay those cash flows. The present value of the (now) corporate debt liabilities is EUR 200,052,250. As in Section 3, the cash flow yield is 3.76%; the Macaulay duration is 6.00; and the convexity is 45.54. We use the portfolio statistics rather than the market value weighted averages because they better summarize Type I liabilities.

In this section, we discuss several approaches to manage these liabilities:

- *Cash flow matching*, which entails building a dedicated portfolio of zero-coupon or fixed-income bonds to ensure that there are sufficient cash inflows to pay the scheduled cash outflows;
- *Duration matching*, which extends the ideas of the previous section to a portfolio of debt liabilities;
- *Derivatives overlay*, in particular using futures contracts on government bonds in the immunization strategy; and
- *Contingent immunization*, which allows for active bond portfolio management until a minimum threshold is reached and that threshold is identified by the interest rate immunization strategy.

4.1 Cash Flow Matching

A classic strategy to eliminate the interest rate risk arising from multiple liabilities is to build a dedicated asset portfolio of high-quality fixed-income bonds that, as closely as possible, matches the amount and timing of the scheduled cash outflows. "Dedicated" means that the bonds are placed in a held-to-maturity portfolio. A natural question is, if the entity has enough cash to build the dedicated bond portfolio, why not just use that cash to buy back and retire the liabilities? The answer is that the buyback strategy is difficult and costly to implement if the bonds are widely held by buy-and-hold institutional and retail investors. Most corporate bonds are rather illiquid, so buying them back on the open market is likely to drive up the purchase price. Cash flow matching can be a better use of the available cash assets.

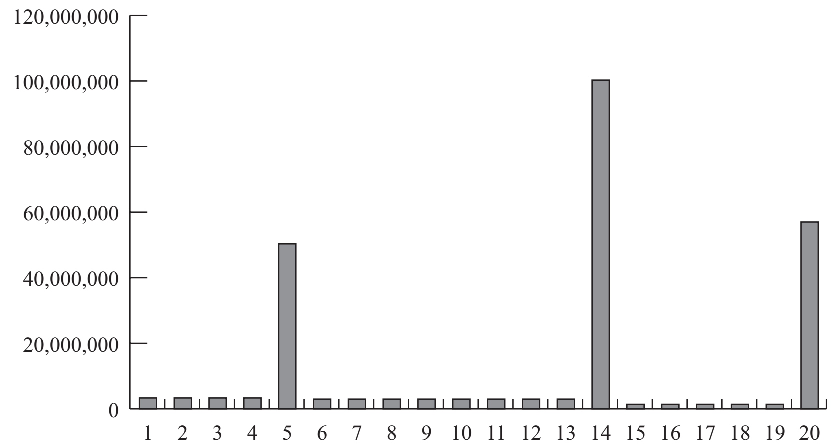
A corporate finance motivation for cash flow matching is to improve the company's credit rating. The entity has sufficient cash assets to retire the debt liabilities, and dedicating the bonds effectively accomplishes that objective. Under some circumstances, a corporation might even be able to remove both the dedicated asset portfolio and the debt liabilities from its balance sheet through the process of **accounting defeasance**.

Also called in-substance defeasance, accounting defeasance is a way of extinguishing a debt obligation by setting aside sufficient high-quality securities, such as US Treasury notes, to repay the liability.[10]

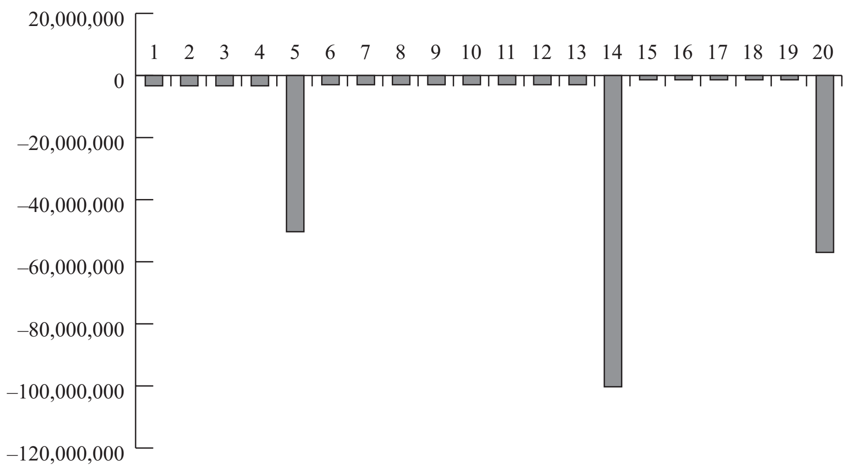
Panel A in Exhibit 9 illustrates the dedicated cash flow matching asset portfolio. These assets could be zero-coupon bonds or traditional fixed-income securities. Panel B represents the amount and timing of the debt liabilities. The amounts come from the third column in Exhibit 4 and are the sum of the coupon and principal payments on the three debt securities.

Exhibit 9 Cash Flow Matching

A. Dedicated Assets



B. Debt Liabilities



A concern when implementing this strategy is the *cash-in-advance constraint*. That means securities are not sold to meet obligations; instead sufficient funds must be available on or before each liability payment date to meet the obligation. The design of traditional bonds—a fixed coupon rate and principal redemption at maturity—is a problem if the liability stream, unlike in Exhibit 9, is a level payment annuity. That

10 Note that the mention of defeasance is intended to motivate the passive fixed income strategies and not to teach the accounting for such transactions.

scenario could lead to large cash holdings between payment dates and, therefore, cash flow reinvestment risk, especially if yields on high-quality, short-term investments are low (or worse, negative).

EXAMPLE 3

Alfred Simonsson is assistant treasurer at a Swedish lumber company. The company has sold a large tract of land and now has sufficient cash holdings to retire some of its debt liabilities. The company's accounting department assures Mr. Simonsson that its external auditors will approve of a defeasement strategy if Swedish government bonds are purchased to match the interest and principal payments on the liabilities. Following is the schedule of payments due on the debt as of June 2017 that the company plans to defease:

June 2018	SEK 3,710,000
June 2019	SEK 6,620,000
June 2020	SEK 4,410,000
June 2021	SEK 5,250,000

The following Swedish government bonds are available. Interest on the bonds is paid annually in May of each year.

Coupon Rate	Maturity Date
2.75%	May 2018
3.50%	May 2019
4.75%	May 2020
5.50%	May 2021

How much in par value for each government bond will Mr. Simonsson need to buy to defease the debt liabilities, assuming that the minimum denomination in each security is SEK 10,000?

Solution:

The cash flow matching portfolio is built by starting with the last liability of SEK 5,250,000 in June 2021. If there were no minimum denomination, that liability could be funded with the 5.50% bonds due May 2021 having a par value of SEK 4,976,303 (= SEK 5,250,000/1.0550). To deal with the constraint, however, Mr. Simonsson buys SEK 4,980,000 in par value. That bond pays SEK 5,253,900 (= SEK 4,980,000 × 1.0550) at maturity. This holding also pays SEK 273,900 (= SEK 4,980,000 × 0.0550) in coupon interest in May 2018, 2019, and 2020.

Then move to the June 2020 obligation, which is SEK 4,136,100 after subtracting the SEK 273,900 received on the 5.50% bond: SEK 4,410,000 – SEK 273,900 = SEK 4,136,100. Mr. Simonsson buys SEK 3,950,000 in par value of the 4.75% bond due May 2020. That bond pays SEK 4,137,625 (= SEK 3,950,000 × 1.0475) at maturity and SEK 187,625 in interest in May 2018 and 2019.

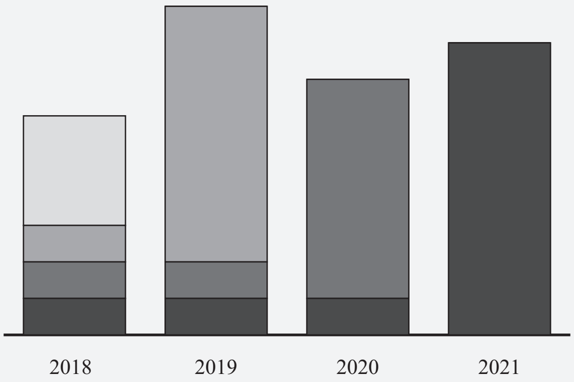
The net obligation in June 2019 is SEK 6,158,475 (= SEK 6,620,000 – SEK 273,900 – SEK 187,625) after subtracting the interest received on the longer-maturity bonds. The company can buy SEK 5,950,000 in par value of the 3.50% bond due May 2019. At maturity, this bond pays SEK 6,158,250 (= SEK 5,950,000 × 1.0350). The small shortfall of SEK 225 (= SEK 6,158,475 – SEK 6,158,250) can be made up because the funds received in May are reinvested until June. This bond also pays SEK 208,250 in interest in May 2018.

Finally, Mr. Simonsson needs to buy SEK 2,960,000 in par value of the 2.75% bond due May 2018. This bond pays SEK 3,041,400 (= SEK 2,960,000 × 1.0275) in May 2018. The final coupon and principal, plus the interest on the 5.50%, 4.75%, and 3.50% bonds, total SEK 3,711,175 (= SEK 3,041,400 + SEK 273,900 + SEK 187,625 + SEK 208,250). That amount is used to pay off the June 2018 obligation of SEK 3,710,000. Note that the excess could be kept in a bank account to cover the 2019 shortfall.

In sum, Mr. Simonsson buys the following portfolio:

Bond	Par Value
2.75% due May 2018	SEK 2,960,000
3.50% due May 2019	SEK 5,950,000
4.75% due May 2020	SEK 3,950,000
5.50% due May 2021	SEK 4,980,000

The following chart illustrates the cash flow matching bond portfolio: Each bar represents the par amount of a bond maturing in that year plus coupon payments from bonds maturing in later years. For example, the 2018 bar has SEK 2.96 million of the 2.75% bond maturing that year, plus coupon payments from the 2019 3.5% bond, 2020 4.75% bond, and 2021 5.5% bond.



4.2 Duration Matching

Duration matching to immunize multiple liabilities is based on similar principles to those covered in the previous section for a single liability. A portfolio of fixed-income bonds is structured and managed to track the performance of the zero-coupon bonds that would perfectly lock in the rates of return needed to pay off the corporate debt liabilities identified in Exhibit 4. In the case of a single liability, the immunization strategy is to match the portfolio Macaulay duration with the investment horizon. Also, the initial investment needs to match (or exceed) the present value of the liability. These two conditions can be combined to prescribe that the money duration of the immunizing portfolio matches the money duration of the debt liabilities. Money duration, often called "dollar duration" in North America, is the portfolio modified duration multiplied by the market value. The modified duration is the portfolio Macaulay duration divided by one plus the cash flow yield per period. With multiple liabilities, matching money durations is useful because the market values and cash flow yields of the assets and liabilities are not necessarily equal.

The money duration for the debt liabilities is EUR 1,178,237,935:

$$\left[\frac{6.0004}{\left(1+\frac{0.037608}{2}\right)}\right] \times 200{,}052{,}250 = 1{,}178{,}237{,}935$$

The term in brackets is the annualized modified duration for the bond portfolio. To keep the numbers manageable, we use the basis point value (BPV) measure for money duration. This measure is the money duration multiplied by 1 bp. The BPV is EUR 117,824 (= EUR 1,178,237,935 × 0.0001). For each 1 bp change in the cash flow yield, the market value changes by approximately EUR 117,824. It is an approximation because convexity is not included. A closely related risk measure is the present value of a basis point (PVBP), also called the PV01 (present value of an "01", meaning 1 bp) and, in North America, the DV01 (dollar value of an "01").

Exhibit 10 shows the three bonds purchased by the asset manager on 15 February 2017. The total cash outlay on that date is EUR 202,224, 094 (= EUR 41,772,719 + EUR 99,750,000 + EUR 60,701,375 = the market values of the three bonds). Exhibit 11 presents the table used to calculate the cash flow yield and the risk statistics. The annualized cash flow yield is 3.5822%. It is the internal rate of return on the cash flows in the second column of Exhibit 11, multiplied by two. The annualized Macaulay duration for the portfolio is 5.9308 (= 11.8615/2) and the modified duration is 5.8264 (= 5.9308/[1 + 0.035822/2]). The annualized dispersion and convexity statistics are 12.3048 (= 49.2194/4) and 48.6846 (= $\{201.7767/[1 + 0.035822/2]^2\}/4$), respectively. Notice that the first few cash flows for the assets in Exhibit 11 are less than the liability payments in Exhibit 4. That disparity indicates that some of the bonds held in the asset portfolio will need to be sold to meet the obligations.

Exhibit 10 The Bond Portfolio to Immunize the Multiple Liabilities

	1.5-Year Bond	6-Year Bond	11.5-Year Bond
Coupon rate	1.00%	2.875%	4.50%
Maturity date	15 August 2018	15 February 2023	15 August 2028
Price	99.875	99.75	100.25
Yield to maturity	1.0842%	2.9207%	4.4720%
Par value	41,825,000	100,000,000	60,550,000
Market value	41,772,719	99,750,000	60,701,375
Macaulay duration	1.493	5.553	9.105
Convexity	2.950	34.149	96.056
Allocation	20.657%	49.326%	30.017%

Exhibit 11 Portfolio Statistics

Time	Date	Cash Flow	PV of Cash Flow	Weight	Time × Weight	Dispersion	Convexity
0	15-Feb-17	–202,224,094					
1	15-Aug-17	3,009,000	2,956,054	0.0146	0.0146	1.7245	0.0292
2	15-Feb-18	3,009,000	2,904,040	0.0144	0.0287	1.3966	0.0862

Exhibit 11 (Continued)

Time	Date	Cash Flow	PV of Cash Flow	Weight	Time × Weight	Dispersion	Convexity
3	15-Aug-18	44,834,000	42,508,728	0.2102	0.6306	16.5068	2.5225
4	15-Feb-19	2,799,875	2,607,951	0.0129	0.0516	0.7970	0.2579
5	15-Aug-19	2,799,875	2,562,062	0.0127	0.0633	0.5965	0.3801
6	15-Feb-20	2,799,875	2,516,981	0.0124	0.0747	0.4276	0.5228
7	15-Aug-20	2,799,875	2,472,692	0.0122	0.0856	0.2890	0.6847
8	15-Feb-21	2,799,875	2,429,183	0.0120	0.0961	0.1791	0.8649
9	15-Aug-21	2,799,875	2,386,440	0.0118	0.1062	0.0966	1.0621
10	15-Feb-22	2,799,875	2,344,449	0.0116	0.1159	0.0402	1.2753
11	15-Aug-22	2,799,875	2,303,196	0.0114	0.1253	0.0085	1.5034
12	15-Feb-23	102,799,875	83,075,901	0.4108	4.9297	0.0079	64.0865
13	15-Aug-23	1,362,375	1,081,607	0.0053	0.0695	0.0069	0.9734
14	15-Feb-24	1,362,375	1,062,575	0.0053	0.0736	0.0240	1.1034
15	15-Aug-24	1,362,375	1,043,878	0.0052	0.0774	0.0508	1.2389
16	15-Feb-25	1,362,375	1,025,510	0.0051	0.0811	0.0869	1.3794
17	15-Aug-25	1,362,375	1,007,465	0.0050	0.0847	0.1315	1.5245
18	15-Feb-26	1,362,375	989,738	0.0049	0.0881	0.1844	1.6738
19	15-Aug-26	1,362,375	972,323	0.0048	0.0914	0.2450	1.8271
20	15-Feb-27	1,362,375	955,214	0.0047	0.0945	0.3129	1.9839
21	15-Aug-27	1,362,375	938,406	0.0046	0.0974	0.3875	2.1439
22	15-Feb-28	1,362,375	921,894	0.0046	0.1003	0.4686	2.3067
23	15-Aug-28	61,912,375	41,157,805	0.2035	4.6811	25.2505	112.3462
			202,224,094	1.0000	11.8615	49.2194	201.7767

The market value of the immunizing fixed-income bonds is EUR 202,224,094. That amount is higher than the value of the liabilities, which is EUR 200,052,250. The reason for the difference in market values as of 15 February 2017 is the difference in the cash flow yields. The high-quality assets needed to immunize the corporate liabilities have a cash flow yield of 3.5822%, which is lower than the cash flow yield of 3.7608% on the debt obligations. The assets grow at a lower rate and, therefore, need to start at a higher level. If we discount the debt liabilities scheduled in the third column of Exhibit 4 at 3.5822%, the present value is EUR 202,170,671, indicating that initially, the immunizing portfolio is slightly overfunded. Importantly, the asset portfolio BPV is EUR 117,824 (= 202,224,094 × 5.8264 × 0.0001), matching the BPV for the debt liabilities.

There is another meaningful difference in the structure of the asset and liability portfolios. Although the money durations are the same, the dispersion and convexity statistics for the assets are greater than for the liabilities—12.30 compared with 8.26 for dispersion, and 48.68 compared with 45.54 for convexity. This difference is required to achieve immunization for multiple liabilities. (Mathematically, in the optimization problem to minimize the difference in the change in the values of assets and liabilities, the first derivative leads to matching money duration [or BPV] and the second derivative to having a higher dispersion.) Intuitively, this condition follows from the general result that, for equal durations, a more convex portfolio generally outperforms a less convex portfolio (higher gains if yields fall, lower losses if yields rise). But, as in the case of immunizing a single liability, the dispersion of the assets should be as low as possible subject to being greater than or equal to the dispersion of the liabilities to mitigate the effect of non-parallel shifts in the yield curve. Note that from Equation 1, higher dispersion implies higher convexity when the Macaulay durations and cash flow yields are equal.

Some numerical examples are useful to illustrate that immunization of multiple liabilities is essentially an interest rate risk hedging strategy. The idea is that changes in the market value of the asset portfolio closely match changes in the debt liabilities whether interest rates rise or fall. Exhibit 12 demonstrates this dynamic.

Exhibit 12 Immunizing Multiple Liabilities

Upward Parallel Shift	Immunizing Assets	Debt Liabilities	Difference
ΔMarket value	−2,842,408	−2,858,681	16,273
ΔCash flow yield	0.2437%	0.2449%	−0.0012%
ΔPortfolio BPV	−2,370	−2,207	−163

Downward Parallel Shift	Immunizing Assets	Debt Liabilities	Difference
ΔMarket value	2,900,910	2,913,414	−12,504
ΔCash flow yield	−0.2437%	−0.2449%	0.0012%
ΔPortfolio BPV	2,429	2,256	173

Steepening Twist	Immunizing Assets	Debt Liabilities	Difference
ΔMarket value	−1,178,071	−835,156	−342,915
ΔCash flow yield	0.1004%	0.0711%	0.0293%
ΔPortfolio BPV	−984	−645	−339

Flattening Twist	Immunizing Assets	Debt Liabilities	Difference
ΔMarket value	1,215,285	850,957	364,328
ΔCash flow yield	−0.1027%	−0.0720%	−0.0307%
ΔPortfolio BPV	1,016	658	358

First, we allow the yield curve to shift upward in a parallel manner. The yields on the bonds in Exhibit 10 go up instantaneously by 25 bps on 15 February 2017, immediately after the asset portfolio is purchased. That increase results in a drop in market value of EUR 2,842,408. The yields on the debt liabilities in Exhibit 4 also go up by 25 bps, dropping the market value by EUR 2,858,681. The difference is EUR 16,273, a small amount given that the size of portfolios exceeds EUR 200 million. This scenario implicitly assumes no change in the corporate entity's credit risk. Next, we shift the yield curve downward by 25 bps. Both the asset and liability portfolios gain market value by almost the same amount. The difference is only EUR 12,504.

The driving factor behind the success of the strategy given these upward and downward shifts is that the portfolio durations are matched and changes in the cash flow yields are very close: 24.37 bps for the assets and 24.49 bps for the liabilities.[11] As explained in the previous section, a parallel shift is a sufficient but not necessary condition for immunization. Although not shown in Exhibit 12, an upward non-parallel shift of 15.9 bps in the 1.5-year bond, 23.6 bps in the 6-year bond, and 27.5 bps in the 11.5-year bond leads to virtually the same change in market value (EUR 2,842,308) as the 25 bp parallel shift. Those particular changes are chosen because they result in the same change in the cash flow yield of 24.37 bps.

The structural risk to the immunization strategy is apparent in the third scenario in Exhibit 12. This scenario is the steepening twist in which short-term yields on high-quality bonds go down while long-term yields go up. The 1.5-year yield is assumed to drop by 25 bps. The 6-year yield remains the same, and the 11.5-year yield goes up by 25 bps. These changes lead to a loss of EUR 1,178,071 in the asset portfolio as the cash flow yield increases by 10.04 bps. The maturities of the debt liabilities differ from those of the assets. For simplicity, we assume that those yields change in proportion to the differences in maturity around the six-year pivot point for the twist. The 2.5-year yield drops by 19.44 bps (= 25 bps × 3.5/4.5), the 7-year yield goes up by 4.55 bps (= 25 bps × 1/5.5), and the 10-year by 18.18 bps (= 25 bps × 4/5.5). The market value of the liabilities drops by only EUR 835,156 because the cash flow yield increases by only 7.11 bps. The value of the assets goes down by more than the liabilities—the difference is EUR 342,915. The steepening twist to the shape of the yield curve is the source of the loss.

The results of the fourth scenario show that a flattening twist can lead to a comparable gain if long-term high-quality yields fall while short-term yields rise. We make the same assumptions about proportionate changes in the yields. In this case, the cash flow yield of the assets goes down more and the market value rises higher than the debt liabilities. Clearly, an entity that pursues immunization of multiple liabilities hopes that steepening twists are balanced out by flattening twists and that most yield curve shifts are more or less parallel.

Exhibit 12 also reports the changes in the portfolio BPVs for the assets and liabilities. Before the yield curve shifts and twists, the BPVs are matched at EUR 117,824. Afterward, there is a small money duration mismatch. In theory, the asset manager needs to rebalance the portfolio immediately. In practice, the manager likely waits until the mismatch is large enough to justify the transactions costs in selling some bonds and buying others. Another method to rebalance the portfolio is to use interest rate derivatives.

EXAMPLE 4

A Japanese corporation recently sold one of its lines of business and would like to use the cash to retire the debt liabilities that financed those assets. Summary statistics for the multiple debt liabilities, which range in maturity from three to seven years, are market value, JPY 110.4 billion; portfolio modified duration, 5.84; portfolio convexity, 46.08; and BPV, JPY 64.47 million.

11 The astute reader might have noticed in Exhibit 12 that the asset portfolio rises slightly less than the liabilities when the yield curve shifts down in a parallel manner by 25 bps. Hence, the loss is EUR 12,504 despite the greater convexity of the assets. That disparity is explained by the slightly higher decrease in the cash flow yield on the liabilities.

An investment bank working with the corporation offers three alternatives to accomplish the objective:

1. **Bond tender offer.** The corporation would buy back the debt liabilities on the open market, paying a premium above the market price. The corporation currently has a single-A rating and hopes for an upgrade once its balance sheet is improved by retiring the debt. The investment bank anticipates that the tender offer would have to be at a price commensurate with a triple-A rating to entice the bondholders to sell. The bonds are widely held by domestic and international institutional investors.
2. **Cash flow matching.** The corporation buys a portfolio of government bonds that matches, as closely as possible, the coupon interest and principal redemptions on the debt liabilities. The investment bank is highly confident that the corporation's external auditors will agree to accounting defeasement because the purchased bonds are government securities. That agreement will allow the corporation to remove both the defeasing asset portfolio and the liabilities from the balance sheet.
3. **Duration matching.** The corporation buys a portfolio of high-quality corporate bonds that matches the duration of the debt liabilities. Interest rate derivative contracts will be used to keep the duration on its target as time passes and yields change. The investment bank thinks it is very unlikely that the external auditors will allow this strategy to qualify for accounting defeasement. The corporation can explain to investors and the rating agencies in the management section of its annual report, however, that it is aiming to "effectively defease" the debt. To carry out this strategy, the investment bank suggests three different portfolios of investment-grade corporate bonds that range in maturity from 2 years to 10 years. Each portfolio has a market value of about JPY 115 billion, which is considered sufficient to pay off the liabilities.

	Portfolio A	Portfolio B	Portfolio C
Modified duration	5.60	5.61	5.85
Convexity	42.89	50.11	46.09
BPV (in millions)	JPY 64.50	JPY 64.51	JPY 67.28

After some deliberation and discussion with the investment bankers and external auditors, the corporation's CFO chooses Strategy 3, duration matching.

1. Indicate the likely trade-offs that led the corporate CFO to choose the duration matching strategy over the tender offer and cash flow matching.
2. Indicate the portfolio that the corporation should choose to carry out the duration matching strategy.

Solution to 1:

The likely trade-offs are between removing the debt liabilities from the balance sheet, either by directly buying the bonds from investors or by accounting defeasement via cash flow matching, and the cost of the strategy. The tender offer entails buying the bonds at a triple-A price, which would be considerably higher than at a single-A price. Cash flow matching entails buying even more expensive government bonds. The duration matching strategy can be implemented at a lower cost because the asset portfolio consists of less expensive investment-grade bonds. The CFO has chosen the lowest-cost strategy, even though the debt liabilities will remain on the balance sheet.

Solution to 2:

The corporation should recommend Portfolio B. Portfolio C closely matches the modified duration (as well as the convexity) of the liabilities. Duration matching when the market values of the assets and liabilities differ, however, entails matching the money durations, in particular the BPVs. The choice then comes down to Portfolios A and B. Although both have BPVs close to the liabilities, it is incorrect to choose A based on its BPV being "closer."

The important difference between Portfolios A and B lies in the convexities. To immunize multiple liabilities, the convexity (and dispersion of cash flows) of the assets needs to be greater than the liabilities. Therefore, Portfolio A does not meet that condition.

Recall that in Example 2, the correct immunizing portfolio is the one with the lower convexity, which minimizes the structural risk to the strategy. But, that bond portfolio still has a convexity greater than the zero-coupon bond that would provide perfect immunization. This greater convexity of the immunizing portfolio is because the dispersion of the zero-coupon bond is zero and the durations are the same. As seen in Equation 1, that dispersion implies a lower convexity statistic.

4.3 Derivatives Overlay

Interest rate derivatives can be a cost-effective method to rebalance the immunizing portfolio to keep it on its target duration as the yield curve shifts and twists and as time passes. Suppose that in the duration matching example in Section 4.2, there is a much larger instantaneous upward shift in the yield curve on 15 February 2017. In particular, all yields shift up by 100 bps. Because yields and duration are inversely related, the portfolio duration statistics go down, as does the market value. The BPV of the immunizing asset portfolio decreases from EUR 117,824 to EUR 108,679, a drop of EUR 9,145. The BPV for the debt liabilities goes down to EUR 109,278, a drop of EUR 8,546. There is now a duration gap of –EUR 599 (= EUR 108,679 – EUR 109,278). The asset manager could sell some of the 1%, 1.5-year bonds and buy some more of the 4.50%, 11-year bonds to close the money duration gap. A more efficient and lower-cost rebalancing strategy, however, is likely to buy, or go long, a few interest rate futures contracts to rebalance the portfolio.

To address the question of the required number of contracts to close, or reduce, a duration gap, we change the example from euros to US dollars. Doing so allows us to illustrate the calculations for the required number of futures contracts using the actively traded 10-year US Treasury note futures contract offered at the CME Group. The present value of corporate debt liabilities shown in Exhibits 3 and 4 now is assumed to be USD 200,052,250. Risk and return statistics are invariant to currency denomination, so the portfolio Macaulay duration is still 6.0004 and the BPV is USD 117,824.

Unlike the previous example for duration matching of multiple liabilities, however, we assume that the asset manager buys a portfolio of high-quality, short-term bonds. This portfolio has a market value of USD 222,750,000, Macaulay duration of 0.8532, and cash flow yield of 1.9804%. Discounting the debt liabilities in the third column of Exhibit 4 at 1.9804% gives a present value of USD 222,552,788. This value indicates that the immunizing portfolio is overfunded on 15 February 2017. The BPV for the asset portfolio is USD 18,819:

$$\left[\frac{0.8532}{\left(1+\dfrac{0.019804}{2}\right)}\right] \times 222{,}750{,}000 \times 0.0001 = 18{,}819$$

There are a number of reasons why the asset manager might elect to hold a portfolio of short-term bonds rather than intermediate-term and long-term securities. Perhaps there is much greater liquidity and the perception of finer pricing in the short-term market. Another possibility is that the entity faces liquidity constraints and needs to hold these short-term bonds to meet regulatory requirements. A derivatives overlay strategy is then used to close the duration gap while keeping the underlying portfolio unchanged. In general, a derivatives overlay transforms some aspect of the underlying portfolio—the currency could be changed with foreign exchange derivatives or the credit risk profile with credit default swap contracts. Here, interest rate derivatives are used to change the interest rate risk profile, increasing the portfolio BPV from USD 18,819 to USD 117,824.

Although the details of interest rate futures contracts are covered in other readings, some specific features of the 10-year US Treasury note contract traded at the CME Group are important for this example. Each contract is for USD 100,000 in par value and has delivery dates in March, June, September, and December. The T-notes qualifying for delivery range from 6.5 to 10 years in maturity. (In January 2016, the CME Group introduced the Ultra 10-year contract for which the qualifying T-notes have maturities from 9 years and 5 months to 10 years.) Conversion factors that are used to make the qualifying T-notes roughly equivalent for delivery by the contract seller, or short position, are based on an arbitrary yield to maturity of 6.00%. If the eligible T-note has a coupon rate below (above) 6.00%, the conversion factor is less (more) than 1.0000. The invoice price paid by the buyer of the contract, the long position, at the expiration of the contract is the futures price multiplied by the conversion factor, plus accrued interest. The logic of this design is that if the contract seller chooses to deliver a qualifying T-note having a lower (higher) coupon rate than 6.00%, the buyer pays a lower (higher) price.

The key point is that, although the eligible T-notes are roughly equivalent, one will be identified as the cheapest-to-deliver (CTD) security. Importantly, the duration of the 10-year T-note futures contract is assumed to be the duration of the CTD T-note. A factor in determining the CTD T-note is that the conversion factors for each qualifying security are based on the arbitrary assumption of a 6.00% yield to maturity. In practice, when yields are below 6.00% the CTD security typically is the qualifying T-note having the lowest duration. Therefore, the 10-year T-note futures contract essentially has been acting as a 6.5-year contract. (That explains the motivation for introducing the Ultra 10-year contract—to provide a hedging instrument more closely tied to the 10-year T-note traded in the cash market).

To illustrate the importance of using the risk statistics for the CTD T-note, Exhibit 13 reports two hypothetical qualifying securities for the March 2017 10-year futures contract. One is designated the 6.5-year T-note. It has a coupon rate of 2.75% and matures on 15 November 2023. As of 15 February 2017, it is assumed to be priced to yield 3.8088%. Its BPV per USD 100,000 in par value is USD 56.8727, and its conversion factor is 0.8226. The other is the on-the-run 10-year T-note. Its coupon rate is 4.00%, and it matures on 15 February 2027. Its BPV is USD 81.6607, and its conversion factor is 0.8516.

Exhibit 13 Two Qualifying T-Notes for the March 2017 10-Year T-Note Futures Contract as of 15 February 2017

	6.5-Year T-Note	10-Year T-Note
Coupon rate	2.75%	4.00%
Maturity date	15 November 2023	15 February 2027
Full price per 100,000 in par value	USD 94,449	USD 99,900

Exhibit 13 (Continued)

	6.5-Year T-Note	10-Year T-Note
Yield to maturity	3.8088%	4.0122%
Modified duration	6.0215	8.1742
BPV per 100,000 in par value	56.8727	81.6607
Conversion factor	0.8226	0.8516

The calculation of the required number of futures contract, denoted N_f, comes from this relationship:

$$\text{Asset portfolio BPV} + (N_f \times \text{Futures BPV}) = \text{Liability portfolio BPV} \tag{2}$$

Inherent in this expression is the important idea that, although futures contracts have a market value of zero as a result of daily mark-to-market valuation and settlement, they can add to or subtract from the asset portfolio BPV. This equation can be rearranged to isolate N_f:

$$N_f = \frac{\text{Liability portfolio BPV} - \text{Asset portfolio BPV}}{\text{Futures BPV}} \tag{3}$$

If N_f is a positive number, the asset manager buys, or goes long, the required number of futures contracts. Doing so raises the money duration of the assets to match that of the liabilities. If N_f is a negative number, the asset manager sells, or goes short, futures contracts to reduce the money duration. In our problem, the asset portfolio BPV is USD 18,819 and the liability portfolio BPV is USD 117,824. Therefore, N_f is a large positive number and depends on the BPV for the futures contract. The exact formulation for the Futures BPV is complicated, however, and goes beyond the scope of this reading. It involves details such as the number of days until the expiration of the contract, the interest rate for that period, and the accrued interest on the deliverable bond. To simplify, we use an approximation formula that is common in practice:

$$\text{Futures BPV} \approx \frac{\text{BPV}_{\text{CTD}}}{\text{CF}_{\text{CTD}}} \tag{4}$$

where CF_{CTD} is the conversion factor for the CTD security. (In interest futures markets that do not have a CTD security, the Futures BPV is simply the BPV of the deliverable bond.)

If the CTD security is the 6.5-year T-note shown in Exhibit 13, the Futures BPV is estimated to be USD 69.1377 (= 56.8727/0.8226). Then the required number of contracts is approximately 1,432:

$$\frac{117{,}824 - 18{,}819}{69.1377} = 1{,}432$$

But, if the CTD security is the 10-year T-note, the Futures BPV is USD 95.8909 (= 81.6607/0.8516). To close the money duration gap, the required number of contracts is only 1,032.

$$\frac{117{,}824 - 18{,}819}{95.8909} = 1{,}032$$

Clearly, the asset manager must know the CTD T-note to use in the derivatives overlay strategy. The difference of 400 futures contracts is significant.

The asset manager has established a synthetic "barbell" strategy having positions in the short-term and longer-term segments of the yield curve. The term "synthetic" means "created with derivatives." The underlying asset portfolio is concentrated in the short-term market. The derivatives portfolio is either at the 6.5-year or 10-year segment of the yield curve. There also are actively traded two-year and five-year Treasury futures contracts at CME Group. Therefore, the asset manager could choose to spread out the futures contracts across other segments of the yield curve. That diversification reduces the structural risk to the immunization strategy arising from non-parallel shifts and twists to the curve.

EXAMPLE 5

A Frankfurt-based asset manager uses the Long Bund contract traded at the Intercontinental Exchange (ICE) futures exchange to manage the gaps that arise from "duration drift" in a portfolio of German government bonds that are used to immunize a portfolio of corporate debt liabilities. This futures contract has a notional principal of EUR 100,000 and a 6% coupon rate. The German government bonds that are eligible for delivery have maturities between 8.5 years and 10.5 years.

Currently, the corporate debt liabilities have a market value of EUR 330,224,185, a modified duration of 7.23, and a BPV of EUR 238,752. The asset portfolio has a market value of EUR 332,216,004, a modified duration of 7.42, and a BPV of EUR 246,504. The duration drift has arisen because of a widening spread between corporate and government bond yields as interest rates in general have come down. The lower yields on government bonds have increased the modified durations relative to corporates.

Based on the deliverable bond, the asset manager estimates that the BPV for each futures contract is EUR 65.11.

1 Does the asset manager go long (buy) or go short (sell) the futures contract?
2 How many contracts does the manager buy or sell to close the duration gap?

Solution to 1:

The money duration of the assets, as measured by the BPV, is greater than the money duration of debt liabilities. This relationship is true of the modified duration statistics as well, but the money duration is a better measure of the gap because the market values differ. The asset manager needs to go short (or sell) Long Bund futures contracts.

Solution to 2:

Use Equation 3 to get the requisite number of futures contracts to sell.

$$N_f = \frac{\text{Liability portfolio BPV} - \text{Asset portfolio BPV}}{\text{Futures BPV}}$$

where Liability portfolio BPV = 238,752, Asset portfolio BPV = 246,504, and Futures BPV = 65.11.

$$N_f = \frac{238{,}752 - 246{,}504}{65.11} = -119.06$$

The minus sign indicates the need to go short (or sell) 119 contracts to close the duration gap.

4.4 Contingent Immunization

The last two examples illustrate that the initial market value for the immunizing asset portfolio can vary according to the strategy chosen by the asset manager. In the duration matching example, the initial market value of the asset portfolio is EUR 202,224,094, while the liabilities are EUR 200,052,250. The derivatives overlay example is to hold a portfolio of short-term bonds having a market value of USD 222,750,000 and 1,432 10-year futures contracts (assuming that the CTD eligible security is the 6.5-year T-note) to immunize the liability of USD 200,052,250.

The difference between the market values of the assets and liabilities is the **surplus**. The initial surplus in the duration matching example is EUR 2,171,844 (= EUR 202,224,094 – EUR 200,052,250); the surplus in the derivatives overlay example is USD 22,697,750 (= EUR 222,750,000 –EUR 200,052,250). The presence of a significant surplus allows the asset manager to consider a hybrid passive–active strategy known as **contingent immunization**. The idea behind contingent immunization is that the asset manager can pursue active investment strategies, as if operating under a total return mandate, as long as the surplus is above a designated threshold. If the actively managed assets perform poorly, however, and the surplus evaporates, the mandate reverts to the purely passive strategy of building a duration matching portfolio and then managing it to remain on duration target.

In principle, the available surplus can be deployed into any asset category, including equity, fixed income, and alternative investments. The surplus could be used to buy out-of-the-money commodity option contracts or credit default swaps. The objective is to attain gains on the actively managed funds in order to reduce the cost of retiring the debt obligations. Obviously, liquidity is an important criterion in selecting the investments because the positions would need to be unwound if losses cause the surplus to near the threshold.

A natural setting for contingent immunization is in the fixed-income derivatives overlay strategy. Instead of buying, or going long, 1,432 10-year T-note futures contracts, the asset manager could intentionally over-hedge or under-hedge, depending on the held view on rate volatility at the 6.5-year segment of the Treasury yield curve. That segment matters because the 10-year T-note futures contract price responds to changes in the yield of the CTD security. The asset manager could buy more (less) than 1,432 contracts if she expects the 6.5-year Treasury yield to go down (up) and the futures price to go up (down).

Suppose that on 15 February 2017, the price of the March 10-year T-note futures contract is quoted to be 121-03. The price is 121 and 3/32 percent of USD 100,000, which is the contract size. Therefore, the delivery price in March would be USD 121,093.75 multiplied by the conversion factor, plus the accrued interest. What matters to the asset manager is the change in the settlement futures price from day to day. For each futures contract, the gain or loss is USD 31.25 for each 1/32nd change in the futures price, calculated as 1/32 percent of USD 100,000.

Now suppose that the asset manager anticipates an upward shift in the yield curve. Such a shift would cause bond prices to drop in both the Treasury cash and futures markets. Suppose that the quoted March futures price drops from 121-03 to 119-22. That is a 45/32nd change in the price and causes a loss of USD 1,406.25 (= 45 × USD 31.25) per contract. If the asset manager holds 1,432 long contracts, the loss that day is USD 2,013,750 (= USD 1,406.25 × 1,432). But if the asset manager is allowed to under-hedge, he could have dramatically reduced the number of long futures contracts and maybe even gone short in anticipation of the upward shift. The presence of the surplus allows the manager the opportunity to take a view on interest rates and save some of the cost of the strategy to retire the debt liabilities. The objective is to be over-hedged when yields are expected to fall and under-hedged when they are expected to rise.

EXAMPLE 6

An asset manager is asked to build and manage a portfolio of fixed-income bonds to retire multiple corporate debt liabilities. The debt liabilities have a market value of GBP 50,652,108, a modified duration of 7.15, and a BPV of GBP 36,216.

The asset manager buys a portfolio of British government bonds having a market value of GBP 64,271,055, a modified duration of 3.75, and a BPV of GBP 24,102. The initial surplus of GBP 13,618,947 and the negative duration gap of GBP 12,114 are intentional. The surplus allows the manager to pursue a contingent immunization strategy to retire the debt at, hopefully, a lower cost than a more conservative duration matching approach. The duration gap requires the manager to buy, or go long, interest rate futures contracts to close the gap. The manager can choose to over-hedge or under-hedge, however, depending on market circumstances.

The futures contract that the manager buys is based on 10-year gilts having a par value of GBP 100,000. It is estimated to have a BPV of GBP 98.2533 per contract. Currently, the asset manager has purchased, or gone long, 160 contracts.

Which statement *best* describes the asset manager's hedging strategy and the held view on future 10-year gilt interest rates? The asset manager is:

A over-hedging because the rate view is that 10-year yields will be rising.

B over-hedging because the rate view is that 10-year yields will be falling.

C under-hedging because the rate view is that 10-year yields will be rising.

D under-hedging because the rate view is that 10-year yields will be falling.

Solution:

B is correct. The asset manager is over-hedging because the rate view is that 10-year yields will be falling. First calculate the number of contracts (N_f) needed to fully hedge (or immunize) the debt liabilities. The general relationship is Equation 2: Asset portfolio BPV + (N_f × Futures BPV) = Liability portfolio BPV.

Asset portfolio BPV is GBP 24,102; Futures BPV is 98.2533; and Liability portfolio BPV is 36,216.

$$24{,}102 + (N_f \times 98.2533) = 36{,}216$$
$$N_f = 123.3$$

The asset manager is over-hedging because a position in 160 long futures contracts is more than what is needed to close the duration gap. Long, or purchased, positions in interest rate futures contracts gain when futures prices rise and rates go down. The anticipated gains from the strategic decision to over-hedge in this case further increase the surplus and reduce the cost of retiring the debt liabilities.

5 LIABILITY-DRIVEN INVESTING—AN EXAMPLE OF A DEFINED BENEFIT PENSION PLAN

In Section 2, we introduced four types of liabilities: Types I, II, III, and IV. In Sections 3 and 4, we looked at Type I liabilities for which the amount and timing of cash flows are known to the asset manager. That knowledge allows the manager to consider immunization strategies using yield duration statistics such as Macaulay, modified, and money duration. An example of a Type II liability is a callable bond. The corporate issuer knows that the bond can be repurchased at the preset call prices on the call dates and, if it is not called, that it will be redeemed at par value at maturity. A floating-rate note is an example of a Type III liability. The issuer knows the interest payment dates but not the amounts, which are linked to future rates. Models are needed to project the amounts and dates of the cash flows and to calculate the effective durations of the callable and floating-rate securities. Because there are no well-defined yields to maturity as a result of the uncertain amounts and timing of cash flows, yield duration statistics such as Macaulay and modified duration do not apply.

Defined benefit pension plan obligations are a good example of Type IV liabilities for which both the amounts and dates are uncertain.[12] An LDI strategy for this entity starts with a model for these liabilities. We reveal some of the assumptions that go into this complex financial modeling problem by assuming the work history and retirement profile for a representative employee covered by the pension plan. We assume that this employee has worked for G years, a sufficient length of time to ensure that the retirement benefits are vested. The employee is expected to work for another T years and then to retire and live for Z years. Exhibit 14 illustrates this time line.

Exhibit 14 Time Line Assumptions for the Representative Employee

Although there are many types of pension plans worldwide, here we model a final-pay US defined benefit plan. In principle, the same type of model can be built to illustrate retirement obligations in other countries. In this example, the retired employee receives a fixed lifetime annuity based on her wage at the time of retirement, denoted W_T. Some pension plans index the annual retirement benefit to inflation. Our example assumes an annuity fixed in nominal terms, calculated as the final wage, W_T, multiplied by a multiplier, m, multiplied by the total number of years worked, $G + T$.

There are two general measures of the retirement obligations as of Time 0—the accumulated benefit obligation (ABO) and the projected benefit obligation (PBO). The ABO calculates the liability based on the G years worked and the current annual wage, denoted W_0, even though the annuity paid in retirement is based on W_T and $G + T$ years. The use of the current annual wage and the number of years worked is because the ABO represents the *legal liability* today of the plan sponsor if the plan were to be closed or converted to another type of plan, such as a defined contribution plan. The ABO is the present value of the annuity, discounted at an annual rate r on high-quality corporate bonds,[13] which for simplicity we assume applies for all periods (a flat yield curve).

$$\text{ABO} = \frac{1}{(1+r)^T} \times \left[\frac{m \times G \times W_0}{1+r} + \frac{m \times G \times W_0}{(1+r)^2} + \cdots + \frac{m \times G \times W_0}{(1+r)^Z}\right]$$

The term in brackets is the value of the Z-year annuity as of year T, and that sum is discounted back over T years to Time 0.

12 This section is based on Adams and Smith (2009).

13 In the United States, government regulators and the accounting authorities allow high-quality corporate bonds to be used to discount the future liabilities.

The PBO liability measure uses the projected wage for year T instead of the current wage in the Z-year annuity.

$$\text{PBO} = \frac{1}{(1+r)^T} \times \left[\frac{m \times G \times W_T}{1+r} + \frac{m \times G \times W_T}{(1+r)^2} + \cdots + \frac{m \times G \times W_T}{(1+r)^Z}\right]$$

Although the ABO is the legal obligation to the plan sponsor, the PBO is the liability reported in financial statements and used to assess the plan's funding status. The plan is over-funded (under-funded) if the current fair value of assets is more (less) than the present value of the promised retirement benefits.

The next step is to consider how wages evolve between dates 0 and T. We denote w to be the average annual wage growth rate for the employee's remaining work life of T years. Therefore, the relationship between W_0 and W_T is $W_T = W_0 \times (1 + w)^T$.

After some algebraic manipulation and substitution, the two liability measures can be written more compactly as follows:

$$\text{ABO} = \frac{m \times G \times W_0}{(1+r)^T} \times \left[\frac{1}{r} - \frac{1}{r \times (1+r)^Z}\right]$$

$$\text{PBO} = \frac{m \times G \times W_0 \times (1+w)^T}{(1+r)^T} \times \left[\frac{1}{r} - \frac{1}{r \times (1+r)^Z}\right]$$

Note that the PBO always will be larger than the ABO by the factor of $(1 + w)^T$, assuming positive wage growth in nominal terms.[14]

We see in this simple model several of the important assumptions that go into using an LDI strategy to manage these Type IV liabilities. The assumed post-retirement lifetime (Z years) is critical. A higher value for Z increases both the ABO and PBO measures of liability. The pension plan faces *longevity risk*, which is the risk that employees live longer in their retirement years than assumed in the models. Some plans have become under-funded and have had to increase assets because regulators required that they recognize longer life expectancies. Another important assumption is the time until retirement (T years). In the ABO measure, increases in T reduce the liability. That result also holds for the PBO as long as w is less than r. Assuming w is less than r is reasonable if it can be assumed that employees over time generally are compensated for price inflation and some part of real economic growth, as well as for seniority and productivity improvements, but overall the labor income growth rate does not quite keep pace with the nominal return on high-quality financial assets.

We now use a numerical example to show how the effective durations of ABO and PBO liability measures are calculated. Assume that $m = 0.02$, $G = 25$, $T = 10$, $Z = 17$, W_0 = USD 50,000 and $r = 0.05$. We also assume that the wage growth rate w is an arbitrarily chosen constant fraction of the yield on high-quality corporate bonds r—in particular, that $w = 0.9 \times r$ so that $w = 0.045$ (= 0.9 × 0.05). Based on these assumptions, the ABO and PBO for the representative employee are USD 173,032 and USD 268,714, respectively.

$$\text{ABO} = \frac{0.02 \times 25 \times 50{,}000}{(1.05)^{10}} \times \left[\frac{1}{0.05} - \frac{1}{0.05 \times (1.05)^{17}}\right] = 173{,}032$$

14 The second term to the right of the equal sign in the foregoing expressions may be familiar to readers as the present value factor for an annuity.

$$\text{PBO} = \frac{0.02 \times 25 \times 50{,}000 \times (1.045)^{10}}{(1.05)^{10}} \times \left[\frac{1}{0.05} - \frac{1}{0.05 \times (1.05)^{17}}\right] = 268{,}714$$

If the plan covers 10,000 similar employees, the total liability is approximately USD 1.730 billion ABO and USD 2.687 billion PBO. Assuming that the pension plan has assets with a market value of USD 2.700 billion, the plan currently is overfunded by both measures of liability.

In general, the effective durations for assets or liabilities are obtained by raising and lowering the assumed yield curve in the valuation model and recalculating the present values.

$$\text{Effective duration} = \frac{(\text{PV}_{-}) - (\text{PV}_{+})}{2 \times \Delta\text{Curve} \times (\text{PV}_0)} \tag{5}$$

PV_0 is the initial value, PV_{-} is the new value after the yield curve is lowered by ΔCurve, and PV_{+} is the value after the yield curve is raised. In this simple model with a flat yield curve, we raise *r* from 0.05 to 0.06 (and *w* from 0.045 to 0.054) and lower *r* from 0.05 to 0.04 (and *w* from 0.045 to 0.036). Therefore, ΔCurve = 0.01. A more realistic model would have shape to the yield curve and include the interaction of a yield change on other variables. For example, an increase in yields on high-quality financial assets could be modeled to shorten the time to retirement.

Given our assumptions, ABO_0 is USD 173,032. Redoing the calculations for the higher and lower values for *r* and *w* gives USD 146,261 for ABO_{+} and USD 205,467 for ABO_{-}. The ABO effective duration is 17.1.

$$\text{ABO duration} = \frac{205{,}467 - 146{,}261}{2 \times 0.01 \times 173{,}032} = 17.1$$

Repeating the calculations for the PBO liability measure gives USD 247,477 for PBO_{+} and USD 292,644 for PBO_{-}. Given that PBO_0 is 268,714, the PBO duration is 8.4.

$$\text{PBO} = \frac{292{,}644 - 247{,}477}{2 \times 0.01 \times 268{,}714} = 8.4$$

These calculations indicate the challenge facing the fund manager. There is a significant difference between having liabilities of USD 1.730 billion and an effective duration of 17.1, as measured by the ABO, and liabilities of USD 2.687 billion and an effective duration of 8.4, as measured by the PBO. The ABO BPV is USD 2,958,300 (= USD 1.730 billion × 17.1 × 0.0001), and the PBO BPV is USD 2,257,080 (= USD 2.687 billion × 8.4 × 0.0001). The plan sponsor must decide which liability measure to use for risk management and asset allocation. For example, if the corporation anticipates that it might be a target for an acquisition and that the acquirer likely would want to convert the retirement plan from defined benefit to defined contribution, the ABO measure matters more than the PBO.

We assume that the corporate sponsor sees itself as an ongoing independent institution that preserves the pension plan's current design. Therefore, PBO is the appropriate measure for pension plan liabilities. The plan is fully funded in that the market value of assets, assumed to be USD 2.700 billion, exceeds the PBO of USD 2.687 billion. Currently, the surplus is only USD 13 million (= 2.700 billion − 2.687 billion). That surplus disappears quickly if yields on high-quality corporate bonds that are used to discount the projected benefits drop by about 5 bps to 6 bps. Note that the surplus divided by the PBO BPV is 5.76 (= 13,000,000/2,257,080). Interest rate risk is a major concern to the plan sponsor because changes in the funding status flow through the income statement, thereby affecting reported earnings per share.

Lower yields also raise the market value of assets depending on how those assets are allocated. We assume that the current asset allocation is 50% equity, 40% fixed income, and 10% alternatives. The fixed-income portfolio is managed to track an index of well-diversified corporate bonds—such indexes are covered in a later section of this reading. Relevant at this point is that the chosen bond index reports a modified duration of 5.5.

The problem is to assign a duration for the equity and alternative investments. To be conservative, we assume that there is no stable and predictable relationship between valuations on those asset classes and market interest rates. Therefore, equity duration and alternatives duration are assumed to be zero. Assuming zero duration does not imply that equity and alternatives have no interest rate risk. Effective duration estimates the percentage change in value arising from a change in nominal interest rates. The effect on equity and alternatives depends on *why* the nominal rate changes, especially if that rate change is not widely anticipated in the market. Higher or lower interest rates can arise from a change in expected inflation, a change in monetary policy, or a change in macroeconomic conditions. Only fixed-income securities have a well-defined connection between market values and the yield curve. Nevertheless, assumptions are a source of model risk, as discussed in the next section.

Given these assumptions, we conclude that the asset BPV is USD 594,000 = USD 2.700 billion × [(0.50 × 0) + (0.40 × 5.5) + (0.10 × 0)] × 0.0001. The term in brackets is the estimated effective duration for the asset portfolio, calculated using the shares of market value as the weights. Clearly, the pension plan is running a significant duration gap—the asset BPV of USD 594,000 is much lower than the liability BPV of USD 2,257,080, using the PBO measure. If all yields go down by 10 bps, the market value of assets goes up by approximately USD 5.940 million and the present value of liabilities goes up by USD 22.571 million. The pension plan would have a deficit and be deemed under-funded.

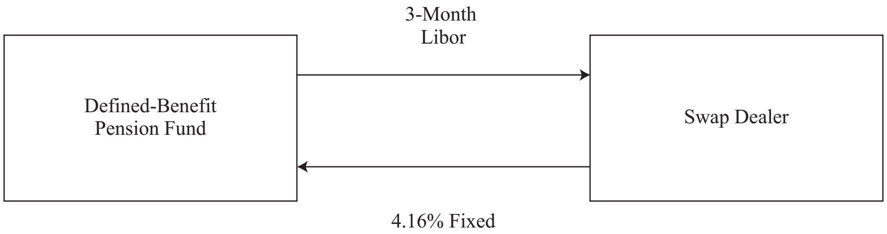
The pension fund manager can choose to reduce, or even eliminate, the duration gap using a derivatives overlay. For example, suppose the Ultra 10-year Treasury futures contract at the Chicago Mercantile Exchange (CME) has a BPV of USD 95.8909 because the on-the-run T-note is the CTD security, as discussed in Section 4.3. Using Equation 3, the pension plan would need to buy, or go long, 17,343 contracts to fully hedge the interest rate risk created by the duration gap:

$$\frac{2{,}257{,}080 - 594{,}000}{95.8909} = 17{,}343$$

We discuss the risks to derivatives overlay strategies associated with LDI in the next section. One concern with hedging with futures is the need for daily oversight of the positions. That need arises because futures contracts are marked to market and settled at the end of each trading day into the margin account. Suppose that the fund did buy 17,343 futures contracts and 10-year Treasury yields go up by 5 bps. Given that the Futures BPV is USD 95.8909 per contract, the *realized* loss that day is more than USD 8.315 million: USD 95.8909 × 5 × 17,343 = 8,315,179. That amount is offset by the *unrealized* reduction in the present value of liabilities. Such a large position in futures contracts would lead to significant daily cash inflows and outflows. For that reason, hedging problems such as the one facing the pension fund often are addressed with over-the-counter interest rate swaps rather than exchange-traded futures contracts.

Suppose that the pension fund manager can enter a 30-year, receive-fixed, interest rate swap against three-month Libor. The fixed rate on the swap is 4.16%. Its effective duration is +16.73, and its BPV is +0.1673 per USD 100 of notional principal. Exhibit 15 illustrates this swap.

Exhibit 15 Interest Rate Swap



The risk statistics for an interest rate swap can be obtained from interpreting the contract as a combination of bonds. From the pension fund's perspective, the swap is viewed as buying a 30-year, 4.16% fixed-rate bond from the swap dealer and financing that purchase by issuing a 30-year floating-rate note (FRN) that pays three-month Libor.[15] The swap's duration is taken to be the (high) duration of the fixed-rate bond minus the (low) duration of the FRN. That explains why a receive-fixed swap has positive duration. From the swap dealer's perspective, the contract is viewed as purchasing a (low duration) FRN that is financed by issuing a (high duration) fixed-rate bond. Hence, the swap has negative duration to the dealer.

The notional principal (NP) on the interest rate swap needed to close the duration gap to zero can be calculated with this expression:

$$\text{Asset BPV} + \left[\text{NP} \times \frac{\text{Swap BPV}}{100}\right] = \text{Liability BPV} \qquad (6)$$

This is similar to Equation 2 for futures contracts. Given that the Asset BPV is USD 594,000 and the Liability BPV is USD 2,257,080 using the PBO measure, the required notional principal for the receive-fixed swap having a BPV of 0.1673 is about USD 994 million.

$$594{,}000 + \left[\text{NP} \times \frac{0.1673}{100}\right] = 2{,}257{,}080,\ \text{NP} = 994{,}070{,}532$$

We use the term "hedging ratio" to indicate the extent of interest rate risk management. A hedging ratio of 0% indicates no hedging at all. The pension plan retains the significant negative duration gap and the risk of lower corporate bond yields if it does not hedge. A hedging ratio of 100% indicates an attempt to fully balance, or to immunize, the assets and liabilities. In this case, the plan manager enters the receive-fixed swap for a notional principal of USD 994 million. In practice, partial hedges are common—the manager's task is to select the hedging ratio between 0% and 100%. The initial use of derivatives entails moving up a substantial learning curve. It is important that all stakeholders to the retirement plan understand the hedging strategy. These stakeholders include the plan sponsor, the regulatory authorities, the auditors, the employees covered by the plan, and perhaps even the employees' union representatives. Interest rate swaps typically have a value of zero at initiation. If swap rates rise, the value of the receive-fixed swap becomes negative and stakeholders will need an explanation of those losses. If the contract is collateralized, the pension fund will have to post cash or marketable securities with the swap dealer. We discuss collateralization further in the next section. The key point is that in all likelihood, the prudent course of action for the plan manager is to use a partial hedge rather than attempt to reduce the duration gap to zero.

15 Swaps are typically quoted as a fixed rate against Libor flat, meaning no spread. The spread over Libor is put into the fixed rate. For instance, a swap of 4.00% against Libor flat is the same as a swap of 4.25% against Libor + 0.25%.

One possibility is that the plan sponsor allows the manager some flexibility in selecting the hedging ratio. This flexibility in selecting the hedging ratio can be called strategic hedging. For example, the mandate could be to stay within a range of 25% to 75%. When the manager anticipates lower market rates and gains on receive-fixed interest rate swaps, the manager prefers to be at the top of an allowable range. On the other hand, if market (swap) rates are expected to go up, the manager could reduce the hedging ratio to the lower end of the range. The performance of the strategic hedging decisions can be measured against a strategy of maintaining a preset hedging ratio, for instance, 50%. That strategy means entering the receive-fixed swap for a notional principal of USD 497 million, which is about half of the notional principal needed to attempt to immunize the plan from interest rate risk (we assume that if the plan manager chooses to enter the receive-fixed swap, its notional principal would be USD 497 million, a 50% hedging ratio).

Another consideration for the plan manager is whether to use an option-based derivatives overlay strategy. Instead of entering a 30-year, receive-fixed interest rate swap against three-month Libor, the pension fund could purchase an option to enter a similar receive-fixed swap. This contract is called a receiver swaption. Suppose that the strike rate on the swaption is 3.50%. Given that the current 30-year swap fixed rate is assumed to be 4.16%, this receiver swaption is out of the money. The swap rate would have to fall by 66 bps (= 4.16% – 3.50%) for the swap contract to have intrinsic value. Suppose that the swaption premium is 100 bps, an amount based on the assumed level of interest rate volatility and the time to expiration (the next date that liabilities are measured and reported). Given a notional principal of USD 497 million, the pension plan pays USD 4.97 million (= USD 497 million × 0.0100) up front to buy the swaption. (This example neglects that the 3.50% swap has a somewhat higher effective duration and BPV than the 4.16% swap.)

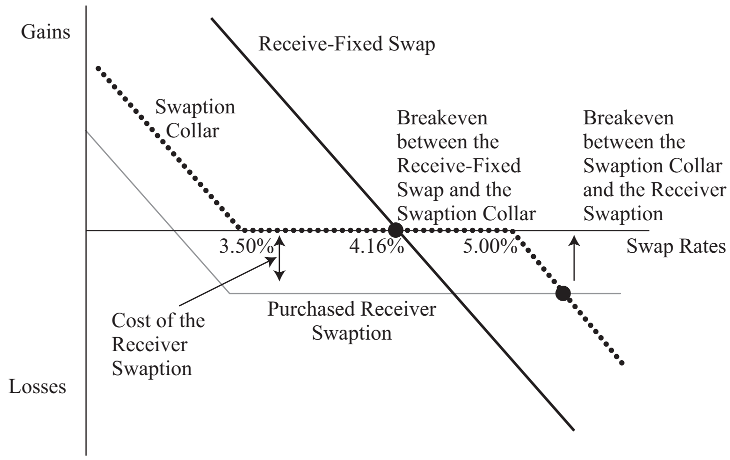
When the expiration date arrives, the plan exercises the swaption if 30-year swap rates are below 3.50%. The plan could "take delivery" of the swap and receive what has become an above-market fixed rate for payment of three-month Libor. Or, the plan could close out the swap with the counterparty to capture the present value of the annuity based on the difference between the contractual fixed rate of 3.50% and the fixed rate in the swap market, multiplied by the notional principal. This gain partially offsets the loss incurred on the higher value for the pension plan liabilities. If 30-year swap rates are equal to or above 3.50% at expiration, the plan lets the swaption expire.

Another derivatives overlay is a swaption collar. The plan buys the same receiver swaption, but instead of paying the premium of USD 4.97 million in cash, the plan writes a payer swaption. Suppose that a strike rate of 5.00% on the payer swaption generates an upfront premium of 100 bps. Therefore, the combination is a "zero-cost" collar, at least in terms of the initial expense. If 30-year swap rates are below 3.50% at expiration, the purchased receiver swaption is in the money and the option is exercised. If the swap rate is between 3.50% and 5.00%, both swaptions are out of the money. But if the swap rate exceeds 5.00%, the payer swaption is in the money to the counterparty. As the writer of the contract, the pension plan is obligated to receive a fixed rate of only 5.00% when the going market rate is higher. The plan could continue with the swap but, in practice, would more likely seek to close it out by making a payment to the counterparty for the fair value of the contract.

Hedging decisions involve a number of factors, including accounting and tax treatment for the derivatives used in the overlay strategy. An important consideration is the various stakeholders' sensitivity to losses on the derivatives. Obviously, the plan manager is a "hero" if yields suddenly go down and if any of the three strategies—enter the receive-fixed swap, buy the receiver swaption, or enter the swaption collar—are undertaken. Note that swap rates do not need to go below 3.50% for the receiver swaption to generate an immediate gain. Its market value would go up if market rates fall (an increase in the value of the option) and it could be sold for more than the purchase price. The problem for the manager, however, occurs if yields suddenly and unexpectedly go up, leading to a significant loss on the hedge. Will being hedged be deemed a managerial mistake by some of the stakeholders? An advantage to buying the receiver swaption is that, like an insurance contract, its cost is a known amount paid upfront. Potential losses on the receive-fixed swap and swaption collar are *time-deferred* and *rate-contingent* and therefore are uncertain.

A factor in the choice of derivatives overlay is the plan manager's view on future interest rates, particularly on high-quality corporate bond yields at the time of the next reporting for liabilities. An irony to interest rate risk management is that the view on rates is part of decision-making even when uncertainty about future rates is the motive for hedging. Exhibit 16 illustrates the payoffs on the three derivatives and the breakeven rates that facilitate the choice of contract.

Exhibit 16 Payoffs on Received-Fixed Swap, Receiver Swaption, and Swaption Collar



Consider first the downward-sloping payoff line for the received-fixed swap, which we assume has a notional principal of USD 497 million (a 50% hedging ratio). There are gains (losses) if rates on otherwise comparable 30-year swaps are below (above) 4.16%. In reality, the payoff line is not linear as shown in the exhibit. Suppose the swap rate moves down to 4.10%. The gain is the present value of the 30-year annuity of USD 149,100 (= [0.0416 – 0.0410] × 0.5 × USD 497,000,000) per period, assuming semi-annual payments. Assuming that 4.10% is the correct rate for discounting, the gain is about USD 5.12 million:

$$\frac{149{,}100}{\left(1+\frac{0.0410}{2}\right)^{1}}+\frac{149{,}100}{\left(1+\frac{0.0410}{2}\right)^{2}}+\cdots+\frac{149{,}100}{\left(1+\frac{0.0410}{2}\right)^{60}}=5{,}120{,}670$$

If the swap rate moves up to 4.22%, the annuity is still USD 149,100. But the loss is about USD 5.05 million using 4.22% to discount the cash flows.

$$\frac{149{,}100}{\left(1+\frac{0.0422}{2}\right)^{1}}+\frac{149{,}100}{\left(1+\frac{0.0422}{2}\right)^{2}}+\cdots+\frac{149{,}100}{\left(1+\frac{0.0422}{2}\right)^{60}}=5{,}047{,}526$$

The payoffs for the purchased 3.50% receiver swaption are shown as the thick line in Exhibit 16. The payoff line includes the cost to buy the swaption. The premium paid at purchase is USD 4.97 million, assuming that the quoted price is 100 bps and the notional principal is USD 497 million. The dotted line shows the payoffs on the swaption collar. It is composed of the long position in the 3.50% receiver swaption and the short position in the 5.00% payer swaption. There is a gain if the swap rate is below 3.50% and a loss if the rate is above 5.00%.

Decision-making is facilitated by breakeven numbers. It is easier to ask "do we expect the rate to be above or below a certain number" than to state a well-articulated probability distribution for the future rate. Exhibit 16 shows two breakeven rates. If the plan manager expects the swap rate to be at or below 4.16%, the receive-fixed swap is preferred. Its gains are higher than the other two derivative overlays. If the manager expects the swap rate to be above 4.16%, however, the swaption collar is attractive because the swap would be incurring a loss. At some point above 5.00%, the purchased receiver swaption is better because it limits the loss. That breakeven rate can be found by trial-and-error search. The task is to find the swap rate that generates a loss that is more than the USD 4.97 million purchase price for the receiver swaption.

Suppose the swap rate goes up to 5.07% on the date that the liabilities are measured and reported. The fair value of the written 5.00% payer swaption starts with the 30-year annuity of USD 173,950 [= (0.0507 – 0.0500) × 0.5 × USD 497,000,000]. The loss of about USD 5.33 million is the present value of that annuity, discounted at 5.07%.

$$\frac{173{,}950}{\left(1+\frac{0.0507}{2}\right)^{1}}+\frac{173{,}950}{\left(1+\frac{0.0507}{2}\right)^{2}}+\cdots+\frac{173{,}950}{\left(1+\frac{0.0507}{2}\right)^{60}}=5{,}333{,}951$$

Therefore, if the plan manager expects the swap rate to be above 5.07%, the purchased receiver swaption is preferred.

In summary, many decisions go into the LDI strategy for defined benefit pension plans. Given the assumptions that lie behind the calculations of the asset BPV and the liability BPV, including the important choice between the ABO and PBO measure of liabilities, the plan manager faces a significant duration gap. The hedging ratio—the percentage of the duration gap to close—is a key decision that might depend on the held view on future interest rates—in particular, on high-quality corporate bond yields that are used to measure the liabilities. Then, given the determined hedging ratio, the choice of derivatives overlay is made. That decision once again depends on many factors, including the view on future rates.

EXAMPLE 7

A corporation is concerned about the defined benefit pension plan that it sponsors for its unionized employees. Because of recent declines in corporate bond yields and weak performance in its equity investments, the plan finds itself to be only about 80% funded. That fact is raising concerns with its employees as well as with the rating agencies. Currently, the present value of the corporation's retirement obligations is estimated by the plan's actuarial advisers to be about USD 1.321 billion using the PBO measure of liabilities. The corporation has no plans to close the defined benefit plan but is concerned about having to report the funding status in its financial statements. The market value of its asset portfolio is USD 1.032 billion—the plan is underfunded by USD 289 million.

The pension fund's asset allocation is rather aggressive: 70% equity, 10% alternative assets, and 20% fixed income. The fund manager hopes that a recovering equity market will reverse the deficit and ultimately return the plan to a fully funded position. Still, the manager is concerned about tightening corporate spreads as the economy improves. That scenario could lead to lower discount rates that are used to calculate the present value of the liabilities and offset any gains in the stock market.

The pension plan has hired a qualified professional asset manager (QPAM) to offer advice on derivatives overlay strategies and to execute the contracts with a commercial bank. The QPAM suggests that the pension plan consider the use of interest rate derivatives to partially close the duration gap between its assets and liabilities. The actuarial advisers to the plan estimate that the effective duration of the liabilities is 9.2, so that the BPV is USD 1.215 million. The corporate sponsor requires that the manager assume an effective duration of zero on equity and alternative assets. The fixed-income portfolio consists mostly of long-term bonds, including significant holdings of zero-coupon government securities. Its effective duration is estimated to be 25.6. Taken together, the asset BPV is USD 528,384. The negative money duration gap is substantial.

The QPAM has negotiated three interest rate derivatives with the commercial bank. The first is a 30-year, 3.80% receive-fixed swap referencing three-month Libor. The swap's effective duration is +17.51 and its BPV is 0.1751 per USD 100 of notional principal. The second is a receiver swaption having a strike rate of 3.60%. The plan pays a premium of 145 bps upfront to buy the right to enter a 30-year swap as the fixed-rate receiver. The expiration date is set to match the date when the pension plan next reports its funding status. The third is a swaption collar, the combination of buying the 3.60% receiver swaption and writing a 4.25% payer swaption. The premiums on the two swaptions offset, so this is a "zero-cost" collar.

After some discussions with the rates desk at the commercial bank and a conversation with the bank's strategy group, the plan manager instructs the QPAM to select the 3.80% receive-fixed interest rate swap. Moreover, the manager chooses a hedging ratio of 75%.

1. Calculate the notional principal on the interest rate swap to achieve the 75% hedging ratio.
2. Indicate the plan manager's likely view on future 30-year swap fixed rates given the decision to choose the swap rather than the purchased receiver swaption or the swaption collar.

Solution to 1:

First calculate the notional principal needed to close the duration gap between assets and liabilities to zero using Equation 6.

$$\text{Asset BPV} + \left(\text{NP} \times \frac{\text{Swap BPV}}{100}\right) = \text{Liability BPV}$$

Asset BPV is USD 528,384; Swap BPV is 0.1751 per 100 of notional principal; and Liability BPV is USD 1.215 million.

$$528{,}384 + \left(\text{NP} \times \frac{0.1751}{100}\right) = 1{,}215{,}000; \ \text{NP} = 392{,}127{,}927$$

A 100% hedging ratio requires a receive-fixed interest rate swap having a notional principal of about USD 392 million. For a hedging ratio of 75%, the notional principal needs to be about USD 294 million (= 392 × 0.75).

Solution to 2:

The plan manager's likely view is that the 30-year swap rate will be less than 3.80%. Then the gain on the swap exceeds that of the purchased receiver swaption having a strike rate of 3.60%, as illustrated in Exhibit 16. If the view is that the swap rate will exceed 3.80%, either the purchased receiver swaption or the swaption collar would be preferred. The swaption collar would be preferred if the rate is expected to be between 3.80% and approximately 4.25%. The purchased receiver swaption will be preferred only if the swap rate is expected to be somewhat above 4.25%, in which case its loss is limited to the premium paid.

Notice that this rate view is also consistent with the concern about lower corporate bond yields and the relatively high hedging ratio.

6 RISKS IN LIABILITY-DRIVEN INVESTING

We have mentioned in previous sections some of the risks to LDI strategies for single and multiple liabilities. In this section, we review those risks and introduce some new ones. The essential relationship for full interest rate hedging is summarized in this expression:

$$\begin{aligned}&\text{Asset BPV} \times \Delta\text{Asset yields} + \text{Hedge BPV} \times \Delta\text{Hedge yields}\\&\approx \text{Liability BPV} \times \Delta\text{Liability yields}\end{aligned} \tag{7}$$

ΔAsset yields, ΔHedge yields, and ΔLiability yields are measured in basis points. This equation describes an immunization strategy (a hedging ratio of 100%) whereby the intent is to match the changes in market value on each side of the balance sheet when yields change. Doing so entails matching the money duration of assets and liabilities. We know, however, that entities also choose to partially hedge interest rate risk by selecting a hedging ratio less than 100%. In any case, Equation 7 serves to indicate the source of the risks to LDI. The “approximately equals” sign (≈) in the equation results from ignoring higher-order terms such as convexity.

We encounter model risk in financial modeling whenever assumptions are made about future events and approximations are used to measure key parameters. The risk is that those assumptions turn out to be wrong and the approximations are inaccurate. For example, in the defined benefit pension plan example in Section 5, we assumed that the effective durations for investments in equity and alternative assets are zero. That assumption introduces the risk that Asset BPV is mis-measured if in fact those market values change as the yield curve shifts. The modeling problem is that the effect on those asset classes is not predictable or stable because it depends on the reason for the change in nominal interest rates. Unlike fixed-income bonds, an increase in expected inflation can have a very different effect on equity and alternative asset valuations than an increase in the real rate.

Measurement error for Asset BPV can even arise in the classic immunization strategy for Type I cash flows, which have set amounts and dates. In practice, it is common to approximate the asset portfolio duration using the weighted average of the individual durations for the component bonds. A better approach to achieve immunization, however, uses the cash flow yield to discount the future coupon and principal payments.[16] This error is minimized when the underlying yield curve is flat or when future cash flows are concentrated in the flattest segment of the curve.

A similar problem arises in measuring Hedge BPV. In Section 4.3 on using derivatives overlays to immunize, we used a common approximation for the Futures BPV. Equation 4 estimates it to be the BPV for the CTD qualifying security divided by its conversion factor. A more developed calculation involving short-term rates and accrued interest, however, could change the number of contracts needed to hedge the interest rate risk. Although the error introduced by using an approximation might not be large, it still can be a source of underperformance in the hedging strategy.

16 See also Footnotes 4 and 7.

Model risk in obtaining a measure of Liability BPV is evident in the defined benefit pension plan example in Section 5. Measuring a defined benefit pension plan's liability is clearly a difficult financial modeling problem. Even the simple models for the two liability measures (the ABO and PBO) necessarily require many assumptions about the future, including the dates when employees retire and their wage levels at those times. The difficulty in projecting life spans of retirees covered by the pension plan leads to longevity risk. The risk is the sponsor has not provided sufficient assets to make the longer-than-expected payout stream. More, and harder-to-make, assumptions are needed to deal with Type IV liabilities and lead to greater uncertainty regarding the models' outputs.

Implicit in Equation 7 is the assumption that all yields change by the same number of basis points—that is, ΔAsset Yields, ΔHedge Yields, and ΔLiability Yields are equal. That is a strong assumption—and a source of risk—if the particular fixed-income assets, the derivatives, and the liabilities are positioned at varying points along the benchmark bond yield curve and at varying spreads to that curve. In Section 3 on immunizing the interest rate risk on a single liability by structuring and managing a portfolio of fixed-income bonds, we point out that a parallel yield curve shift is a sufficient, but not necessary, condition to achieve the desired outcome. Non-parallel shifts as well as twists to the yield curve can result in changes to the cash flow yield on the immunizing portfolio that do not match the change in the yield on the zero-coupon bond that provides perfect immunization. Minimizing dispersion of the cash flows in the asset portfolio mitigates this risk.

Generally, the framework for thinking about interest rate risk rests on changes in the benchmark bond yield curve, which usually is the yield curve for government bonds. In practice, however, ΔAsset Yields and ΔLiability Yields often refer to various classes of corporate bonds. In the example in Section 5, the pension fund holds a portfolio of fixed-income bonds that tracks a well-diversified index of corporate bonds that may include non-investment-grade securities. The present value of retirement benefits, however, depends on yields on high-quality corporate bonds. Therefore, a risk is that the respective spreads on the broad index and the high-quality sector do not move in unison with a shift in the government bond yield curve. A similar spread risk is present in Section 4.2 in the example of immunizing multiple Type I liabilities. The difference is that the assets in that example are of higher quality than the liabilities.

Spread risk also is apparent in the derivatives overlay LDI strategies. In Sections 4.3 and 4.4, we illustrated how futures contracts can be used to hedge the interest rate risk of the multiple liabilities, either passively or contingently. In particular, the futures contracts are on 10-year US Treasury notes whereas the liabilities are corporate obligations. Movements in the corporate–Treasury yield spread introduce risk to the hedging strategy. Usually, yields on high-quality corporate bonds are less volatile than on more-liquid Treasuries. Government bonds are used in a wide variety of hedging as well as speculative trading strategies by institutional investors. Also, inflows of international funds typically are placed in government bonds, at least until they are allocated to other asset classes. Those factors lead to greater volatility in Treasury yields than comparable-maturity corporate bonds.

Another source of spread risk is the use of interest rate swap overlays. In Section 5, we showed how receive-fixed swaps, purchased receiver swaptions, and swaption collars can reduce the duration gap between pension plan assets and liabilities. In that example, ΔHedge Yields refers to fixed rates on interest rate swaps referencing three-month Libor. The spread risk is between high-quality corporate bond yields and swap rates. Typically, there is less volatility in the corporate/swap spread than in the corporate/Treasury spread because both Libor and corporate bond yields contain credit risk vis-à-vis Treasuries. Therefore, one of the usual advantages to hedging corporate bond risk with interest rate swaps is that those derivatives pose less spread risk than Treasury futures contracts.

Counterparty credit risk is a concern if the interest rate swap overlays are uncollateralized, as was common before the 2008–2009 financial crisis. Suppose that the interest rate swap portrayed in Exhibit 15 does not have a collateral agreement, or Credit Support Annex (CSA), to the standard International Swaps and Derivatives Association (ISDA) contract. The credit risk facing the pension plan is that the swap dealer defaults at a time when the replacement swap fixed rate is below 4.16%. In the same manner, the credit risk facing the dealer is that the pension plan defaults at the time when the market rate on a comparable swap is above 4.16%. Therefore, credit risk entails the joint probability of default by the counterparty and movement in market rates that results in the swap being valued as an asset.

Since the 2008–2009 financial crisis, over-the-counter derivatives increasingly include a CSA to the ISDA contract to mitigate counterparty credit risk. Collateral provisions vary. A typical CSA calls for a zero threshold, meaning that only the counterparty for which the swap has negative market value posts collateral, which usually is cash but can be highly marketable securities. The CSA can be one way (only the "weaker" counterparty needs to post collateral when the swap has negative market value from its perspective) or two way (either counterparty is obligated to post collateral when the swap has negative market value). The threshold could be positive, meaning that the swap has to have a certain negative value before collateral needs to be exchanged. Another possibility is that one or both counterparties are required to post a certain amount of collateral, called an independent amount, even if the swap has zero or positive value. This provision makes the CSA similar to the use of margin accounts with exchange-traded futures contracts.

Collateralization on derivatives used in an LDI strategy introduces a new risk factor—the risk that available collateral becomes exhausted. That risk is particularly important for the example in Section 5, in which the pension plan would need to enter a sizable derivatives overlay to even use a 50% hedging ratio, let alone to fully hedge the interest rate risk. That is because the duration gap between assets and liabilities is often large, especially for plans having a significant equity allocation. Therefore, the probability of exhausting collateral is a factor in determining the hedging ratio and the permissible range in the ratio if strategic hedging is allowed.

The same concern about cash management and collateral availability arises with the use of exchange-traded futures contracts. These contracts entail daily mark-to-market valuation and settlement into a margin account. This process requires daily oversight because cash moves into or out of the margin account at the close of each trading day. In contrast, the CSA on a collateralized swap agreement typically allows the party a few days to post additional cash or marketable securities. Also, there usually is a *minimum transfer amount* to mitigate the transactions costs for small inconsequential payments.

Asset liquidity becomes a risk factor in strategies that combine active investing to the otherwise passive fixed-income portfolios. This risk is particularly important with contingent immunization, as in the example in Section 4.4. Then, some or all of the surplus is actively managed. But if losses reduce the surplus to some minimum amount, the positions need to be sold off to revert to a passive duration matching fixed-income portfolio of high-quality bonds. One of the lessons from the 2008–2009 financial crisis is that distressed assets that become hard to value, such as tranches of subprime mortgage-backed securities, also become illiquid.

In summary, an LDI manager has a fundamental choice between managing interest rate risk with asset allocation and with derivatives overlays. As with all financial management decisions, the choice depends on a thorough evaluation of risk and return trade-offs. In some circumstances, derivatives might be deemed too expensive or risky, particularly with regard to available collateral and cash holdings. Then the manager might choose to increase holdings of long-term, high-quality bonds that have high duration statistics. The growth of government zero-coupon bonds, such as US Treasury STRIPS (Separate Trading of Registered Interest and Principal of Securities), facilitates that asset reallocation process.

EXAMPLE 8

A derivatives consultant, a former head of interest rate swaps trading at a major London bank, is asked by a Spanish corporation to devise an overlay strategy to "effectively defease" a large debt liability. That means that there are dedicated assets to retire the debt even if both assets and the liability remain on the balance sheet. The corporation currently has enough euro-denominated cash assets to retire the bonds, but its bank advises that acquiring the securities via a tender offer at this time will be prohibitively expensive.

The 10-year fixed-rate bonds are callable at par value in three years. This is a one-time call option. If the issuer does not exercise the option, the bonds are then non-callable for the remaining time to maturity. The corporation's CFO anticipates higher benchmark interest rates in the coming years. Therefore, the strategy of investing the available funds for three years and then calling the debt is questionable because the embedded call option might be "out of the money" when the call date arrives. Moreover, it is likely that the cost to buy the bonds on the open market at that time will still be prohibitive.

The corporation has considered a cash flow matching approach by buying a corporate bond having the same credit rating and a call structure (call date and call price) close to the corporation's own debt liability. The bank working with the CFO has been unable to identify an acceptable bond, however. Instead, the bank suggests that the corporation buy a 10-year non-callable, fixed-rate corporate bond and use a swaption to mimic the characteristics of the embedded call option. The idea is to transform the callable bond (the liability) into a non-callable security synthetically using the swaption. Then the newly purchased non-callable bond "effectively" defeases the transformed "non-callable" debt liability.

To confirm the bank's recommendation for the derivatives overlay, the CFO turns to the derivatives consultant, asking if the corporation should (1) buy a payer swaption, (2) buy a receiver swaption, (3) write a payer swaption, or (4) write a receiver swaption. The time frames for the swaptions correspond to the embedded call option. They are "3y7y" contracts, an option to enter a seven-year interest rate swap in three years. The CFO also asks the consultant about the risks to the recommended swaption position.

1 Indicate the swaption position that the derivatives consultant should recommend to the corporation.

2 Indicate the risks in using the derivatives overlay.

Solution to 1:

The derivatives consultant should recommend that the corporation choose the fourth option and write a receiver swaption—that is, an option that gives the swaption buyer the right to enter into a swap to receive fixed and pay floating. When the corporation issued the callable bond, it effectively bought the call option, giving the corporation the flexibility to refinance at a lower cost of borrowed funds if benchmark rates and/or the corporation's credit spread narrows. Writing the receiver swaption "sells" that call option, and the corporation captures the value of the embedded call option by means of the premium received. Suppose that market rates in three years are higher than the strike rate on the swaption and the yield on the debt security. Then both options—the embedded call option in the bond liability, as well as the swaption—expire out of the money.

The asset and liability both have seven years until maturity and are non-callable. Suppose instead that market rates fall and bond prices go up. Both options are now in the money. The corporation sells the seven-year bonds (the assets) and uses the proceeds to call the debt liabilities at par value. The gain on that transaction offsets the loss on closing out the swaption with the counterparty.

Solution to 2:

Potential risks to using swaptions include (1) credit risk if the swaption is not collateralized, (2) "collateral exhaustion risk" if it is collateralized, and (3) spread risk between swap fixed rates and the corporation's cost of funds. First, suppose the receiver swaption is not collateralized. In general, the credit risk on an option is unilateral, meaning that the buyer bears the credit risk of the writer. That unilateral risk assumes the premium is paid in full upon entering the contract; in other words, the buyer has met their entire obligation. Therefore, the corporation as the swaption writer would have no additional credit exposure to the buyer. Second, assume that the swaption is collateralized. As the writer of the option, the corporation would need to regularly post cash collateral or marketable securities with either the counterparty or a third-party clearinghouse. The risk is that the corporation exhausts its available cash or holdings of marketable securities and cannot maintain the hedge. Spread risk arises because the value of the embedded call option in three years depends on the corporation's cost of funds at that time, including its credit risk. The value of the swaption depends only on seven-year swap fixed rates at that time. In particular, the risk is that the corporate/swap spread widens when benchmark rates are low and both options can be exercised. If the corporate spread over the benchmark rate goes up, the gain in the embedded call option is reduced. If the swap spread over the same benchmark rate goes down, the loss on the swaption increases. Fortunately, corporate and swap spreads over benchmark rates are usually positively correlated, but still the risk of an unexpected change in the spread should be identified.

7 BOND INDEXES AND THE CHALLENGES OF MATCHING A FIXED-INCOME PORTFOLIO TO AN INDEX

Though the need to offset liabilities through immunization requires a specific bond portfolio, many investors seek a broader exposure to the fixed-income universe. These investors may be attracted to the risk versus return characteristics available in bond markets, or they may seek to allocate a portion of their investable assets to fixed income as part of a well-diversified multi-asset portfolio. In either case, an investment strategy based on a bond market index offers an investor the ability to gain broad exposure to the fixed-income universe. Index-based investments generally offer investors the possibility of greater diversification and lower fees as well as avoiding the downside risk from seeking positive excess returns over time from active management.

An investor seeking to offset a specific liability through immunization gauges the success of his strategy based on how closely the chosen bonds offset the future liability or liabilities under different interest rate scenarios. In contrast, an investor seeking to match the returns of a bond market index will gauge an investment strategy's success in terms of how closely the chosen market portfolio mirrors the return of the underlying bond market index. Deviation of returns on the selected portfolio from bond market index returns are referred to as **tracking risk** or tracking error. Kenneth

Volpert (2012) identifies several methods investors use to match an underlying market index.[17] The first of these is **pure indexing**, in which the investor aims to replicate an existing market index by purchasing all of the constituent securities in the index to minimize tracking risk. The purchase of all securities within an index is known as the **full replication approach**. In **enhanced indexing strategy**, the investor purchases fewer securities than the full set of index constituents but matches primary risk factors (discussed later) reflected in the index. This strategy aims to replicate the index performance under different market scenarios more efficiently than the full replication of a pure indexing approach. **Active management** involves taking positions in primary risk factors that deviate from those of the index in order to generate excess return.

Casual financial market observers usually refer to an equity market index to gauge overall financial market sentiment. Examples often consist of a small set of underlying securities, such as the Dow Jones Industrial Average of 30 US stocks, the CAC 40 traded on Euronext in Paris, or the 50 constituent companies in the Hang Seng Index, which represent more than half the market capitalization of the Hong Kong stock market. When bond markets are mentioned at all, the price and yield of the most recently issued benchmark government bond is typically referenced rather than a bond market index. This contrast reflects the unwieldy nature of bond markets for both the average investor and financial professionals alike.

Although rarely highlighted in the financial press, investments based on bond market indexes form a very substantial proportion of financial assets held by investors. Fixed-income markets have unique characteristics that make them difficult to track, and investors therefore face significant challenges in replicating a bond market index. These challenges include the size and breadth of bond markets, the wide array of fixed-income security characteristics, unique issuance and trading patterns of bonds versus other securities, and the effect of these patterns on index composition and construction, pricing, and valuation. We will tackle each of these issues and their implications for fixed-income investors.

Fixed-income markets are much larger and broader than equity markets. According to the Global McKinsey Institute, global financial instruments reached a total value of USD 212 trillion in 2010, with nearly three-quarters of this total consisting of fixed-income instruments and loans, whereas only USD 54 trillion were equity securities.[18] In addition to the relative size of market capitalization between debt and equity, the number of fixed-income securities outstanding is vastly larger as reflected in broad market indexes. For instance, the MSCI World Index, capturing equities in 23 developed market countries and 85% of the available market capitalization in each market, consists of 1,642 securities, whereas the Bloomberg Barclays Global Aggregate Index, covering global investment-grade debt from 24 local currency markets, consists of more than 16,000 securities. Those fixed-income issuers represent a much wider range of borrowers than the relatively narrow universe of companies issuing equity securities. For example, the oldest and most widely recognized US bond market index, the Bloomberg Barclays US Aggregate Index (one of four regional aggregate benchmarks that constitute the Bloomberg Barclays Global Aggregate Index), includes US Treasuries, government agency securities, corporate bonds, mortgage-backed securities, asset-backed securities, and commercial mortgage-backed securities. Although the large number of index constituents provides a means of risk diversification, in practice it is neither feasible nor cost-effective for investors to pursue a full replication approach with a broad fixed-income market index.

17 Volpert (2012).
18 Roxburgh, Lund, and Piotrowski (2011, p, 2), based on a sample of 79 countries.

Different maturities, ratings, call/put features, and varying levels of security and subordination give rise to a much wider array of public and private bonds available to investors. Exhibit 17 illustrates the number of publicly traded fixed-income and equity securities outstanding for a select group of major global issuers.

Exhibit 17 Debt and Equity Securities Outstanding for Select Issuers

Issuer	Fixed-Income Securities	Common Equity Securities	Preferred Equity Securities
Royal Dutch Shell PLC	39	1	0
BHP Billiton Limited	36	1	0
Johnson & Johnson	26	3	0
Ford Motor Company	243	2	0

Source: Bloomberg as of 28 February 2015.

At the end of 2015, Royal Dutch Shell had 39 bonds outstanding across four currencies, some of which were both fixed and floating rate, with a range of maturities from under a year to bonds maturing in 2045. The existence of many debt securities for a particular issuer suggests that many near substitutes may exist for an investor seeking to pursue an enhanced index strategy. That said, the relative liquidity and performance characteristics of those bonds may differ greatly depending on how recently the bond was issued and how close its coupon is to the yield currently required to price the bond at par.

Unlike equity securities, which trade primarily over an exchange, fixed-income markets are largely over-the-counter markets that rely on broker/dealers as principals to trade in these securities using a quote-based execution process rather than the order-based trading systems common in equity markets. The traditional over-the-counter trading model in fixed-income markets has changed since the 2008 financial crisis.[19] The rising cost of maintaining risk-weighted assets on dealer balance sheets as a result of Basel III capital requirements has had an adverse effect on fixed-income trading and liquidity for a number of reasons. Broker/dealers have reduced bond inventories because of higher capital costs. With lower trading inventories, dealers have both a limited appetite to facilitate trading at narrow bid–offer spreads and are less willing to support larger "block" trades, preferring execution in smaller trade sizes. Finally, a significant decline in proprietary trading among dealers has had a greater pricing effect on less liquid or "off-the-run" bonds. Although many see these structural changes in fixed-income trading acting as a catalyst for more electronic trading, this trend will likely be most significant for the most liquid fixed-income securities in developed markets, with a more gradual effect on less frequently traded fixed-income securities worldwide.

Although fixed-income trading in many markets is difficult to track, in the United States, the world's largest global bond market, regulators developed a vehicle known as the Trade Reporting and Compliance Engine (TRACE) to facilitate mandatory reporting of over-the-counter transactions in eligible fixed-income securities starting in 2001. All broker/dealers that are Financial Industry Regulatory Authority (FINRA) member firms must report corporate bond transactions within 15 minutes of occurrence. Analysis of TRACE trading data demonstrates the distinct nature of

19 McKinsey & Company and Greenwich Associates, *Corporate Bond E-Trading: Same Game, New Playing Field*, August 2013.

fixed-income trading versus equities. For example, in 2012, 38% of the 37,000 TRACE-eligible fixed-income securities did not trade at all, with another 23% trading only a few times during the year, compared with the 1% that traded every business day, according to MarketAxess, a leading electronic trading provider.[20] It is also important to note that the average trade size in dollar terms in the US investment-grade bond market is roughly 70 times the size of the average stock trade.

The illiquid nature of most fixed-income instruments gives rise to pricing and valuation challenges for asset managers. For fixed-income instruments that are not actively traded and therefore do not have an observable price, it is common to use an estimation process known as **matrix pricing** or **evaluated pricing**. Matrix pricing makes use of observable liquid benchmark yields such as Treasuries of similar maturity and duration as well as the benchmark spreads of bonds with comparable times to maturity, credit quality, and sector or security type in order to estimate the current market yield and price. In practice, asset managers will typically outsource this function to a global custodian or external vendor. This estimation analysis is another potential source of variation between index performance and portfolio returns.

The complexity of trading and valuing individual fixed-income securities further underscores the challenges associated with managing an index-based bond portfolio. Early bond indexes, such as those from Standard & Poor's and Citigroup dating back to the 1920s, simply measured the average yield of corporate bonds. Not until the significant advances in computing power of the 1970s did the first broad-based, rate of return–based fixed-income index (now known as the Bloomberg Barclays US Aggregate Index) come into being.[21] Fixed-income indexes change frequently as a result of both new debt issuance and the maturity of outstanding bonds. Bond index eligibility is also affected by changes in ratings and bond callability. As a result, rebalancing of bond market indexes usually occurs monthly rather than semi-annually or annually as it does for equity indexes. Fixed-income investors pursuing a pure indexing strategy therefore must also incur greater transaction costs associated with maintaining a bond portfolio consistent with the index.

Given the significant hurdles involved in bond index matching, asset managers typically seek to target the primary risk factors present in a fixed-income index through a diversified portfolio. Volpert (2012) summarized these primary indexing risk factors as follows:[22]

- **Portfolio modified adjusted duration.** Effective duration, or the sensitivity of a bond's price to a change in a benchmark yield curve, is an important primary factor as a first approximation of an index's exposure to interest rate changes. It is important to factor in option-adjusted duration so that the analysis reflects securities with embedded call risk. Larger rate moves should incorporate the second-order convexity adjustment to increase accuracy.
- **Key rate duration.** Although effective duration may be a sufficient measure for small rate changes and parallel yield curve shifts, the **key rate duration** takes into account rate changes in a specific maturity along the yield curve while holding the remaining rates constant. This measure of duration gauges the index's sensitivity to non-parallel yield curve shifts. By effectively matching the key rate durations between the portfolio and the underlying index, a manager can significantly reduce the portfolio's exposure to changes in the yield curve.

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20 McKinsey & Company and Greenwich Associates (2013, pp. 10–11).
21 The index was created in 1973 by Lehman Brothers, and its sale to Bloomberg LP was announced in December 2015.
22 This section is derived from Volpert (2012, pp. 1133–1138).

- **Percent in sector and quality.** Index yield is most effectively matched by targeting the same percentage weights across fixed-income sectors and credit quality, assuming that maturity parameters have also been met.
- **Sector and quality spread duration contribution.** The portfolio manager can minimize deviations from the benchmark by matching the amounts of index duration associated with the respective issuer sectors and quality categories. The former refers to the issuer type and/or industry segment of the bond issuer. In the case of the latter, the risk that a bond's price will change in response to an idiosyncratic rate move rather than an overall market yield change is known as spread risk. For non-government fixed-income securities, we separate the yield to maturity into a benchmark yield (typically the most recently issued or on-the-run government bond with the closest time to maturity) and a spread reflecting the difference between the benchmark yield and the security-specific yield. **Spread duration** refers to the change in a non-Treasury security's price given a widening or narrowing of the spread compared with the benchmark. Matching the relative quality between the portfolio and the fixed-income index will minimize this risk.
- **Sector/coupon/maturity cell weights.** Asset managers face a number of challenges in matching price/yield sensitivity beyond the use of effective duration. Although convexity is a useful second-order condition that should be used to improve this approximation, the negative convexity of callable bonds may distort the call exposure of an index and lead to costly rebalancing when rates shift. As a result, managers should seek to match the sector, coupon, and maturity weights of callable bonds by sector. Doing so is particularly important in the mortgage sector because of the refinancing of high-coupon securities with lower-coupon bonds.
- **Issuer exposure.** Concentration of issuers within a portfolio exposes the asset manager to issuer-specific event risk. The manager should therefore seek to match the portfolio duration effect from holdings in each issuer.

Another method used to address a portfolio's sensitivity to rate changes along the yield curve is referred to as the **present value of distribution of cash flows methodology**. This approach seeks to approximate and match the yield curve risk of an index over discrete time periods referred to as cash flow vertices, and it involves several steps as follows:

1 The manager divides the cash flows for each non-callable security in the index into discrete semi-annual periods, aggregates them, and then adds the cash flows for callable securities in the index based on the probability of call for each given period.

2 The present value of aggregated cash flows for each semi-annual period is computed, with the total present value of all such aggregated cash flows equal to the index's present value. The percentage of the present value of each cash flow vertex is calculated.

3 The time period is then multiplied by the present value of each cash flow. Because each cash flow represents an effective zero-coupon payment in the corresponding period, the time period reflects the duration of each cash flow. For example, the third period's contribution to duration might be 1.5 years × 3.0%, or 0.045.

4 Finally, each period's contribution to duration is added to arrive at a total representing the bond index's duration. The portfolio being managed will be largely protected from deviations from the benchmark associated with yield curve changes by matching the percentage of the portfolio's present value that comes due at specific points in time with that of the index.

The goal of matching these primary indexing risk factors is to minimize the difference between a given portfolio's return and that of an underlying benchmark index, known as **tracking error**. Tracking error is defined as the standard deviation of a portfolio's active return for a given period, whereby active return is defined as follows:

Active return = Portfolio return – Benchmark index return

If we assume that returns are normally distributed around the mean, then from a statistical perspective, 68% of those returns will lie within one standard deviation of the mean. Therefore, if a fund's tracking error is 50 bps, then for approximately two-thirds of the time period observations, we would expect the fund's return to be less than 50 bps above or below the index's return.

EXAMPLE 9

Cindy Cheng, a Hong Kong–based portfolio manager, has established the All Asia Dragon Fund, a fixed-income fund designed to outperform the Markit iBoxx Asian Local Bond Index (ALBI). The ALBI tracks the total return performance of liquid bonds denominated in local currencies in the following markets: Chinese mainland, Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan Region, and Thailand. The index includes both government and non-government bond issues, with constituent selection criteria by government as well as weights designed to balance the desire for liquidity and stability.[23]

Individual bond weightings are based on market capitalization, and market weights, reviewed annually, are designed to reflect the investability of developing Asian local currency bonds available to international investors. These weights are driven by local market size and market capitalization, secondary bond market liquidity, accessibility to foreign investors, and development of infrastructure that supports fixed-income investment and trading such as credit ratings, yield curves, and derivative products.

Given the large number of bonds in the index, Cheng uses a representative sample of the bonds to construct the fund. She chooses bonds so that the fund's duration, market weights, and sector/quality percentage weights closely match the ALBI. Given the complexity of managing bond investments in these local markets, Cheng is targeting a 1.25% tracking error for the fund.

1 Interpret Cheng's tracking error target for the All Asia Dragon Fund

2 One of Cheng's largest institutional investors has encouraged her to reduce tracking error. Suggest steps Cheng could take to minimize this risk in the fund.

Solution to 1:

The target tracking error of 1.25% means that assuming normally distributed returns, in 68% or two-thirds of time periods, the All Asia Dragon Fund should have a return that is within 1.25% of the ALBI.

Solution to 2:

Cheng could further reduce tracking error beyond her choice of duration, market, and sector/quality weightings to mirror the index by using the present value of distribution of cash flows methodology outlined earlier. By doing so, she can better align the contribution to portfolio duration that comes from each market, sector, and issuer type based on credit quality.

23 Markit iBoxx ALBI™ Index Guide, January 2016, Markit Ltd.

Cheng should consider matching the amount of index duration that comes from each sector, as well as matching the amount of index duration that comes from various quality categories across government and non-government bonds, to minimize tracking error.

Finally, Cheng should evaluate the portfolio duration coming from each issuer to minimize event risk. Again, this evaluation should occur on a duration basis rather than as a percentage of market value to quantify the exposure more accurately versus the benchmark ALBI.

8 ALTERNATIVE METHODS FOR ESTABLISHING PASSIVE BOND MARKET EXPOSURE

Why is passive bond market exposure attractive for investors? A **passive investment** in the fixed-income market may be defined as one that seeks to mimic the prevailing characteristics of the overall investments available in terms of credit quality, type of borrower, maturity, and duration rather than express a specific market view. This approach is consistent with the efficient markets hypothesis in that the portfolio manager seeks to simply replicate broader fixed-income market performance rather than outperform the market. Stated differently, establishing passive bond market exposure does not require the in-depth analysis necessary to achieve an above-market return nor does it require the high trading frequency of active management, which should lead to lower costs for managing and servicing a portfolio. Finally, the stated goal of matching the performance of a broad-based bond index is consistent with the highest degree of portfolio diversification.

Several methods exist for establishing a passive bond market exposure. In what follows, we will explore both full index replication as well as an enhanced indexing strategy and compare the risks, costs, and relative liquidity of these strategies when applied to the bond market.

Bond market index replication is the most straightforward strategy that a manager can use to mimic index performance. Use of full replication reflects the belief or expectation that an active manager cannot consistently outperform the index on a risk-adjusted basis. Initial index replication does not require manager analysis but rather involves sourcing a wide range of securities in exact proportion to the index, many of which may be thinly traded. The manager's ongoing task under full replication is to purchase or sell bonds when there are changes to the index in addition to managing inflows and outflows for a specific fund. For example, the manager may have to sell when a security no longer meets the index criteria, such as when a security either matures or is downgraded.[24] On the other hand, managers must purchase newly issued securities that meet index criteria to maintain full replication, which, depending on the index, may occur quite frequently. Rolling bond maturities, as well as frequent new issuance eligible for inclusion in the index, drive a monthly rebalancing for most fixed-income indexes. The number of purchases and sales required to maintain an exact proportional allocation would be very significant for most bond indexes. As a result, although the large number of index constituents may well provide the best means of risk diversification, in practice it is neither feasible nor cost-effective for investors to pursue full replication for broad-based fixed-income indexes.

24 For the Bloomberg Barclays US Aggregate Bond Index, a fixed-income security becomes ineligible when it either has a maturity of less than one year or is downgraded below the minimum rating (Baa3, BBB–, and BBB– for Moody's Investors Service, Standard & Poor's, and Fitch Ratings, respectively). https://index.barcap.com.

Many limitations of the full replication approach are addressed by an enhanced indexing strategy. This approach's goal is to mirror the most important index characteristics and still closely track index performance over time while purchasing fewer securities. This general approach is referred to as a **stratified sampling** or **cell approach** to indexing. First, each cell or significant index portfolio characteristic is identified and mapped to the current index. Second, the fixed-income portfolio manager identifies a subset of bonds or bond-linked exposures, such as derivatives, with characteristics that correspond to the index. Finally, the positions in each cell are adjusted over time given changes to the underlying index versus existing portfolio positions. For example, say a fixed-income index contains 1,000 fixed-income securities, 10% of which are AAA rated. The portfolio manager might choose five to 10 AAA rated securities within a cell in order to mimic the performance of the AAA rated bonds within the index.

Enhanced indexing is also of critical importance to investors who consider environmental, social, or other factors when selecting a fixed-income portfolio. **Environmental, social, and corporate governance (ESG)**, also called socially responsible investing, refers to the explicit inclusion of ethical, environmental, or social criteria when selecting a portfolio.[25] For example, ESG investors may shun entire sectors such as alcohol-related, gambling, or tobacco companies, or alternatively, they may evaluate underlying issuers based on non-financial criteria such as their adherence to environmental, human rights, or labor standards.

Volpert (2012) outlines a number of enhancement strategies available to portfolio managers seeking to reduce the component of tracking error associated with the expenses and transactions costs of portfolio management as follows:[26]

- **Lower cost enhancements.** The most obvious enhancement is in the area of cost reduction, whether this involves minimizing fund expenses or introducing a more competitive trading process to reduce the bid–offer cost of trading.
- **Issue selection enhancements.** The use of bond valuation models to identify specific issues that are undervalued or "cheap" to their implied value provides another opportunity to enhance return.
- **Yield curve enhancements.** The use of analytical models to gauge and calculate relative value across the term structure of interest rates allows managers to develop strategies to both overweight maturities that are considered undervalued and underweight those that appear to be richly priced.
- **Sector/quality enhancements.** This strategy involves overweighting specific bond and credit sectors across the business cycle to enhance returns. Other sectors are underweighted as a result. This approach may tilt exposure toward corporates given a greater yield spread per unit of duration exposure or shorter maturities or it may over- or underweight specific sectors or qualities based on analysis of the business cycle.

For example, a manager may increase her allocation to Treasuries over corporates when significant spread widening is anticipated, or reverse this allocation if spread narrowing is deemed more likely.

- **Call exposure enhancements.** Because effective duration is a sufficient risk measure only for relatively small rate changes, anticipated larger yield changes may affect bond performance significantly, especially when a bond shifts from trading to maturity to trading to an earlier call date. Large expected yield changes increase the value of call protection, and any significant differences

25 See Hayat and Orsagh (2015).
26 Volpert (2012), pp. 1138–1145.

from index exposure should incorporate potentially large tracking risk implications, as well as the implicit market view that this difference implies. For example, an anticipated drop in yields might cause a callable bond to shift from being priced on a yield-to-maturity basis to a yield-to-call basis. Callable fixed-income securities (priced on a yield-to-call basis) trading above par tend to be less price sensitive for a given effective duration than those priced on a yield-to-maturity basis, suggesting a manager should use metrics other than effective duration in this case when changing exposure.

The stratified sampling approach provides an asset manager the ability to optimize portfolio performance across these characteristics with fewer securities than would be required through full index replication. By matching portfolio performance as closely as possible, investment managers also seek to minimize tracking error, limit the need to purchase or sell thinly traded securities, and/or frequently rebalance the portfolio as would be required when precisely matching the index.

EXAMPLE 10

Adelaide Super, a superannuation fund, offers a range of fixed interest (or fixed-income) investment choices to its members. Superannuation funds are Australian government-supported arrangements for Australian workers to save for retirement, which combine a government-mandated minimum percentage of wages contributed by employers with a voluntary employee contribution that offers tax benefits. Superannuation plans are similar to defined contribution plans common in the United States, Europe, and Asia.

Three of the bond fund choices Adelaide Super offers are as follows:

- **Dundee Australian Fixed-Income Fund.** The investment objective is to outperform the Bloomberg AusBond Composite Index in the medium to long term. The index includes investment-grade fixed-interest bonds with a minimum of one month to maturity issued in the Australian debt market under Australian law, including the government, semi-government, credit, and supranational/sovereign sectors. The index includes AUD-denominated bonds only. The investment strategy is to match index duration but add value through fundamental and model-driven return strategies.
- **Newcastleton Australian Bond Fund.** The fund aims to outperform the Bloomberg AusBond Composite Index over any three-year rolling period, before fees, expenses, and taxes, and uses multiple strategies such as duration, curve positioning, and credit and sector rotation rather than one strategy, allowing the fund to take advantage of opportunities across fixed-income markets under all market conditions.
- **Paisley Fixed-Interest Fund.** The fund aims to provide investment returns after fees in excess of the fund's benchmark, which is the Bloomberg AusBond Bank Bill Index and the Bloomberg AusBond Composite Index (equally weighted) by investing in a diversified portfolio of Australian income-producing assets. Paisley seeks to minimize transaction costs via a buy-and-hold strategy, as opposed to active management. The AusBond Bank Bill Index is based on the bank bill market, which is the short-term market (90 days or less) in which Australian banks borrow from and lend to one another via bank bills.

Rank the three fixed-income funds in order of risk profile, and suggest a typical employee for whom this might be a suitable investment.

Solution:

The Paisley Fixed-Interest Fund represents the lowest risk of the three fund choices, given both its choice of underlying bond index (half of which is in short-term securities) and lack of active management strategies. The Paisley Fund could be a suitable choice for an investor near retirement who is seeking income with a minimum risk profile.

The Dundee Fund represents a medium risk profile given the choice of the composite benchmark and suggests an enhanced approach to indexing. This fund may be the best choice for a middle-aged worker seeking to add a fixed-income component with moderate risk to his portfolio.

The Newcastleton Fund has the highest risk of the three choices and is an example of an actively managed fund that has a mandate to take positions in primary risk factors such as duration and credit that deviate from those of the index in order to generate excess return. This fund could be an appropriate choice for a younger worker who is seeking exposure to fixed income but willing to accommodate higher risk.

Investment managers have several alternatives to investing directly in fixed-income securities in order to seek a passive index-based exposure, including indirectly through a bond mutual fund or a fixed-income **exchange-traded fund** (ETF), as well as through synthetic means such as index-based total return swaps. In considering direct versus indirect investments, the asset manager must weigh the ongoing fees associated with mutual funds and ETFs against the bid–offer cost of direct investment in the underlying securities in the index. In addition, the asset manager can target individual issuers, maturities, and other characteristics in order to meet specific requirements, and the manager faces known interest and principal cash flows as long as the bond is not called or the issuer does not default through the stated maturity date. The indirect alternatives introduce a tradeoff between greater cost and diversification, as well as other factors outlined as follows.

Mutual funds are pooled investment vehicles whose shares or units represent a proportional share in the ownership of the assets in an underlying portfolio. In the case of open-ended mutual funds, new shares may be redeemed or issued at the fund's **net asset value** (NAV) established at the end of each trading day based on the fund's valuation of all existing assets minus liabilities, divided by the total number of shares outstanding. Mutual fund purchases or sales received after a pre-specified cutoff time take place at the NAV on the following business day.

Open-ended bond mutual funds have several additional characteristics that distinguish them from direct investment in fixed-income instruments. The benefit from economies of scale is usually the overriding factor for smaller investors in their choice of a bond mutual fund over direct investment. Because bonds often trade at a minimum lot size of USD 1 million or higher per bond, successful replication of a broad index could easily require hundreds of millions of dollars in investments. Therefore, the additional cost in terms of an upfront load in some instances and an annual management fee may be well worth the greater diversification achievable across fixed-income markets within a larger fund. Although investors benefit from increased diversification, the fund must outline its stated investment objectives and periodic fees, but actual securities holdings are available only on a retroactive basis. Unlike the underlying securities, the bond mutual fund has no maturity date, as the fund manager continuously purchases and sells bonds to track index performance, and monthly interest payments fluctuate based on fund holdings. Finally, although many funds have early redemption penalties for investors who choose to liquidate within 90 days of share purchase, bond mutual fund investors enjoy the advantage of being able to redeem holdings at the fund's NAV rather than facing a need to sell illiquid positions.

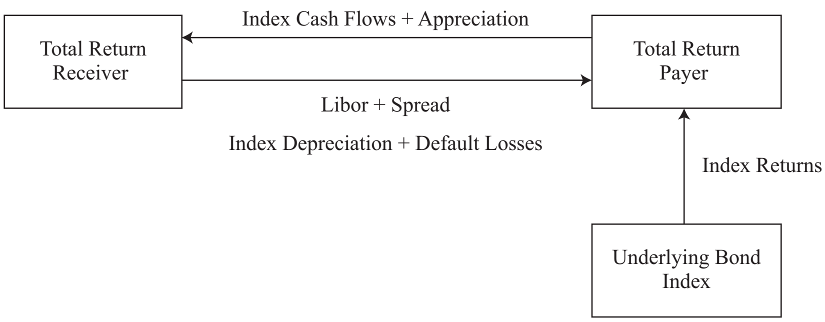
Exchange-traded funds share some mutual fund characteristics but have more tradability features. ETFs solicit broker/dealers, referred to as **authorized participants**, who enter into an agreement with the distributor of the fund, purchasing shares from or selling ETF shares to the fund in what are known as **creation units**—large blocks of ETF shares often traded against a basket of underlying securities. Authorized participants may invest longer-term in the ETF, or they may act as market makers by exchanging creation units with underlying bonds to provide liquidity and ensure the intraday price is a close approximation of the NAV.

Investors benefit from greater bond ETF liquidity versus mutual funds given their availability to be purchased or sold throughout the trading day at a discount or premium relative to the NAV of the underlying bonds. A significant spread between the market price of the underlying fixed-income securities portfolio and an ETF's NAV should drive an authorized participant to engage in arbitrage to profit from a divergence between the two prices. That said, the fact that many fixed-income securities are either thinly traded or not traded at all might allow such a divergence to persist to a much greater degree for a bond ETF than might be the case in the equity market.

Synthetic strategies provide another means of gaining exposure to an index. As in the case of portfolio immunization outlined earlier, both over-the-counter and exchanged-traded alternatives are available to portfolio managers in managing index exposure. Over-the-counter solutions entail customized arrangements between two counterparties that reference an underlying market price or index, and exchange-traded products involve financial instruments with standardized terms, documentation, and pricing traded on an organized exchange.

A **total return swap** (TRS) is the most common over-the-counter portfolio derivative strategy, combining elements of interest rate swaps and credit derivatives. Similar to an interest rate swap, a total return swap involves the periodic exchange of cash flows between two parties for the life of the contract. Unlike an interest rate swap, in which counterparties exchange a stream of fixed cash flows versus a floating-rate benchmark such as Libor (the London Interbank Offered Rate) to transform fixed assets or liabilities to a variable exposure, a TRS has a periodic exchange based on a reference obligation that is an underlying equity, commodity, or bond index. Exhibit 18 outlines the most basic TRS structure. The **total return receiver** receives both the cash flows from the underlying index as well as any appreciation in the index over the period in exchange for paying Libor plus a pre-determined spread. The **total return payer** is responsible for paying the reference obligation cash flows and return to the receiver but will also be compensated by the receiver for any depreciation in the index or default losses incurred on the portfolio.

Exhibit 18 Total Return Swap Mechanics



The TRS transaction is an over-the-counter derivative contract based on an ISDA master agreement. This contract specifies a notional amount, periodic cash flows, and final maturity, as well as the credit and other legal provisions related to the transaction. The historical attractiveness of using TRS stemmed from the efficient risk transfer on the reference obligation from one counterparty to another on a confidential basis without requiring the full cash outlay associated with the mutual fund or ETF purchase. In fact, another way to think of the TRS is as a synthetic secured financing transaction in which the investor (the total return receiver) benefits from more-advantageous funding terms faced by a dealer (typically the total return payer) offering to facilitate the transaction.

The potential for both a smaller initial cash outlay and lower swap bid–offer costs, when compared with the transaction costs of direct purchase or use of a mutual fund or ETF, are the most compelling reasons to consider a TRS to add fixed-income exposure. That said, several considerations may offset these benefits in a number of instances. First, the investor does not legally own the underlying assets but rather has a combined synthetic long position in both the market and credit risk of the index that is contingent upon the performance of the total return payer. Given the shorter nature of these contracts compared with an investor's typical longer-term time horizon, the total return receiver must both perform the necessary credit due diligence on its counterparty and also face the rollover risk upon maturity of having the ability to renew the contract with reasonable pricing and business terms in the future. Second, as a funding cost arbitrage transaction, the TRS can allow investors to gain particular access to subsets of the fixed-income markets, such as bank loans or high-yield instruments for which cash markets are relatively illiquid or the cost and administrative complexity of maintaining a portfolio of these instruments is prohibitive for the investor. Finally, structural changes to the market, greater regulatory oversight of derivatives markets, and changes to Basel III capital rules affecting dealers have raised the cost and operational burden of these transactions. The need to collateralize mark-to-market positions significantly increases the operational risks of TRS, including more-frequent collateralization within a $T + 1$ timeframe, or shorter, as well as the need for expertise in execution and settlement.[27]

The availability of exchange-traded interest rate products continues to evolve with the shifting market landscape and changes in investor demand. For many years, the most prevalent liquid interest rate futures and option contracts available on global futures exchanges such as Eurex, the Intercontinental Exchange, and the Chicago Mercantile Exchange were limited to individual fixed-income securities. Examples include money market instruments such as Eurodollar futures and options contracts, as well as contracts on longer-term government securities such as US Treasuries, gilts, and German bunds in specific benchmark maturities. As for exchange-traded derivatives on debt indexes, this type of instrument only became legal in the United States in 2006, as the US Commodity Futures Trading Commission (CFTC) and the US Securities and Exchange Commission (SEC) issued joint final rules permitting the trading of futures on debt indexes.[28] Although the over-the-counter use of total return swaps on debt indexes continues, the use of exchange-traded futures on debt indexes has proven less popular, and the CME Group delisted its Barclays US Aggregate Bond Index contract in June 2015.[29] Other exchanges have been slow to adopt such instruments. Similarly, although the launch of ETF futures on equity indexes at the CME Group in 2005 marked a shift toward these instruments to gain broad-based

27 Aakko and Martel (2013).

28 US Commodity Futures Trading Commission, Press Release PR5195-06, CFTC and SEC Issue Rules for Trading Futures on Debt Security Index Contracts, 10 July 2006, available at www.cftc.gov and www.sec.gov.

29 CME Group, Advisory Notice #15-156, Product Modification Summary: Delist Barclays US Aggregate Bond Index Contracts, 8 June 2015, available at www.cmegroup.com index exposure, the exchange stopped listing new ETF contracts in 2010 in response to a lack of liquidity in these instruments.[30] In contrast to futures market developments, the exchange-traded options market for interest rate–related ETFs remains active. As of the end of 2015, the Chicago Board Options Exchange offered options with physical settlement and American-style exercise on a range of interest rate ETFs across Treasury funds, high-yield, investment grade corporate, and inflation-protected securities.[31] Frequent changes in the availability of specific exchange-traded derivative instruments on fixed-income indexes make it challenging for investors to rely on such strategies, versus an over-the-counter hedge, over time.

9 BENCHMARK SELECTION

The choice of a benchmark is perhaps an investment manager's most important decision beyond the passive versus active decision or the form that the investment takes, as described earlier. Benchmark selection is one of the final steps in the broader asset allocation process.

The asset allocation process starts with a clear delineation of the portfolio manager's investment goals and objectives. Examples of such goals might include the protection of funds (especially against inflation), broad market replication, predictable returns within acceptable risk parameters, or maximum absolute returns through opportunistic means. The manager must agree on an investment policy with the asset owners, beneficiaries, and other constituents outlining return objectives, risk tolerance, and constraints to narrow choices available in the broader capital markets to meet these objectives. A **strategic asset allocation** targeting specific weightings for each permissible asset class is the result of this process, while a **tactical asset allocation** range often provides the investment manager some short-term flexibility to deviate from these weightings in response to anticipated market changes.

Bonds figure prominently in most asset allocations given that they represent the largest fraction of global capital markets, capture a wide range of issuers and, as borrowed funds, represent claims that should theoretically involve lower risk than common equity. Choosing a fixed-income benchmark is unique, however, in that the investor usually has some degree of fixed-income exposure embedded within its asset/liability portfolio, as outlined in the foregoing immunization and liability-driven investing examples. The investment manager must therefore consider these implicit or explicit duration preferences when choosing a fixed-income benchmark.

Benchmark selection must factor in the broad range of issuers and characteristics available in the fixed-income markets. In general, the use of an index as a widely accepted benchmark requires clear, transparent rules for security inclusion and weighting, investability, daily valuation and availability of past returns, and turnover. Unlike in equity indexes, fixed-income market dynamics can drive deviation from a stable benchmark sought by investors for a number of reasons. First, the finite maturity of bonds in a static portfolio implies that duration will drift downward over time. Second, market dynamics and issuer preferences tend to dictate both issuer composition for broad-based indexes as well as maturity selection for narrower indexes. For example, as shown in Exhibit 19, the composition of the Bloomberg Barclays US Aggregate Bond Index changed significantly during the years prior to and after the 2008 financial crisis, with a large increase in securitized debt pre-crisis and a significant rise in government debt thereafter:

30 Yesalavich (2010).
31 See www.cboe.com/InterestRateETF for the full range of available contracts.

Exhibit 19 Bloomberg Barclays US Aggregate Bond Index Sector Allocation, Selected Years

Year	Government	Corporate	Securitized
1993	53.0%	17.0%	30.0%
1998	46.0%	22.0%	32.0%
2000	38.0%	24.0%	39.0%
2005	40.2%	19.5%	40.2%
2008	38.6%	17.7%	43.7%
2010	45.8%	18.8%	35.5%
2015	44.8%	24.2%	31.0%

Source: Lehman Brothers, Barclays.

Separately, a corporate debt index investor might find her benchmark choice no longer desirable if issuers refinance maturing bonds for longer maturities and extend overall debt duration. Third, value-weighted indexes assign a larger share of the index to borrowers with the largest amount of outstanding debt, leading a more leveraged issuer or sector to receive a higher weight. Creditworthiness and leverage tend to be negatively correlated. As a particular issuer or sector of the economy borrows more, investors tracking a value-weighted index will automatically increase their fixed-income exposure to these borrowers. The greater allocation to more-levered borrowers is known as the "bums problem."[32] Examples of the bums problem for entire sectors of the fixed-income market include the large increase in global telecoms–related debt financing in 2000 and the increase in US mortgage-backed financing prior to the 2008 financial crisis, both of which negatively affected investors who faced higher allocation to these sectors through a value-weighted index.

The dynamics of fixed-income markets require investors to more actively understand and define their underlying duration preferences as well as a desired risk and return profile within their fixed-income allocation when conducting benchmark selection. Expressed differently, the desired duration profile may be considered the portfolio "beta," with the targeted duration equal to an investor's preferred duration exposure. Once these parameters are clear, investors may wish to combine several well-defined sub-benchmark categories into an overall benchmark. Examples of sub-benchmark categories might include Treasuries (or domestic sovereign bonds), US agencies or other asset-backed securities, corporate bonds, high-yield bonds, bank loans, developed markets global debt, or emerging markets debt.

For fixed-income investors seeking to reduce the cost of active management while addressing systematic biases such as the bums problem, a third alternative known as **smart beta** has emerged. Smart beta involves the use of simple, transparent, rules-based strategies as a basis for investment decisions. The starting point for smart beta investors is an analysis of the well-established, static strategies that tend to drive excess portfolio returns. In theory, asset managers who are able to isolate and pursue such strategies can capture a significant proportion of these excess returns without the significantly higher fees associated with active management. Although the use of smart beta strategies is more established among equity managers, fixed-income managers are increasing their use of these techniques as well.[33]

32 See Siegel (2003).
33 See Staal et al. (2015).

EXAMPLE 11

Given the significant rise in regional bond issuance following the 2008 financial crisis, Next Europe Asset Management Limited aims to grow its assets under management by attracting a variety of new local Eurozone investors to the broader set of alternatives available in the current fixed-income market. Several of the indexes that Next Europe offers as a basis for investment are as follows:

- **S&P Eurozone Sovereign Bond Index.** This index consists of fixed-rate, sovereign debt publicly issued by Eurozone national governments for their domestic markets with various maturities including 1 to 3 years, 3 to 5 years, 5 to 7 years, 7 to 10 years, and 10+ years. For example, the one- to three-year index had a weighted average maturity of 1.88 years and a modified duration of 1.82 as of 31 December 2015.[34]
- **Bloomberg EUR Investment Grade European Corporate Bond Index (BERC).** The BERC index consists of local, EUR-based corporate debt issuance in Eurozone countries and had an effective duration of 5.39 as of January 2016.
- **Bloomberg EUR High Yield Corporate Bond Index (BEUH).** This index consists of sub-investment grade, EUR-denominated bonds issued by Eurozone-based corporations. It had an effective duration of 4.44 as of January 2016.[35]
- **FTSE Pfandbrief Index.** The Pfandbrief, which represents the largest segment of the German private debt market, is a bond issued by German mortgage banks, collateralized by long-term assets such as real estate or public sector loans. These securities are also referred to as covered bonds, and are being used as a model for similar issuance in other European countries.

The FTSE Pfandbrief indexes include jumbo Pfandbriefs from German issuers, as well as those of comparable structure and quality from other Eurozone countries. The sub-indexes offer a range of maturities including 1 to 3 years, 3 to 5 years, 5 to 7 years, 7 to 10 years and 10+ years.[36]

Which of the above indexes would be suitable for the following investor portfolios?

1 A highly risk-averse investor who is sensitive to fluctuations in portfolio value.

2 A new German private university that has established an endowment with a very long-term investment horizon.

3 A Danish life insurer relying on the fixed-income portfolio managed by Next Europe to meet both short-term claims as well as offset long-term obligations.

Solution to 1:

Given this investor's high degree of risk aversion, an index with short or intermediate duration with limited credit risk would be most appropriate to limit market value risk. Of the alternatives listed above, the S&P Eurozone Sovereign Bond 1–3 Years Index or the FTSE 1–3 Year Pfandbrief Index (given the high credit quality of covered bonds) would be appropriate choices.

34 www.us.spindices.com
35 www.bloombergindexes.com
36 www.ftse.com/products/indices

Solution to 2:

This investor's very long investment horizon suggests that the BERC is an appropriate index, because it has the longest duration of the indexes given. In addition, the long-term S&P Eurozone Sovereign Bond or FTSE Pfandbrief indexes (10+ years) could be appropriate choices as well. Next Europe should consider the tradeoff between duration and risk in its discussion with the endowment.

Solution to 3:

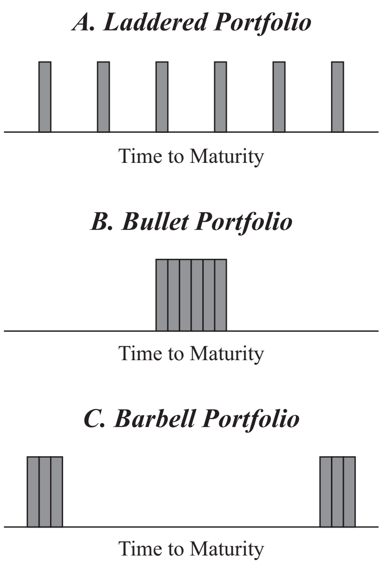
The Danish life insurer faces two types of future obligation, namely a short-term outlay for expected claims and a long-term horizon for future obligations. For the short-term exposure, stability of market value is a primary consideration, and the insurer would seek an index with low market risk. Of the above alternatives, the 1–3 Years S&P Sovereign Bond or the FTSE Pfandbrief 1–3 Year alternatives would be the best choices. The longer-term alternatives in the Solution to 2 would be most appropriate for the long-term future obligations.

LADDERED BOND PORTFOLIOS

10

A popular fixed-income investment strategy in the wealth management industry is to build a "laddered" portfolio for clients. Exhibit 20 illustrates this approach, along with two other maturity-based strategies—a "bullet" portfolio and a "barbell" portfolio. The laddered portfolio spreads the bonds' maturities and par values more or less evenly along the yield curve. The bullet portfolio concentrates the bonds at a particular point on the yield curve, whereas the barbell portfolio places the bonds at the short-term and long-term ends of the curve. In principle, each can have the same portfolio duration statistic and approximately the same change in value for a parallel shift in the yield curve. A non-parallel shift or a twist in the curve, however, leads to very different outcomes for the bullet and barbell structures. An obvious advantage to the laddered portfolio is protection from shifts and twists—the cash flows are essentially "diversified" across the time spectrum.

Exhibit 20 Laddered, Bullet, and Barbell Fixed-Income Portfolios



This "diversification" over time provides the investor a balanced position between the two sources of interest rate risk—cash flow reinvestment and market price volatility. Bonds mature each year and are reinvested at the longer-term end of the ladder, typically at higher rates than short-term securities. Over time, the laddered portfolio likely includes bonds that were purchased at high interest rates as well as low interest rates. Investors familiar with "dollar cost averaging" will see the similarity. In addition, by reinvesting funds as bonds mature maintains the duration of the overall portfolio.

Another attractive feature to the laddered portfolio apparent in Exhibit 20 is in convexity. Convexity, technically, is the second-order effect on the value of an asset or liability given a change in the yield to maturity. Importantly, it is affected by the dispersion of cash flows, as indicated in Equation 1 repeated here:

$$\text{Convexity} = \frac{\text{Macaulay duration}^2 + \text{Macaulay duration} + \text{Dispersion}}{(1 + \text{Cash flow yield})^2}$$

If the three portfolios have the same duration (and cash flow yield), then the barbell clearly has the highest convexity and the bullet the lowest. The laddered portfolio also has high convexity because its cash flows by design are spread over the time line. Compared with the barbell, the laddered portfolio has much less cash flow reinvestment risk.

In practice, perhaps the most desirable aspect of the laddered portfolio is in liquidity management. This aspect is particularly relevant if the bonds are not actively traded, as is the case for many corporate securities. As time passes, there is always a bond that is close to redemption. Its duration will be low so that its price is fairly stable even in a time of interest rate volatility. If the client needs immediate cash, the soon-to-mature bond makes for high-quality collateral on a personal loan or, for an institution, a repo contract. As the bonds mature, the final coupon and principal can be deployed for consumption or reinvested in a long-term bond at the back of the ladder.

Another way for a wealth manager to build a laddered portfolio for a client is to use fixed-maturity corporate bond ETFs. These ETFs have a designated year of maturity and credit risk profile—for instance, 2021 investment-grade corporate bonds. This ETF is a passively managed (and, therefore, low-administrative-cost) fund that seeks to replicate the performance of an index of, for instance, 50 held-to-maturity investment-grade corporate bonds that mature in 2021. As discussed in previous sections, the ETF manager can use a stratified sampling approach to track the index.

Suppose that in 2017, the wealth manager buys for the client roughly equal positions in the 2018 through 2025 fixed-maturity corporate bond ETFs. These purchases create a laddered portfolio that should provide the same benefits as holding the bonds directly—price stability in the soonest-to-mature ETF and greater convexity than holding more of a bullet portfolio. Moreover, the ETFs should be more liquid than positions in the actual bonds.

But laddered portfolios are not without limitations. For many investors, the decision to build a laddered bond portfolio should be weighed against buying shares in a fixed-income mutual fund, especially if the portfolio consists of a limited number of corporate bonds. Clearly, the mutual fund provides greater diversification of default risk. Moreover, actual bonds can entail a much higher cost of acquisition. If the entire investment needs to be liquidated, the mutual fund shares can be redeemed more quickly than the bonds can be sold, and likely at a better price.

EXAMPLE 12

Zheng Zilong, CFA, is a Shanghai-based wealth adviser. A major client of his, the Wang family, holds most of its assets in residential property and equity investments. Mr. Zheng recommends that the Wang family also have a laddered portfolio of Chinese government bonds. He suggests the following portfolio, priced for settlement on 1 January 2017:

Coupon Rate	Payment Frequency	Maturity	Flat Price	Yield (s.a.)	Par Value	Market Value
3.22%	Annual	26-Mar-18	101.7493	1.758%	10 Million	10,422,826
3.14%	Annual	8-Sept-20	102.1336	2.508%	10 Million	10,312,292
3.05%	Annual	22-Oct-22	101.4045	2.764%	10 Million	10,199,779
2.99%	Semi-annual	15-Oct-25	101.4454	2.803%	10 Million	10,208,611
					40 Million	41,143,508

The yields to maturity on the first three bonds have been converted from a periodicity of one to two in order to report them on a consistent semi-annual bond basis, as indicated by "(s.a.)". The total market value of the portfolio is CNY 41,143,508. The cash flow yield for the portfolio is 2.661%, whereas the market value weighted average yield is 2.455%.

Most important for his presentation to the senior members of the Wang family is the schedule for the 30 cash flows:

1	26-Mar-17	322,000	16	8-Sep-20	10,314,000
2	15-Apr-17	149,500	17	15-Oct-20	149,500
3	8-Sep-17	314,000	18	22-Oct-20	305,000
4	15-Oct-17	149,500	19	15-Apr-21	149,500
5	22-Oct-17	305,000	20	15-Oct-21	149,500
6	26-Mar-18	10,322,000	21	22-Oct-21	305,000
7	15-Apr-18	149,500	22	15-Apr-22	149,500
8	8-Sep-18	314,000	23	15-Oct-22	149,500
9	15-Oct-18	149,500	24	22-Oct-22	10,305,000
10	22-Oct-18	305,000	25	15-Apr-23	149,500
11	15-Apr-19	149,500	26	15-Oct-23	149,500
12	8-Sep-19	314,000	27	15-Apr-24	149,500
13	15-Oct-19	149,500	28	15-Oct-24	149,500
14	22-Oct-19	305,000	29	15-Apr-25	149,500
15	15-Apr-20	149,500	30	15-Oct-25	10,149,500

Indicate the main points that Mr. Zheng should emphasize in this presentation about the laddered portfolio to senior members of the Wang family.

Solution:

Mr. Zheng should emphasize three features of the portfolio:

1 **High credit quality.** Given that the family already has substantial holdings in residential property and equity, which are subject to price volatility and risk, investments in government bonds provide the Wang family with holdings in a very low-risk asset class.

2 **Liquidity.** The schedule of payments shows that coupon payments are received each year. These funds can be used for any cash need, including household expenses. The large principal payments can be reinvested in longer-term government bonds at the back of the ladder.

3 **Yield curve diversification.** The bond investments are spread out along four segments of the government bond yield curve. If they were concentrated at a single point, the portfolio would have the risk of higher yields at that point. By spreading out the maturities in the ladder formation, the portfolio has the benefit of diversification.

SUMMARY

This reading covers structured and passive total return fixed-income strategies: immunization of single and multiple liabilities, indexation, and laddering. The reading makes the following main points:

- Passive fixed-income investing requires a frame of reference, such as a balance sheet, to structure the bond portfolio. This frame of reference can be as simple as the time to retirement for an individual or as complex as a balance sheet of rate-sensitive assets and liabilities for a company.
- Asset–liability management strategies consider both assets and liabilities.
- Liability-driven investing takes the liabilities as given and builds the asset portfolio in accordance with the interest rate risk characteristics of the liabilities.
- Asset-driven liabilities take the assets as given and structures debt liabilities in accordance with the interest rate characteristics of the assets.
- Assets and liabilities can be categorized by the degree of certainty surrounding the amount and timing of cash flows. Type I assets and liabilities, such as traditional fixed-rate bonds with no embedded options, have known amounts and payment dates. For Type I assets and liabilities, yield duration statistics such as Macaulay, modified, and money duration apply. Type II, III, and IV assets and liabilities have uncertain amounts and/or uncertain timing of payment. For Type II, III, and IV assets and liabilities, curve duration statistics such as effective duration are needed. A model is used to obtain the estimated values when the yield curve shifts up and down by the same amount.
- Immunization is the process of structuring and managing a fixed-income portfolio to minimize the variance in the realized rate of return over a known investment horizon.
- In the case of a single liability, immunization is achieved by matching the Macaulay duration of the bond portfolio to the horizon date. As time passes and bond yields change, the duration of the bonds changes and the portfolio needs to be rebalanced. This rebalancing can be accomplished by buying and selling bonds or using interest rate derivatives such as futures contracts and interest rate swaps.
- An immunization strategy aims to lock in the cash flow yield on the portfolio, which is the internal rate of return on the cash flows. It is not the weighted average of the yields to maturity on the bonds that constitute the portfolio.

- Immunization can be interpreted as "zero replication" in that the performance of the bond portfolio over the investment horizon replicates the zero-coupon bond that provides for perfect immunization. This zero-coupon bond has a maturity that matches the date of the single liability—there is no coupon reinvestment risk nor price risk as the bond is held to maturity (assuming no default).
- The risk to immunization is that as the yield curve shifts and twists, the cash flow yield on the bond portfolio does not match the change in the yield on the zero-coupon bond that would provide for perfect immunization.
- A sufficient, but not necessary, condition for immunization is a parallel (or shape-preserving) shift whereby all yields change by the same amount in the same direction. If the change in the cash flow yield is the same as that on the zero-coupon bond being replicated, immunization can be achieved even with a non-parallel shift to the yield curve.
- Structural risk to immunization arises from some non-parallel shifts and twists to the yield curve. This risk is reduced by minimizing the dispersion of cash flows in the portfolio, which can be accomplished by minimizing the convexity statistic for the portfolio. Concentrating the cash flows around the horizon date makes the immunizing portfolio closely track the zero-coupon bond that provides for perfect immunization.
- For multiple liabilities, one method of immunization is cash flow matching. A portfolio of high-quality zero-coupon or fixed-income bonds is purchased to match as closely as possible the amount and timing of the liabilities.
- A motive for cash flow matching can be accounting defeasance, whereby both the assets and liabilities are removed from the balance sheet.
- Immunization of multiple liabilities can be achieved by structuring and managing a portfolio of fixed income bonds. Because the market values of the assets and liabilities differ, the strategy is to match the money durations. The money duration is the modified duration multiplied by the market value. The basis point value is a measure of money duration calculated by multiplying the money duration by 0.0001.
- The conditions to immunize multiple liabilities are that (1) the market value of assets is greater than or equal to the market value of the liabilities, (2) the asset basis point value (BPV) equals the liability BPV, and (3) the dispersion of cash flows and the convexity of assets are greater than those of the liabilities.
- A derivatives overlay—for example, interest rate futures contracts—can be used to immunize single or multiple liabilities.
- The number of futures contracts needed to immunize is the liability BPV minus the asset BPV, divided by the futures BPV. If the result is a positive number, the entity buys, or goes long, futures contracts. If the result is a negative number, the entity sells, or goes short, futures contracts. The futures BPV can be approximated by the BPV for the cheapest-to-deliver security divided by the conversion factor for the cheapest-to-deliver security.
- Contingent immunization adds active management of the surplus, which is the difference between the asset and liability market values, with the intent to reduce the overall cost of retiring the liabilities. In principle, any asset classes can be used for the active investment. The entity can choose to over-hedge or under-hedge the number of futures contracts needed for passive immunization.
- Liability-driven investing (LDI) often is used for complex rate-sensitive liabilities, such as those for a defined benefit pension plan. The retirement benefits for covered employees depend on many variables, such as years of employment,

age at retirement, wage level at retirement, and expected lifetime. There are different measures for the liabilities: for instance, the accumulated benefit obligation (ABO) that is based on current wages and the projected benefit obligation (PBO) that is based on expected future wages. For each liability measure (ABO or PBO), a model is used to extract the effective duration and BPV.

- Interest rate swap overlays can be used to reduce the duration gap as measured by the asset and liability BPVs. There often is a large gap because pension funds hold sizable asset positions in equities that have low or zero effective durations and their liability durations are high.
- The hedging ratio is the percentage of the duration gap that is closed with the derivatives. A hedging ratio of zero implies no hedging. A hedging ratio of 100% implies immunization—that is, complete removal of interest rate risk.
- Strategic hedging is the active management of the hedging ratio. Because asset BPVs are less than liability BPVs in typical pension funds, the derivatives overlay requires the use of receive-fixed interest rate swaps. Because receive-fixed swaps gain value as current swap market rates fall, the fund manager could choose to raise the hedging ratio when lower rates are anticipated. If rates are expected to go up, the manager could strategically reduce the hedging ratio.
- An alternative to the receive-fixed interest rate swap is a purchased receiver swaption. This swaption confers to the buyer the right to enter the swap as the fixed-rate receiver. Because of its negative duration gap (asset BPV is less than liability BPV), the typical pension plan suffers when interest rates fall and could become underfunded. The gain on the receiver swaption as rates decline offsets the losses on the balance sheet.
- Another alternative is a swaption collar, the combination of buying the receiver swaption and writing a payer swaption. The premium received on the payer swaption that is written offsets the premium needed to buy the receiver swaption.
- The choice among hedging with the receive-fixed swap, the purchased receiver swaption, and the swaption collar depends in part on the pension fund manager's view on future interest rates. If rates are expected to be low, the receive-fixed swap typically is the preferred derivative. If rates are expected to go up, the swaption collar can become attractive. And if rates are projected to reach a certain threshold that depends on the option costs and the strike rates, the purchased receiver swaption can become the favored choice.
- Model risks arise in LDI strategies because of the many assumptions in the models and approximations used to measure key parameters. For example, the liability BPV for the defined benefit pension plan depends on the choice of measure (ABO or PBO) and the assumptions that go into the model regarding future events (e.g., wage levels, time of retirement, and time of death).
- Spread risk in LDI strategies arises because it is common to assume equal changes in asset, liability, and hedging instrument yields when calculating the number of futures contracts, or the notional principal on an interest rate swap, to attain a particular hedging ratio. The assets and liabilities are often on corporate securities, however, and their spreads to benchmark yields can vary over time.
- The Credit Support Annex to the standard ISDA swap agreement often calls for collateralization by one or both counterparties to the contract. This requirement introduces the risk of exhausting available securities or cash assets to serve as collateral.

- Investing in a fund that tracks a bond market index offers the benefits of both diversification and low administrative costs. The deviation of the returns between the index and the fund is called tracking risk, or tracking error. Tracking risk arises when the fund manager chooses to buy only a subset of the index, a strategy called enhanced indexing, because fully replicating the index can be impractical as a result of the large number of bonds in the fixed-income universe.
- Corporate bonds are often illiquid. Capital requirements have reduced the incentive for broker/dealers to maintain inventory in thinly traded securities. The lack of active trading is a challenge for valuation. Matrix pricing uses available data on comparable securities to estimate the fair value of the illiquid bonds.
- The primary risk factors encountered by an investor tracking a bond index include decisions regarding duration (option-adjusted duration for callable bonds, convexity for possible large yield shifts, and key rate durations for non-parallel shifts) and portfolio weights (assigned by sector, credit quality, maturity, coupon rate, and issuer).
- Index replication is one method to establish a passive exposure to the bond market. The manager buys or sells bonds only when there are changes to the index. Full replication can be expensive, however, as well as infeasible for broad-based fixed-income indexes that include many illiquid bonds.
- Several enhancement strategies can reduce the costs to track a bond index: lowering trading costs, using models to identify undervalued bonds and to gauge relative value at varying points along the yield curve, over/under weighting specific credit sectors over the business cycle, and evaluating specific call features to identify value given large yield changes.
- Investors can obtain passive exposure to the bond market using mutual funds and exchange-traded funds that track a bond index. Shares in mutual funds are redeemable at the net asset value with a one-day time lag. Exchange-traded fund (ETF) shares have the advantage of trading on an exchange.
- A total return swap, an over-the-counter derivative, allows an institutional investor to transform an asset or liability from one asset category to another—for instance, from variable-rate cash flows referencing Libor to the total return on a particular bond index.
- A total return swap (TRS) can have some advantages over a direct investment in a bond mutual fund or ETF. As a derivative, it requires less initial cash outlay than direct investment in the bond portfolio for similar performance. A TRS also carries counterparty credit risk, however. As a customized over-the-counter product, a TRS can offer exposure to assets that are difficult to access directly, such as some high-yield and commercial loan investments.
- Selecting a particular bond index is a major decision for a fixed-income investment manager. Selection is guided by the specified goals and objectives for the investment. The decision should recognize several features of bond indexes: (1) Given that bonds have finite maturities, the duration of the index drifts down over time; (2) the composition of the index changes over time with the business cycle and maturity preferences of issuers; and (3) value-weighted indexes assign larger shares to borrowers having more debt, leading to the "bums problem" that bond index investors can become overly exposed to leveraged firms.
- A laddered bond portfolio is a common investment strategy in the wealth management industry. The laddered portfolio offers "diversification" over the yield curve compared with "bullet" or "barbell" portfolios. This structure is especially

attractive in stable, upwardly sloped yield curve environments as maturing short-term debt is replaced with higher-yielding long-term debt at the back of the ladder.

- A laddered portfolio offers an increase in convexity because the cash flows have greater dispersions than a more concentrated (bullet) portfolio.
- A laddered portfolio provides liquidity in that it always contains a soon-to-mature bond that could provide high-quality, low-duration collateral on a repo contract if needed.
- A laddered portfolio can be constructed with fixed-maturity corporate bond ETFs that have a designated maturity and credit risk profile.

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PRACTICE PROBLEMS

The following information relates to Questions 1–8

Serena Soto is a risk management specialist with Liability Protection Advisors. Trey Hudgens, CFO of Kiest Manufacturing, enlists Soto's help with three projects. The first project is to defease some of Kiest's existing fixed-rate bonds that are maturing in each of the next three years. The bonds have no call or put provisions and pay interest annually. Exhibit 1 presents the payment schedule for the bonds.

Exhibit 1 Kiest Manufacturing Bond Payment Schedule As of 1 October 2017

Maturity Date	Payment Amount
1 October 2018	$9,572,000
1 October 2019	$8,392,000
1 October 2020	$8,200,000

The second project for Soto is to help Hudgens immunize a $20 million portfolio of liabilities. The liabilities range from 3.00 years to 8.50 years with a Macaulay duration of 5.34 years, cash flow yield of 3.25%, portfolio convexity of 33.05, and basis point value (BPV) of $10,505. Soto suggested employing a duration-matching strategy using one of the three AAA rated bond portfolios presented in Exhibit 2.

Exhibit 2 Possible AAA Rated Duration-Matching Portfolios

	Portfolio A	Portfolio B	Portfolio C
Bonds (term, coupon)	4.5 years, 2.63% 7.0 years, 3.50%	3.0 years, 2.00% 6.0 years, 3.25% 8.5 years, 3.88%	1.5 years, 1.25% 11.5 years, 4.38%
Macaulay duration	5.35	5.34	5.36
Cash flow yield	3.16%	3.33%	3.88%
Convexity	31.98	34.51	50.21
BPV	$10,524	$10,506	$10,516

Soto explains to Hudgens that the underlying duration-matching strategy is based on the following three assumptions.

1. Yield curve shifts in the future will be parallel.
2. Bond types and quality will closely match those of the liabilities.
3. The portfolio will be rebalanced by buying or selling bonds rather than using derivatives.

The third project for Soto is to make a significant direct investment in broadly diversified global bonds for Kiest's pension plan. Kiest has a young workforce, and thus, the plan has a long-term investment horizon. Hudgens needs Soto's help to select a benchmark index that is appropriate for Kiest's young workforce and avoids the "bums" problem. Soto discusses three benchmark candidates, presented in Exhibit 3.

Exhibit 3 Global Bond Index Benchmark Candidates

Index Name	Effective Duration	Index Characteristics
Global Aggregate	7.73	Market cap weighted; Treasuries, corporates, agency, securitized debt
Global Aggregate GDP Weighted	7.71	Same as Global Aggregate, except GDP weighted
Global High Yield	4.18	GDP weighted; sovereign, agency, corporate debt

With the benchmark selected, Hudgens provides guidelines to Soto directing her to (1) use the most cost-effective method to track the benchmark and (2) provide low tracking error.

After providing Hudgens with advice on direct investment, Soto offered him additional information on alternative indirect investment strategies using (1) bond mutual funds, (2) exchange-traded funds (ETFs), and (3) total return swaps. Hudgens expresses interest in using bond mutual funds rather than the other strategies for the following reasons.

Reason 1 Total return swaps have much higher transaction costs and initial cash outlay than bond mutual funds.

Reason 2 Unlike bond mutual funds, bond ETFs can trade at discounts to their underlying indexes, and those discounts can persist.

Reason 3 Bond mutual funds can be traded throughout the day at the net asset value of the underlying bonds.

1 Based on Exhibit 1, Kiest's liabilities would be classified as:
   - **A** Type I.
   - **B** Type II.
   - **C** Type III.

2 Based on Exhibit 2, the portfolio with the greatest structural risk is:
   - **A** Portfolio A.
   - **B** Portfolio B.
   - **C** Portfolio C.

3 Which portfolio in Exhibit 2 fails to meet the requirements to achieve immunization for multiple liabilities?
   - **A** Portfolio A
   - **B** Portfolio B
   - **C** Portfolio C

4 Based on Exhibit 2, relative to Portfolio C, Portfolio B:
   - **A** has higher cash flow reinvestment risk.
   - **B** is a more desirable portfolio for liquidity management.
   - **C** provides less protection from yield curve shifts and twists.

5 Soto's three assumptions regarding the duration-matching strategy indicate the presence of:

A model risk.

B spread risk.

C counterparty credit risk.

6 The global bond benchmark in Exhibit 3 that is *most* appropriate for Kiest to use is the:

A Global Aggregate Index.

B Global High Yield Index.

C Global Aggregate GDP Weighted Index.

7 To meet both of Hudgens's guidelines for the pension's bond fund investment, Soto should recommend:

A pure indexing.

B enhanced indexing.

C active management.

8 Which of Hudgens's reasons for choosing bond mutual funds as an investment vehicle is correct?

A Reason 1

B Reason 2

C Reason 3

The following information relates to questions 9–17

SD&R Capital (SD&R), a global asset management company, specializes in fixed-income investments. Molly Compton, chief investment officer, is meeting with a prospective client, Leah Mowery of DePuy Financial Company (DFC).

Mowery informs Compton that DFC's previous fixed income manager focused on the interest rate sensitivities of assets and liabilities when making asset allocation decisions. Compton explains that, in contrast, SD&R's investment process first analyzes the size and timing of client liabilities, then builds an asset portfolio based on the interest rate sensitivity of those liabilities.

Compton notes that SD&R generally uses actively managed portfolios designed to earn a return in excess of the benchmark portfolio. For clients interested in passive exposure to fixed-income instruments, SD&R offers two additional approaches.

Approach 1 Seeks to fully replicate the Bloomberg Barclays US Aggregate Bond Index.

Approach 2 Follows an enhanced indexing process for a subset of the bonds included in the Bloomberg Barclays US Aggregate Bond Index. Approach 2 may also be customized to reflect client preferences.

To illustrate SD&R's immunization approach for controlling portfolio interest rate risk, Compton discusses a hypothetical portfolio composed of two non-callable, investment-grade bonds. The portfolio has a weighted average yield-to-maturity of 9.55%, a weighted average coupon rate of 10.25%, and a cash flow yield of 9.85%.

Mowery informs Compton that DFC has a single $500 million liability due in nine years, and she wants SD&R to construct a bond portfolio that earns a rate of return sufficient to pay off the obligation. Mowery expresses concern about the risks associated with an immunization strategy for this obligation. In response, Compton makes the following statements about liability-driven investing:

Statement 1 Although the amount and date of SD&R's liability is known with certainty, measurement errors associated with key parameters relative to interest rate changes may adversely affect the bond portfolios.

Statement 2 A cash flow matching strategy will mitigate the risk from non-parallel shifts in the yield curve.

Compton provides the four US dollar–denominated bond portfolios in Exhibit 1 for consideration. Compton explains that the portfolios consist of non-callable, investment-grade corporate and government bonds of various maturities because zero-coupon bonds are unavailable.

Exhibit 1 Proposed Bond Portfolios to Immunize SD&R Single Liability

	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4
Cash flow yield	7.48%	7.50%	7.53%	7.51%
Average time to maturity	11.2 years	9.8 years	9.0 years	10.1 years
Macaulay duration	9.8	8.9	8.0	9.1
Market value weighted duration	9.1	8.5	7.8	8.6
Convexity	154.11	131.75	130.00	109.32

The discussion turns to benchmark selection. DFC's previous fixed-income manager used a custom benchmark with the following characteristics:

Characteristic 1 The benchmark portfolio invests only in investment-grade bonds of US corporations with a minimum issuance size of $250 million.

Characteristic 2 Valuation occurs on a weekly basis, because many of the bonds in the index are valued weekly.

Characteristic 3 Historical prices and portfolio turnover are available for review.

Compton explains that, in order to evaluate the asset allocation process, fixed-income portfolios should have an appropriate benchmark. Mowery asks for benchmark advice regarding DFC's portfolio of short-term and intermediate-term bonds, all denominated in US dollars. Compton presents three possible benchmarks in Exhibit 2.

Exhibit 2 Proposed Benchmark Portfolios

Benchmark	Index	Composition	Duration
1	Bloomberg Barclays US Bond Index	80% US government bonds 20% US corporate bonds	8.7
2 Index Blend	50% Bloomberg Barclays US Corporate Bond Index	100% US corporate bonds	7.5
	50% Bloomberg Barclays Short-Term Treasury Index	100% short-term US government debt	0.5
3	Bloomberg Barclays Global Aggregate Bond Index	60% EUR-denominated corporate bonds 40% US-denominated corporate debt	12.3

9 The investment process followed by DFC's previous fixed-income manager is *best* described as:

A asset-driven liabilities.

B liability-driven investing.

C asset–liability management.

10 Relative to Approach 2 of gaining passive exposure, an advantage of Approach 1 is that it:

A reduces the need for frequent rebalancing.

B limits the need to purchase bonds that are thinly traded.

C provides a higher degree of portfolio risk diversification.

11 Relative to Approach 1 of gaining passive exposure, an advantage of Approach 2 is that it:

A minimizes tracking error.

B requires less risk analysis.

C is more appropriate for socially responsible investors.

12 The two-bond hypothetical portfolio's immunization goal is to lock in a rate of return equal to:

A 9.55%.

B 9.85%.

C 10.25%.

13 Which of Compton's statements about liability-driven investing is (are) correct?

A Statement 1 only.

B Statement 2 only.

C Both Statement 1 and Statement 2.

14 Based on Exhibit 1, which of the portfolios will *best* immunize SD&R's single liability?

A Portfolio 1

B Portfolio 2

C Portfolio 3

15 Which of the portfolios in Exhibit 1 *best* minimizes the structural risk to a single-liability immunization strategy?

A Portfolio 1

B Portfolio 3

C Portfolio 4

16 Which of the custom benchmark's characteristics violates the requirements for an appropriate benchmark portfolio?

A Characteristic 1

B Characteristic 2

C Characteristic 3

17 Based on DFC's bond holdings and Exhibit 2, Compton should recommend:

A Benchmark 1.

B Benchmark 2.

C Benchmark 3.

The following information relates to questions 18–23

Doug Kepler, the newly hired chief financial officer for the City of Radford, asks the deputy financial manager, Hui Ng, to prepare an analysis of the current investment portfolio and the city's current and future obligations. The city has multiple liabilities of different amounts and maturities relating to the pension fund, infrastructure repairs, and various other obligations.

Ng observes that the current fixed-income portfolio is structured to match the duration of each liability. Previously, this structure caused the city to access a line of credit for temporary mismatches resulting from changes in the term structure of interest rates.

Kepler asks Ng for different strategies to manage the interest rate risk of the city's fixed-income investment portfolio against one-time shifts in the yield curve. Ng considers two different strategies:

Strategy 1: Immunization of the single liabilities using zero-coupon bonds held to maturity.

Strategy 2: Immunization of the single liabilities using coupon-bearing bonds while continuously matching duration.

The city also manages a separate, smaller bond portfolio for the Radford School District. During the next five years, the school district has obligations for school expansions and renovations. The funds needed for those obligations are invested in the Bloomberg Barclays US Aggregate Index. Kepler asks Ng which portfolio management strategy would be most efficient in mimicking this index.

A Radford School Board member has stated that she prefers a bond portfolio structure that provides diversification over time, as well as liquidity. In addressing the board member's inquiry, Ng examines a bullet portfolio, a barbell portfolio, and a laddered portfolio.

18 A disadvantage of Strategy 1 is that:

A price risk still exists.

B interest rate volatility introduces risk to effective matching.

C there may not be enough bonds available to match all liabilities.

19 Which duration measure should be matched when implementing Strategy 2?

A Key rate

B Modified

C Macaulay

20 An upward shift in the yield curve on Strategy 2 will *most likely* result in the:

A price effect cancelling the coupon reinvestment effect.

B price effect being greater than the coupon reinvestment effect.

C coupon reinvestment effect being greater than the price effect.

21 The effects of a non-parallel shift in the yield curve on Strategy 2 can be reduced by:

A minimizing the convexity of the bond portfolio.

B maximizing the cash flow yield of the bond portfolio.

C minimizing the difference between liability duration and bond-portfolio duration.

22 Ng's response to Kepler's question about the most efficient portfolio management strategy should be:

A full replication.

B active management.

C an enhanced indexing strategy.

23 Which portfolio structure should Ng recommend that would satisfy the school board member's preference?

A Bullet portfolio

B Barbell portfolio

C Laddered portfolio

The following information relates to questions 24–26

Chaopraya Av is an investment advisor for high-net-worth individuals. One of her clients, Schuylkill Cy, plans to fund her grandson's college education and considers two options:

Option 1 Contribute a lump sum of $300,000 in 10 years.

Option 2 Contribute four level annual payments of $76,500 starting in 10 years.

The grandson will start college in 10 years. Cy seeks to immunize the contribution today.

For Option 1, Av calculates the present value of the $300,000 as $234,535. To immunize the future single outflow, Av considers three bond portfolios given that no zero-coupon government bonds are available. The three portfolios consist of non-callable, fixed-rate, coupon-bearing government bonds considered free of default risk. Av prepares a comparative analysis of the three portfolios, presented in Exhibit 1.

Exhibit 1 Results of Comparative Analysis of Potential Portfolios

	Portfolio A	Portfolio B	Portfolio C
Market value	$235,727	$233,428	$235,306
Cash flow yield	2.504%	2.506%	2.502%
Macaulay duration	9.998	10.002	9.503
Convexity	119.055	121.498	108.091

Av evaluates the three bond portfolios and selects one to recommend to Cy.

24 **Recommend** the portfolio in Exhibit 1 that would *best* achieve the immunization. **Justify** your response.

Template for Question 24

Recommend the portfolio in Exhibit 1 that would *best* achieve the immunization. (circle one)	Justify your response.
Portfolio A Portfolio B Portfolio C	

Cy and Av now discuss Option 2.

Av estimates the present value of the four future cash flows as $230,372, with a money duration of $2,609,700 and convexity of 135.142. She considers three possible portfolios to immunize the future payments, as presented in Exhibit 2.

Exhibit 2 Data for Bond Portfolios to Immunize Four Annual Contributions

	Portfolio 1	Portfolio 2	Portfolio 3
Market value	$245,178	$248,230	$251,337
Cash flow yield	2.521%	2.520%	2.516%
Money duration	2,609,981	2,609,442	2,609,707
Convexity	147.640	139.851	132.865

25 **Determine** the *most appropriate* immunization portfolio in Exhibit 2. **Justify** your decision.

Template for Question 25

Determine the *most appropriate* immunization portfolio in Exhibit 2. (circle one)	Justify your decision.
Portfolio 1 Portfolio 2 Portfolio 3	

After selecting a portfolio to immunize Cy's multiple future outflows, Av prepares a report on how this immunization strategy would respond to various interest rate scenarios. The scenario analysis is presented in Exhibit 3.

Exhibit 3 Projected Portfolio Response to Interest Rate Scenarios

	Immunizing Portfolio	Outflow Portfolio	Difference
Upward parallel shift			
Δ Market value	–6,410	–6,427	18
Δ Cash flow yield	0.250%	0.250%	0.000%
Δ Portfolio BPV	–9	–8	–1
Downward parallel shift			
Δ Market value	6,626	6,622	4
Δ Cash flow yield	–0.250%	–0.250%	0.000%
Δ Portfolio BPV	9	8	1
Steepening twist			
Δ Market value	–1,912	347	–2,259
Δ Cash flow yield	0.074%	–0.013%	0.087%
Δ Portfolio BPV	–3	0	–3
Flattening twist			
Δ Market value	1,966	–343	2,309
Δ Cash flow yield	–0.075%	0.013%	–0.088%
Δ Portfolio BPV	3	0	3

26 **Discuss** the effectiveness of Av's immunization strategy in terms of duration gaps.

SOLUTIONS

1 A is correct. Type I liabilities have cash outlays with known amounts and timing. The dates and amounts of Kiest's liabilities are known; therefore, they would be classified as Type I liabilities.

2 C is correct. Structural risk arises from the design of the duration-matching portfolio. It is reduced by minimizing the dispersion of the bond positions, going from a barbell structure to more of a bullet portfolio that concentrates the component bonds' durations around the investment horizon. With bond maturities of 1.5 and 11.5 years, Portfolio C has a definite barbell structure compared with those of Portfolios A and B, and it is thus subject to a greater degree of risk from yield curve twists and non-parallel shifts. In addition, Portfolio C has the highest level of convexity, which increases a portfolio's structural risk.

3 A is correct. The two requirements to achieve immunization for multiple liabilities are for the money duration (or BPV) of the asset and liability to match and for the asset convexity to exceed the convexity of the liability. Although all three portfolios have similar BPVs, Portfolio A is the only portfolio to have a lower convexity than that of the liability portfolio (31.98, versus 33.05 for the $20 million liability portfolio), and thus, it fails to meet one of the two requirements needed for immunization.

4 B is correct. Portfolio B is a laddered portfolio with maturities spread more or less evenly over the yield curve. A desirable aspect of a laddered portfolio is liquidity management. Because there is always a bond close to redemption, the soon-to-mature bond can provide emergency liquidity needs. Barbell portfolios, such as Portfolio C, have maturities only at the short-term and long-term ends and thus are much less desirable for liquidity management.

5 A is correct. Soto believes that any shift in the yield curve will be parallel. Model risk arises whenever assumptions are made about future events and approximations are used to measure key parameters. The risk is that those assumptions turn out to be wrong and the approximations are inaccurate. A non-parallel yield curve shift could occur, resulting in a mismatch of the duration of the immunizing portfolio versus the liability.

6 C is correct. Kiest has a young workforce and thus a long-term investment horizon. The Global Aggregate and Global Aggregate GDP Weighted Indexes have the highest durations (7.73 and 7.71, respectively) and would be appropriate for this group. Hudgens also wants to avoid the "bums" problem, however, which arises as a result of a market-cap-weighted portfolio increasing the weight of a particular issuer or sector that has increasing borrowings. The Global Aggregate Index is a market-cap-weighted index. As a result, the Global Aggregate GDP Weighted Index is the most appropriate selection for Kiest.

7 B is correct. Low tracking error requires an indexing approach. A pure indexing approach for a broadly diversified bond index would be extremely costly because it requires purchasing all the constituent securities in the index. A more efficient and cost-effective way to track the index is an enhanced indexing strategy, whereby Soto would purchase fewer securities than the index but would match primary risk factors reflected in the index. Closely matching these risk factors could provide low tracking error.

8 B is correct. Although a significant spread between the market price of the underlying fixed-income securities portfolio and an ETF's NAV should drive an authorized participant to engage in arbitrage, many fixed-income securities are either thinly traded or not traded at all. This situation might allow such a divergence to persist.

9 C is correct. Asset–liability management strategies consider both assets and liabilities in the portfolio decision-making process. Mowery notes that DFC's previous fixed-income manager attempted to control for interest rate risk by focusing on both the asset and the liability side of the company's balance sheet. The previous manager thus followed an asset–liability management strategy.

10 C is correct. Approach 1 is a full replication approach, whereas Approach 2 follows an enhanced indexing strategy. Both full replication and enhanced indexing can be used to establish a passive exposure to the bond market. Under full replication, the manager buys or sells bonds when there are changes to the index. The larger number of index constituents associated with full replication provides a higher degree of risk diversification compared with an enhanced indexing strategy.

11 C is correct. Enhanced indexing is especially useful for investors who consider environmental, social or other factors when selecting a fixed-income portfolio. Environmental, social, and corporate governance (ESG) investing, also called socially responsible investing, refers to the explicit inclusion or exclusion of some sectors, which is more appropriate for an enhanced index strategy relative to a full index replication strategy. In particular, Approach 2 may be customized to reflect client preferences.

12 B is correct. Immunization is the process of structuring and managing a fixed-income portfolio to minimize the variance in the realized rate of return and to lock in the cash flow yield (internal rate of return) on the portfolio, which in this case is 9.85%.

13 C is correct. Compton is correct that measurement error can arise even in immunization strategies for Type 1 cash flows, which have set amounts and set dates. Also, a parallel shift in yield curves is a sufficient but not a necessary condition to achieve the desired outcome. Non-parallel shifts as well as twists in the yield curve can change the cash flow yield on the immunizing portfolio; however, minimizing the dispersion of cash flows in the asset portfolio mitigates this risk. As a result, both statements are correct.

14 B is correct. In the case of a single liability, immunization is achieved by matching the bond portfolio's Macaulay duration with the horizon date. DFC has a single liability of $500 million due in nine years. Portfolio 2 has a Macaulay duration of 8.9, which is closer to 9 than that of either Portfolio 1 or 3. Therefore, Portfolio 2 will best immunize the portfolio against the liability.

15 C is correct. Structural risk to immunization arises from twists and non-parallel shifts in the yield curve. Structural risk is reduced by minimizing the dispersion of cash flows in the portfolio, which can be accomplished by minimizing the convexity for a given cash flow duration level. Because Portfolio 4 has the lowest convexity compared with the other two portfolios and also has a Macaulay duration close to the liability maturity of nine years, it minimizes structural risk.

16 B is correct. The use of an index as a widely accepted benchmark requires clear, transparent rules for security inclusion and weighting, investability, daily valuation, availability of past returns, and turnover. Because the custom benchmark is valued weekly rather than daily, this characteristic would be inconsistent with an appropriate benchmark.

17 B is correct. DFC has two types of assets, short term and intermediate term. For the short-term assets, a benchmark with a short duration is appropriate. For the intermediate-term assets, a benchmark with a longer duration is appropriate. In this situation, DFC may wish to combine several well-defined sub-benchmark categories into an overall blended benchmark (Benchmark 2). The Bloomberg Barclays Short-Term Treasury Index is an appropriate benchmark for the short-term assets, and SD&R uses a 50% weight for this component. The longer-duration Bloomberg Barclays US Corporate Bond Index is an appropriate benchmark for the intermediate-term assets, and SD&R uses a 50% weight for this component. As a result, Compton should recommend proposed Benchmark 2.

18 C is correct. It may be impossible to acquire zero-coupon bonds to precisely match liabilities because the city's liabilities have varying maturities and amounts. In many financial markets, zero-coupon bonds are unavailable.

19 C is correct. An investor having an investment horizon equal to the bond's Macaulay duration is effectively protected, or immunized, from the first change in interest rates, because price and coupon reinvestment effects offset for either higher or lower rates.

20 A is correct. An upward shift in the yield curve reduces the bond's value but increases the reinvestment rate, with these two effects offsetting one another. The price effect and the coupon reinvestment effect cancel each other in the case of an upward shift in the yield curve for an immunized liability.

21 A is correct. Minimizing the convexity of the bond portfolio minimizes the dispersion of the bond portfolio. A non-parallel shift in the yield curve may result in changes in the bond portfolio's cash flow yield. In summary, the characteristics of a bond portfolio structured to immunize a single liability are that it (1) has an initial market value that equals or exceeds the present value of the liability, (2) has a portfolio Macaulay duration that matches the liability's due date, and (3) minimizes the portfolio convexity statistic.

22 C is correct. Under an enhanced indexing strategy, the index is replicated with fewer than the full set of index constituents but still matches the original index's primary risk factors. This strategy replicates the index performance under different market scenarios more efficiently than the full replication of a pure indexing approach.

23 C is correct. The laddered approach provides both diversification over time and liquidity. Diversification over time offers the investor a balanced position between two sources of interest rate risk: cash flow reinvestment and market price volatility. In practice, perhaps the most desirable aspect of a laddered portfolio is liquidity management, because as time passes, the portfolio will always contain a bond close to maturity.

24

Template for Question 24

Recommend the portfolio in Exhibit 1 that would *best* achieve the immunization. (circle one)
Portfolio A
Portfolio B
Portfolio C

Justification:

Portfolio A is the most appropriate portfolio because it is the only one that satisfies the three criteria for immunizing a single future outflow (liability), given that the cash flow yields are sufficiently close in value:

1 Market Value: Portfolio A's initial market value of $235,727 exceeds the outflow's present value of $234,535. Portfolio B is not appropriate because its market value of $233,428 is less than the present value of the future outflow of $234,535. A bond portfolio structured to immunize a single liability must have an initial market value that equals or exceeds the present value of the liability.

2 Macaulay Duration: Portfolio A's Macaulay duration of 9.998 closely matches the 10-year horizon of the outflow. Portfolio C is not appropriate because its Macaulay duration of 9.503 is furthest away from the investment horizon of 10 years.

3 Convexity: Although Portfolio C has the lowest convexity at 108.091, its Macaulay duration does not closely match the outflow amount. Of the remaining two portfolios, Portfolio A has the lower convexity at 119.055; this lower convexity will minimize structural risk.

Default risk (credit risk) is not considered because the portfolios consist of government bonds that presumably have default probabilities approaching zero.

25

Template for Question 25
Determine the *most appropriate* immunization portfolio in Exhibit 2. (circle one)
Portfolio 1
Portfolio 2
Portfolio 3

Justification:

Portfolio 2 is the most appropriate immunization portfolio because it is the only one that satisfies the following two criteria for immunizing a portfolio of multiple future outflows:

1 Money Duration: Money durations of all three possible immunizing portfolios match or closely match the money duration of the outflow portfolio. Matching money durations is useful because the market values and cash flow yields of the immunizing portfolio and the outflow portfolio are not necessarily equal.

2 Convexity: Given that the money duration requirement is met by all three possible immunizing portfolios, the portfolio with the lowest convexity that is above the outflow portfolio's convexity of 135.142 should be selected. The dispersion, as measured by convexity, of the immunizing portfolio should be as low as possible subject to being greater than or equal to the dispersion of the outflow portfolio. This will minimize the effect of non-parallel shifts in the yield curve. Portfolio 3's convexity of 132.865 is less than the outflow portfolio's convexity, so Portfolio 3 is not appropriate. Both Portfolio 1 and Portfolio 2 have convexities that exceed the convexity of the outflow

portfolio, but Portfolio 2's convexity of 139.851 is lower than Portfolio 1's convexity of 147.640. Therefore, Portfolio 2 is the most appropriate immunizing portfolio.

The immunizing portfolio needs to be greater than the convexity (and dispersion) of the outflow portfolio. But, the convexity of the immunizing portfolio should be minimized in order to minimize dispersion and reduce structural risk.

26 Av's strategy immunizes well for parallel shifts, with little deviation between the outflow portfolio and the immunizing portfolio in market value and BPV. Because the money durations are closely matched, the differences between the outflow portfolio and the immunizing portfolio in market value are small and the duration gaps (as shown by the difference in Δ Portfolio BPVs) between the outflow portfolio and the immunizing portfolio are small for both the upward and downward parallel shifts.

Av's strategy does not immunize well for the non-parallel steepening and flattening twists (i.e., structural risks) shown in Exhibit 3. In those cases, the outflow portfolio and the immunizing portfolio market values deviate substantially and the duration gaps between the outflow portfolio and the immunizing portfolio are large.

PORTFOLIO MANAGEMENT

STUDY SESSION

8

Fixed-Income Portfolio Management (2)

This study session covers yield curve and credit strategies for fixed-income portfolios. Fundamental concepts necessary for understanding yield curves and yield curve strategies are reviewed. Portfolio management strategies, which are based on the investor's expectations regarding the level, slope, and curvature of the yield curve, are presented. Strategies used to construct and manage fixed-income credit portfolios follow. Coverage includes various credit spread measures, bottom-up and top-down approaches to credit strategies, and credit-related risks.

READING ASSIGNMENTS

Reading 20	Yield Curve Strategies by Robert W. Kopprasch, PhD, CFA, and Steven V. Mann, PhD
Reading 21	Fixed-Income Active Management: Credit Strategies by Campe Goodman, CFA, and Oleg Melentyev, CFA

READING

20

Yield Curve Strategies

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

Robert W. Kopprasch, PhD, CFA (USA). Steven V. Mann, PhD, is at the University of South Carolina (USA).

LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	**a.** describe major types of yield curve strategies;
☐	**b.** explain how to execute a carry trade;
☐	**c.** explain why and how a fixed-income portfolio manager might choose to alter portfolio convexity;
☐	**d.** formulate a portfolio positioning strategy given forward interest rates and an interest rate view;
☐	**e.** explain how derivatives may be used to implement yield curve strategies;
☐	**f.** evaluate a portfolio's sensitivity to a change in curve slope using key rate durations of the portfolio and its benchmark;
☐	**g.** discuss inter-market curve strategies;
☐	**h.** construct a duration-neutral government bond portfolio to profit from a change in yield curve curvature;
☐	**i.** evaluate the expected return and risks of a yield curve strategy.

INTRODUCTION

1

Active portfolio management seeks to outperform a benchmark. Portfolio returns are often evaluated relative to a benchmark that has characteristics aligned with the investment manager's mandate or style. Managers seek to outperform the benchmark by constructing a portfolio that is not fully representative of the index. Any differences from the benchmark are typically deliberate and not the result of illiquidity or inconvenience.

CFA Institute would like to thank Christopher D. Piros, PhD, CFA, for his contributions in writing Section 3.1.4 Carry Trade; Section 5 Inter-Market Curve Strategies; and part of Section 7 A Framework for Evaluating Yield Curve Trades.

Active yield curve strategies are designed to capitalize on expectations regarding the level, slope, or shape (curvature) of yield curves. This reading focuses on the challenges of developing and implementing active fixed-income portfolio strategies for which the primary tools are based in the dynamics of yield curves. In most instances, we have chosen to illustrate the strategies and dynamics using the US Treasury curve because of data availability. These same strategies, however, can be implemented in any jurisdiction with a well-developed sovereign debt market—a market where there are regular bond issuances along the yield curve and the market is liquid.

Section 2 discusses some foundational concepts essential for understanding yield curve strategies and expands on three basic changes to yield curves: level, slope, and curvature. It also addresses convexity, an important tool for fixed-income portfolio managers. Section 3 discusses how a portfolio manager can use strategies to express a directional view on interest rates. Section 4 addresses how and why a portfolio manager might choose to position a portfolio in anticipation of various yield curve environments. Section 5 discusses inter-market curve strategies and how to properly hedge foreign market returns into the home (base) country currency. Section 6 compares the performance of various duration-neutral portfolios in multiple yield curve environments. Section 7 presents a framework for analyzing the expected return and risk of a yield curve strategy. The reading concludes with a summary.

2 FOUNDATIONAL CONCEPTS FOR ACTIVE MANAGEMENT OF YIELD CURVE STRATEGIES

An understanding of yield curves and their behavior is necessary to understand how fixed-income markets work. The three primary forms of the yield curve—par, spot, and forward curves—contain useful information; the challenge lies in extracting and interpreting this information to make better investment decisions. Extracting the information contained in a yield curve is a focus for fixed-income professionals, central bankers, and other market participants.

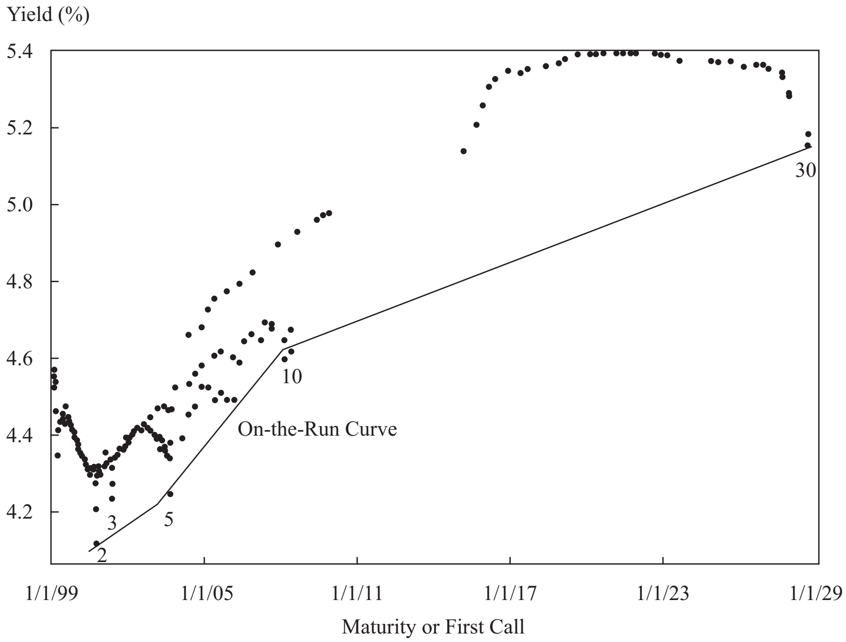
What Is a Yield Curve?

When someone refers to “the yield curve,” the implied assumption is that there is one yield curve that applies to all investors in a given market. In reality, a yield curve is a stylized representation of the yields available to investors at various maturities within a market. To model a yield curve, one must make certain assumptions, and those assumptions may vary by investor or by the intended use of the curve. Problems involved in modeling the yield curve include the following:

- Unsynchronized observations of various maturities on the curve
- Gaps in maturities that require interpolation and/or smoothing
- Observations that seem inconsistent with neighboring values
- Differences in accounting or regulatory treatment of certain bonds that may make them look like outliers

As an example, the on-the-run curve can differ significantly from a curve that includes off-the-run securities, especially during a crisis, when “flight to quality” becomes common and investors gravitate to the more liquid on-the-run issues. Consider the curve in Exhibit 1 from 1998, during the Long-Term Capital Management crisis.

Exhibit 1 Weekend-Adjusted Yields for Coupon Treasuries (as of 30 October 1998)



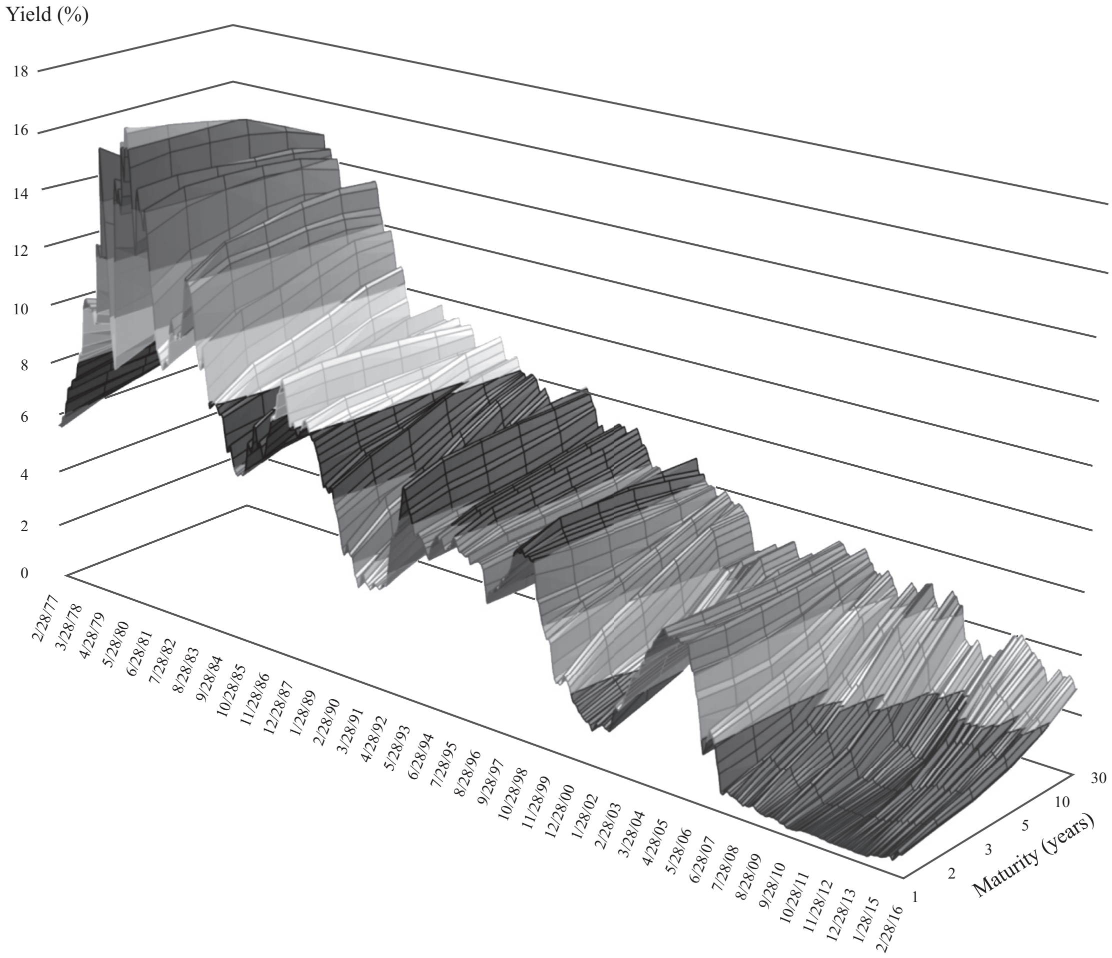
Notes: The three-year Treasury note had been discontinued as an on-the-run issue. The "3" on the chart shows the yield value of the most recently issued three-year note, which was only marginally longer than the new two-year notes at the time.
Source: Salomon Brothers.

Notice how the (interpolated) on-the-run curve, shown as the solid line in Exhibit 1, does not adequately represent the securities available for purchase in the Treasury market. In Exhibit 1, the interpolated yield for the January 2017 maturity is about 4.85%. Actual Treasuries with January 2017 maturity, however, could have been purchased at that time with yields of about 5.35%. Investors considering the purchase of similar-maturity, non-Treasury securities could have drawn two very different conclusions regarding the attractiveness of those investments depending on whether they used the interpolated on-the-run curve or the actual off-the-run curve.

2.1 A Review of Yield Curve Dynamics

A historical perspective of yield curves illustrates the variety of yield curve changes from which a fixed-income portfolio manager seeks to profit. Exhibit 2 depicts the changing level, slope, and curvature of the on-the-run US Treasury curve (sampled quarterly) during the past 40 years: clearly, the yield curve is dynamic. The many possible changes in the yield curve can be distilled into three basic movements: a change in (1) level (a parallel shift in the yield curve); (2) slope (a flattening or steepening of the yield curve); and (3) curvature. These three basic movements are discussed below.

Exhibit 2 On-the-Run US Treasury Curves, Monthly, 1977–2016



Source: US Federal Reserve Bank.

A change in level occurs when all the yields represented on the curve change by the same number of basis points. This movement is usually referred to as a parallel shift. For simplicity, when a portfolio manager models the impact of an expected yield curve change, it is often assumed that the curve changes only in parallel shifts, but Exhibit 2 shows clearly that this assumption is unreliable.

Exhibit 3 plots yield levels for the 34 years ending in 2016, using the US 10-year on-the-run note as the proxy for the entire curve. For nearly this entire time span, yields have been generally declining, resulting in yields in major fixed-income markets around the world that are at historically low levels.

Exhibit 3 On-the-Run 10-Year US Treasury Yield, 1982–2016

Source: Yield Book.

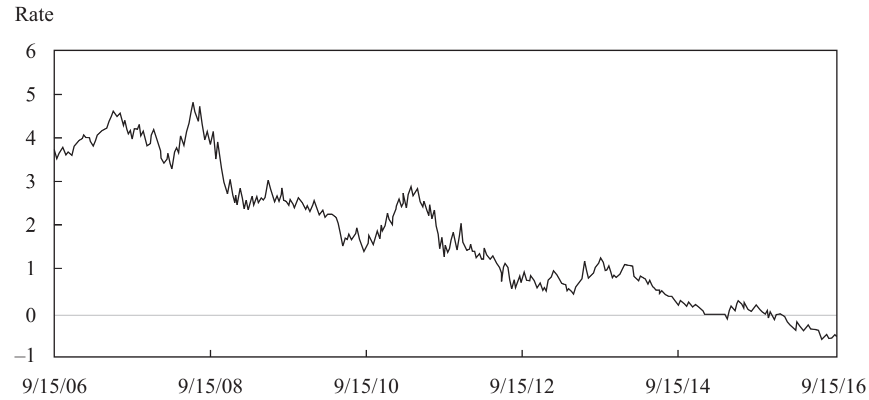
During the period shown in Exhibit 3, US rates have fallen to new lows and rates in other parts of the world have done something previously believed to be impossible: They have gone into negative territory. Exhibit 4 shows the 10-year history of the 5-year euro area government bond rate as it moved toward and then below zero.[1]

Although euro rates briefly reached negative values in April 2015, they have been consistently below zero for virtually all of 2016. Even though below-zero rates do not cause theoretical problems, other issues arise. Several governments have issued bonds with a negative yield, but these have mainly been re-openings of existing bonds with positive coupon rates.[2] If negative rates persist, we may see a new-issue bond with a negative coupon. Consider this: If the coupon rate is negative, we now have two-way credit exposure—the bond owner now owes regular payments to the issuer. We would also need new payment mechanisms to facilitate the "reverse" flow of coupons from investor to issuer. And, bond analysis must adapt to a new reality—if bonds are issued with negative coupon rates, the modified duration on those bonds will be larger than the maturity.

1 The European Central Bank estimates zero-coupon yield curves for the euro area using actively traded euro-denominated bonds issued by euro area central governments.

2 In a reopening, an issuer sells more of a bond that already exists in the marketplace. The new bonds have the same coupon, maturity, and even the same security identifier as the existing bond.

Exhibit 4 Five-Year Euro Area Government Bond Rate (September 2006–September 2016)

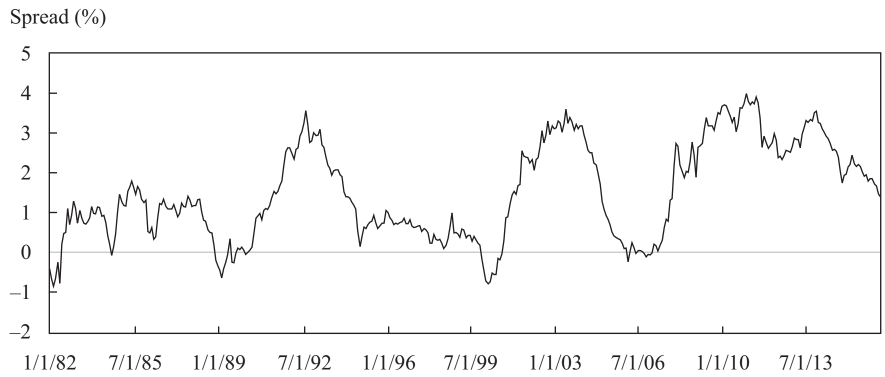


Source: Yield Book.

Yield curve slope is measured as the spread between the yield on a long-maturity bond and the yield on a shorter-maturity bond. For example, the slope of the US Treasury yield curve could be determined by the difference between the yield on the 30-year Treasury bond (30s) and the yield on the 2-year Treasury note (2s). If the 2-year benchmark yield is 0.625% and the 30-year benchmark yield is 2.875%, the slope of the curve is the difference between the two yields—in this case, 2.250%, or 225 bps. As the spread increases, or widens, the yield curve is said to steepen. As the spread narrows, the yield curve is said to flatten. If the spread turns negative, the yield curve is described as inverted. These are changes in slope that managers try to anticipate and exploit. Most of the time, the spread is positive and the yield curve is upward sloping. A positive yield curve is thus also known as a "normal" yield curve.

Exhibit 5 plots the slope of the yield curve, using on-the-run 30s yield minus on-the-run 2s yield as the proxy for the slope. It is referred to as the 2s–30s spread.

Exhibit 5 2s–30s Yield Spread, 1982–2016



Source: Yield Book.

Yield curve curvature is a function of the relationship between yields at the short end of the curve, at a midpoint along the curve, and at the long end of the curve. A common measure of yield curve curvature is the **butterfly spread**:

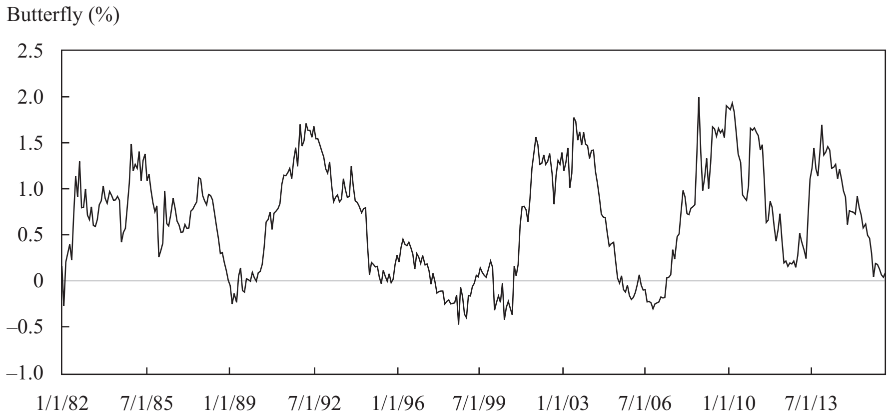
$$\text{Butterfly spread} = -(\text{Short-term yield}) + (2 \times \text{Medium-term yield}) - \text{Long-term yield} \quad (1)$$

The butterfly spread takes on larger positive values when the yield curve has more curvature. One widely used measure of the butterfly spread is calculated using the on-the-run 2-year, 10-year, and 30-year Treasuries as the short-, medium-, and long-term yields, respectively:

$$-(\text{2-Year yield}) + (2 \times \text{10-Year yield}) - \text{30-Year yield}$$

Exhibit 6 displays the historical levels of this proxy for the US Treasury yield curve's curvature.

Exhibit 6 Butterfly Spread 2s/10s/30s, 1982–2016



Source: Yield Book.

The three changes in yield curve shape do not occur in isolation—they are correlated with one another. That is, certain directional moves in the level of interest rates tend to be associated with certain changes in the shape of the curve. For an upward shift in level, the yield curve typically flattens and becomes less curved. Conversely, for a downward shift in level, the yield curve typically steepens and becomes more curved. This occurs because short-term rates tend to be more volatile than long-term rates—for any generalized movement in the yield curve, the short end of the curve tends to move much more than the long end.[3]

3 See, for example, *Principles of Principal Components* by Bulent Baygün, Janet Showers, and George Cherpelis. Salomon Smith Barney (31 January 2000).

2.2 Duration and Convexity

For the reader's convenience, we provide a brief review of various duration measures.

- **Macaulay duration** is analogous to a bond's effective maturity, incorporating all of the bond's projected cash flows—both principal and interest. It is a weighted average of time to receive the bond's promised payments. The present value of each payment to be received is weighted by the present value of all future payments.
- **Modified duration** provides a more direct measure of the relationship between changes in a bond's yield and percentage changes in its price. Modified duration is the Macaulay duration statistic divided by one plus the yield to maturity for each period. It provides an estimate of the percentage price change for a bond given a 1% (100 bps) change in its yield to maturity. It is important to remember that modified duration estimates the percentage price change of the full price, including accrued interest. Given the low coupon rates of most government bonds issued in the last several years, forgetting this detail leads to only a small estimation error. At higher coupon levels, however, the estimation error may be more substantial if the bond has significant accrued interest.
- **Effective duration** is the sensitivity of a bond's price to a change in a benchmark yield curve (as opposed to the price response to a change in the bond's own yield, which might result from factors other than changes in the benchmark yields). Effective duration is similar to modified duration, but its calculation is flexible to allow its use in cases when the bond has an embedded option. As an example, a callable bond has cash flows that are contingent on future interest rates. The issuer may call the bond as interest rates fall—depending on its ability to refinance the debt. Such a bond does not have well-defined cash flows to plug into the modified and Macaulay duration calculations.
- **Key rate duration** (also called partial duration, or partials) is a measure of a bond's sensitivity to a change in the benchmark yield curve at a specific maturity point or segment. Key rate durations help identify "shaping risk" for a bond or a portfolio—that is, its sensitivity to changes in the shape of the benchmark yield curve (e.g., the yield curve becoming steeper or flatter, or showing more or less curvature).
- The **money duration** of a bond is a measure of the price change in units of the currency in which the bond is denominated. Money duration can be stated per 100 of par value or in terms of the bond's actual position size in the portfolio. In the United States, money duration is commonly called "dollar duration."
- The **price value of a basis point** (PVBP) is an estimate of the change in a bond's price given a 1 bp change in yield to maturity. PVBP "scales" money duration so that it can be interpreted as money gained or lost for each basis point change in the reference interest rate. This measure is also referred to as the "dollar value of an 0.01" (pronounced oh-one) and abbreviated as DV01. It is calibrated to a bond's par value of 100; for example, a DV01 of $0.08 is equivalent to 8 cents per 100 points. (The terms PVBP and DV01 are used interchangeably; we will generally use PVBP but DV01 has the same meaning).

Duration is a first-order effect that attempts to capture a linear relationship between bond prices and yield to maturity. **Convexity** is a second-order effect that describes a bond's price behavior for larger movements in yield. It captures the extent to which the yield/price relationship deviates from a linear relationship. If a bond has positive convexity, then the bond price increases more if interest rates decrease (and decreases less if interest rates increase) than the duration estimate would suggest. Said another way, the expected return of a bond with positive convexity will be higher than the return of an identical-duration, lower-convexity bond if interest rates change. This price behavior is valuable to investors, and therefore a bond with higher convexity might be expected to have a lower yield than a similar-duration bond with less convexity.

Although convexity is valuable when interest rates are expected to change, it is likely to be even more valuable when interest rate volatility is expected to increase. This dynamic tends to drive changes in the shape of the yield curve—as convexity becomes more valuable, investors will bid up prices on the longer-maturity bonds (which have more convexity), and the long end of the curve may decline or even invert (or invert further), increasing the curvature of the yield curve.

Macaulay duration and modified duration cannot be used to measure the price risk of securities whose cash flows change when interest rates change.[4] Similarly, nominal convexity calculations assume that the cash flows do not change when yields change. **Effective convexity**, like effective duration, uses a methodology that can accommodate cash flows that change when yields change (as in the case of callable bonds or mortgage-backed securities [MBS]). This measure is used when describing the price behavior of bonds with embedded options.

A helpful heuristic for understanding convexity is that, for zero-coupon bonds:

- Macaulay durations increase linearly with maturity—a 30-year zero-coupon bond has three times the duration of a 10-year zero-coupon bond.
- Convexity is approximately proportional to duration squared; therefore, a 30-year zero-coupon bond has about nine times the convexity of a 10-year zero-coupon bond.[5]
- Coupon-paying bonds have more convexity than zero-coupon bonds of the same duration—a 30-year coupon-paying bond with a duration of approximately 18 years has more convexity than an 18-year zero-coupon bond.[6] The more widely dispersed a bond's cash flows are around the duration point, the more convexity it will exhibit. For this reason, a zero-coupon bond has the lowest convexity of all bonds of a given duration.

Although convexity can be a valuable tool when positioning a portfolio, it is important to remember that convexity is a second-order effect; it operates behind duration in importance and can largely be ignored for small yield changes. When convexity is added with the use of derivatives, however, it can be extremely important to returns. This effect will be demonstrated later in this reading. Negative convexity may also be an important factor in a bond or portfolio's returns. For bonds with short options positions embedded in their structures (such as MBS or callable bonds) or portfolios with short options positions, convexity's effect may be large.

Adding convexity to a portfolio is not free: Portfolios with higher convexity are most often characterized by lower yields. Investors will be willing to pay for increased convexity when they expect yields to change by more than enough to cover the give-up in yield. Convexity is more valuable when yields are more volatile.

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4 In the early 1970s, researchers noticed that if one analytically solved (using calculus) for a bond's volatility in response to a small yield change, the solution involved a complicated expression that could be simplified into Macaulay duration divided by (1 + Periodic yield). This formula became known as "modified" duration. But, the derivation of that expression assumed that the cash flows did not change when interest rates changed. Thus, modified duration cannot be used when analyzing securities that violate this assumption, such as callables and mortgage-backed securities, among others.

5 This statement is true for Macaulay duration but only approximate for modified duration because of the divisor $(1 + y)$.

6 This is explained in "Understanding Duration and Convexity," Robert Kopprasch, Chapter 5 in *The Handbook of Fixed Income Securities*, 2nd Edition, Frank J. Fabozzi, ed., Dow Jones–Irwin, 1986.

A portfolio's convexity can be altered by shifting the maturity/duration distribution of bonds in the portfolio, by adding physical bonds with the desired convexity properties, or by using derivatives. We will discuss these approaches in more detail as we move to discussing specific approaches to implementing the yield curve strategies introduced herein.

3 MAJOR TYPES OF YIELD CURVE STRATEGIES

This reading focuses on "active" yield curve strategies. Although the term "active" seems to imply active or frequent trading, some active strategies entail little or no trading. Instead, the term "active strategies" implies only that the manager makes a deliberate choice to deviate from the characteristics of the relevant benchmark in an attempt to outperform that benchmark.

At the most basic level, fixed-income portfolio returns come either from yield (typically defined by the cash flows associated with the portfolio) or from price change over the measurement interval. In the current low interest rate environment, significant yield accumulation is a difficult challenge, so managers use various techniques to enhance portfolio yield. The two most obvious are (1) maturity extension (if the yield curve is upward sloping) and (2) buying lower-credit securities. There are other techniques as well, and we discuss them in the following section on strategies under a stable yield curve. Yield return takes a long time to accumulate, however, and yield can be quickly overwhelmed by price change. So, it can be especially important for managers to either use expected price changes to enhance return or protect the portfolio from unexpected price changes to preserve the yield. We will also discuss the first of these two approaches in the sections that follow.

We have loosely classified the active strategies into two groups based on the yield curve environment in which they are typically used. As you will see from the discussion in the balance of this reading, however, each strategy may be useful in more than one environment.

1. Active strategies under assumption of a stable yield curve
   - Buy and hold
   - Roll down/ride the yield curve
   - Sell convexity
   - The carry trade
2. Active strategies for yield curve movement of level, slope, and curvature
   - Duration management
   - Buy convexity
   - Bullet and barbell structures

Portfolio managers have several tools at their disposal to add value relative to a benchmark. The most powerful tool is duration adjustment, but leverage, sector weightings, and convexity can also be used to enhance portfolio returns. The application of these strategies depends on several factors, including the following:

- The investment mandate that the investment manager has been hired to fulfill
- The investment guidelines imposed by the asset owner, especially regarding duration or duration deviations from a benchmark, credit quality, geographic constraints, turnover, concentration, and so on

- The investment manager's expectations regarding future yield curve moves and the manager's conviction in those expectations
- The costs of being wrong—whether measured as outright loss, poor relative performance, client loss, or reputational impairment

A Note to Readers Regarding Portfolios

The examples in this reading use numerous portfolios. Some examples use fictional bonds, and others use actual Treasury bonds available at the time of writing. Typically, the latter will be the "on-the-run" (i.e., the most recently issued) Treasury benchmark bonds. The same bonds appear in some different examples, sometimes with the same size positions, making them appear identical. Note, however, that they may have been priced at slightly different points in time, and thus the analytics (yield, duration, and so on) vary slightly. These differences are not mistakes but rather reflect the market at work.

3.1 Strategies under Assumptions of a Stable Yield Curve

The primary strategies a portfolio manager might use when she expects the yield curve to remain stable—no change in level, slope, or curvature—are 1) buy and hold; 2) riding the yield curve; 3) sell convexity; and 4) the carry trade.

3.1.1 *Buy and Hold*

In an active "buy and hold" strategy, the portfolio manager constructs a portfolio whose characteristics diverge from the benchmark characteristics, and the portfolio is held nearly constant with no active trading during a certain period. If the portfolio manager believes the yield curve is likely to remain stable, she may make an active decision to position the portfolio with longer duration and higher yield to maturity in order to generate higher returns than the benchmark. Alternatively, she may target segments of the yield curve where price changes are not likely to materially affect the portfolio's total return. The lack of turnover in the portfolio makes the strategy appear passive, but it can be quite aggressive at the same time.

3.1.2 *Riding the Yield Curve*

Riding the yield curve is a strategy based on the premise that, as a bond ages it will decline in yield if the yield curve is upward sloping. This concept is known as "roll down"—the bond rolls down the (static) curve. It has some similarities to the buy-and-hold strategy in that the securities, once purchased, are not typically traded. It differs from buy and hold, however, in its time horizon and expected accumulation. The manager is not only accumulating coupon income but is expecting to add to returns by selling the security at a lower yield at the horizon.

A portfolio manager will ride the yield curve when he expects a reasonably static yield curve. This strategy requires an upward-sloping yield curve; the manager will buy a bond in anticipation of profiting from the price increase as the time to maturity shortens. Say, for example, a five-year maturity par bond is selling at a yield to maturity of 5% and a four-year maturity par bond is selling at a yield to maturity of 4%. As time passes and the five-year bond becomes a four-year bond, its price will rise to the point that its yield to maturity equals 4%. In addition to collecting the interest income during the period, the portfolio manager benefits from this price appreciation. This strategy may be particularly effective if the manager targets portions of the yield curve that are relatively steep and where price appreciation resulting from the bond's migration to maturity can be significant.

If the manager's curve view changes, the "trade" will be unwound and the portfolio will be repositioned in accordance with the manager's revised expectations.

3.1.3 *Sell Convexity*

Recall that the price of a bond with higher convexity increases more if interest rates decrease, and decreases less if interest rates increase, than does the price of an equal-duration but lower-convexity bond. The expected (instantaneous) return of a bond with greater convexity will be higher than the return of an otherwise identical lower-convexity bond if interest rates change. If, as is usually the case, a bond with higher convexity has a lower yield, and the portfolio manager believes that the yield curve is likely to remain unchanged, the convexity in his portfolio is of little value to him. Holding those higher-convexity bonds means he is giving up yield. In this instance, he might choose to sell convexity.

To sell convexity, the portfolio manager could sell calls on bonds held in the portfolio, or he could sell puts on bonds he would be willing to own if, in fact, the put was exercised. In either case, the option premium received would augment the yield of the portfolio and the portfolio convexity would be lower—an acceptable condition if he thinks future volatility is likely to be less than what current options prices reflect.[7]

The portfolio would earn additional returns in the form of option premiums. Selling convexity outright is a strategy used only infrequently by managers of traditional fixed-income portfolios, because many institutional asset owners are reluctant to allow their fixed income investment managers to engage in option writing.

There are securities that inherently provide an option-writing opportunity for managers that are otherwise constrained. Callable bonds are one example. In exchange for a higher yield at the outset, the owner of the callable bond has effectively sold a call option to the issuer of the bond. He owns all of the downside but risks having the bond called away from him if yields fall (and prices rise) beyond the call price. This price behavior is often referred to as "negative convexity." The option is not separable from the security, but it is still very much a call option.

Mortgage-backed securities are another example of securities that provide an option-writing opportunity. Homeowners are the "issuers" of the underlying mortgages (they issue the mortgage, and the bank buys it). The homeowner must eventually repay the principal, and typically has the right to prepay—or call—the mortgage. In exchange for the higher yield typically available on MBS (compared with non-callable bonds of a similar duration), the portfolio manager has assumed some negative convexity. Although this option is very complex, making it difficult to fully understand and value, the reader should be aware that owning MBS in a portfolio is loosely equivalent to writing options.

3.1.4 *Carry Trade*

Another way to position a portfolio in anticipation of a static curve is to use the advantages of "carry." In general terms, a **carry trade** involves buying a security and financing it at a rate that is lower than the yield on that security. In a common carry trade, a portfolio manager borrows in the currency of a low interest rate country, converts the loan proceeds into the currency of a higher interest rate country, and invests in a higher-yielding security of that country. This trade frequently uses a high degree of leverage and entails foreign exchange risk. The goal is to earn the spread between the two rates—earning more on the higher-yielding instrument than you are paying on the lower-yielding (financing) instrument. To be executed successfully, the trade must be unwound before any change in interest rates and/or foreign exchange rates creates a loss in the higher-yielding security that exceeds the carry (income) earned to date. Although commonly spoken of in the context of cross-border trades, a carry trade might just as easily be executed using two positions in the same currency. Carry

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7 Note that selling a call would also reduce portfolio duration, whereas selling a put would increase duration. To keep portfolio duration the same, a manager could sell an appropriate combination of calls and puts.

trades in a single currency (also known as intra-market carry trades) almost always aim to exploit an upward sloping ("normal") yield curve. As a result of this duration mismatch, such trades can entail substantial interest rate risk.

There are at least three basic ways to implement a carry trade to exploit a stable, upward-sloping yield curve:

- **a** Buy a bond and finance it in the repo market.
- **b** Received fixed and pay floating on an interest rate swap.
- **c** Take a long position in a bond (or note) futures contract.

The first two of these approaches involve explicit financing at the short end of the yield curve and explicit accrual/receipt of a higher fixed rate at the long end of the yield curve. Specifically, the first approach (a) involves creating an asset and a liability, while the second approach (b) replicates the cash flows associated with such an asset and a liability. Although carry trades generally require two positions, as indicated in the third approach (c), a long position in a bond (or note) futures contract actually constitutes a carry trade in and of itself. Standard arbitrage arguments imply that the futures contract price should equal the cost of buying the bond today and financing it to the futures delivery date less the yield earned before delivery. If the futures price were higher the seller of the futures contract could make an arbitrage profit by explicitly buying and financing the bond and then delivering the bond against the futures contract. If the futures price were lower the buyer of the futures contract could make an arbitrage profit by selling the bond short today, investing the proceeds in the money market, and taking delivery of the bond via the futures contract.[8] With arbitrage enforcing this relationship between spot and futures prices, the futures price will converge to the spot price at expiration, and the long futures position will have implicitly earned the accrued interest on the bond and paid the financing cost.

Inter-market carry trades, those involving more than one currency are more varied and complex. First, the trade depends on more than one yield curve. Second, the investor must either accept or somehow hedge currency risk. Third, there may or may not be a duration mismatch. We defer detailed discussion of these issues to the more general coverage of inter-market trades in Section 5. For now, we outline a few ways to implement such trades.

If the investor is comfortable accepting currency exposure, the inter-market carry trade simply involves borrowing in the low interest rate currency and lending in the high interest rate currency. Among the ways to implement such a trade are the following:

1. Borrow from a bank in the lower rate currency, convert the proceeds to the higher rate currency, and invest in a bond denominated in that currency.
2. Enter into a currency swap, receiving payments in the higher rate currency and making payments in the lower rate currency.
3. Borrow in the higher rate currency, invest the proceeds in an instrument denominated in that currency, and convert the financing position to the lower rate currency via the FX forward market (buy the higher rate currency forward versus the lower rate currency).

In principle, the investor can pick the most favorable maturity on each side of the trade since the primary motivation is usually the spread between the respective yield curves rather than maturity mismatches. For example, a currency swap could be structured as fixed rate versus floating rate, floating versus floating, or fixed versus fixed.

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8 This follows from the carry arbitrage model (with continuous compounding): $F_0(T) = S_0 e^{(r_c + \theta - \gamma)T}$, where T is time to expiration, and the futures price, $F_0(T)$, is equal to the spot price, S_0, compounded at the risk-free rate, r_c, plus other carry costs, θ, less carry benefits, γ. Here γ is yield, and 0 is zero.

Note that in the third approach listed above, the cross-currency aspect is introduced via the FX forward position rather than by explicit borrowing in the lower rate currency. The rationale is that more favorable loan terms may be available by borrowing in the same currency as the asset being funded, for example in the repo market.

Exhibit 7 Combining Bond, Repo, and Currency Forward Positions

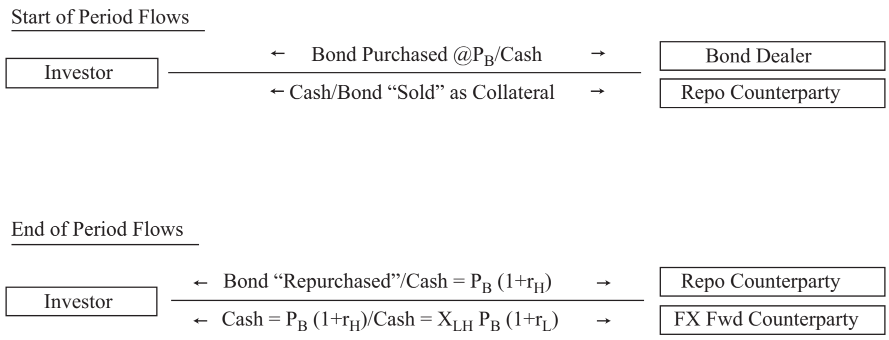


Exhibit 7 illustrates how this combination works. At the start of the period, the investor buys a bond denominated in the higher yielding currency from a bond dealer and concurrently "sells" it to a repo counterparty, promising to repurchase it in the future (hence the name "repurchase agreement") at a pre-determined price that includes the financing rate. Importantly, the investor owns the bond and will earn whatever return it generates. Exhibit 7 shows the bond purchase and repo financing transactions as being separate, but often the bond dealer is also the repo counterparty.[9] The investor also executes a currency forward contract agreeing to pay [$X_{LH} \times P_B \times (1 + r_L)$] units of the lower interest rate currency at expiration in return for receiving [$P_B \times (1 + r_H)$] units of the higher interest rate currency. Here, P_B denotes the price paid for the bond, X_{LH} is the initial spot exchange rate (expressed as lower interest rate currency per unit of the higher interest rate currency), and r_H and r_L denote the respective higher and lower interest rates. This forward contract implicitly entails borrowing [$X_{LH} \times P_B$] at rate r_L and lending P_B at rate r_H. Covered interest arbitrage ensures that these implicit loans reflect the rates available on actual (unsecured) loans in each currency. At the end of the period the investor receives [$P_B \times (1 + r_H)$] from the FX forward, which suffices to repurchase the bond. The investor pays [$X_{LH} \times P_B \times (1 + r_L)$] units of the lower interest rate currency to discharge the implicit loan in that currency. On net, the investor owns the bond, having financed it at the lower rate (r_L). In fact, the net cost of financing may be even lower. Due to the secured nature of the repurchase agreement, the repo rate will normally be less than the unsecured rate (r_H) in the same currency. This situation lowers the investor's net cost and, as noted above, may be the reason for implementing the carry trade this way.

The reader may recall the notion of uncovered interest rate parity from the Level II reading on currency exchange rate determination. The idea is that short-term interest rate differentials will be offset one-for-one by depreciation of the higher interest rate currency. This result would imply that inter-market carry trades will not, on average, be able to capture differences in short-term rates (though differences at longer maturities might still be profitable). Empirical studies consistently show that uncovered parity does not hold. In particular, higher interest rate currencies do not systematically depreciate, and the likelihood of inter-market carry trades being profitable is fairly

9 In practice, the "cash" side of the transactions will not quite offset since the repo counterparty will not lend 100% of the value of the collateral. The difference, say 2% of the collateral value, is called the "haircut."

high. However, the distribution of returns is both fat-tailed and negatively skewed, implying that when losses occur, they are relatively likely to be large. The box titled "Crowding and the Yen Carry Trade," below, describes what happens when previously profitable carry trades break down.[10]

In order to eliminate currency exposure in an inter-market trade, the investor must, explicitly or implicitly, both borrow and lend in each currency. The essence of this trade is to exploit differences in the slopes of the two yield curves rather than the difference in overall rate levels. The idea, assuming normal, upward sloping yield curves, is to lend at the long end and borrow at the short end on the relatively steep curve, and to lend at the short end and borrow at the long end on the relatively flat curve. Among the ways to implement this trade are the following:

- Receive fixed/pay floating in the steeper market and pay fixed/receive floating in the flatter market.
- Take a long position in bond (or note) futures in the steeper market and a short futures position in the flatter market.

Sonia Alexis, CFA, a portfolio manager at Wessex Worldwide, a global macro hedge fund based in London, believes that yield curves around the world will be stable over the next six months. With UK rates very low and the yield curve quite flat, she is looking at carry trades in other markets as a way to generate higher returns. She notes that New Zealand, where the curve is relatively steep, and Mexico, where rates are much higher but the curve is flat, may be good candidates. Swap rates (Libor-flat) in the three currencies, all quoted as annual rates with semi-annual payments and compounding, are shown in Exhibit 8.

Exhibit 8 Swap Rates (Libor-Flat) for GBP, NZD and MXN for Various Maturities

	6 Mo	1 Yr	2 Yr	3 Yr	4 Yr	5 Yr
GBP	0.47%	0.68%	0.59%	0.68%	0.76%	0.84%
NZD	2.03%	2.07%	2.28%	2.56%	2.76%	2.92%
MXN	7.19%	7.28%	7.24%	7.21%	7.22%	7.25%

Based on this information, Alexis calculates the best potential carry in each market as well as the best inter-market positions. Her results are presented in Exhibit 9.

Exhibit 9 Intra- and Inter-Market Carry Trades Using GBP, NZD, and MXN

Position	Calculation	6Mo Carry
Intra-Market Trades		
Pay 6mo GBP/Receive 5yr GBP	(0.84 – 0.47)/2 =	18.5 bps
Pay 6mo NZD/Receive 5yr NZD	(2.92 – 2.03)/2 =	44.5 bps
Pay 6mo MXN/Receive 1yr MXN	(7.28 – 7.19)/2 =	4.5 bps

(continued)

10 A relatively comprehensive examination of carry trades within and across asset classes, including currencies, can be found in R.S.J. Koijen, T.J. Moskowitz, L.H. Pedersen, and E.B. Vrugt, "Carry," Fama-Miller Working Paper (1 November 2016).

Exhibit 9 (Continued)

Position	Calculation	6Mo Carry
Inter-Market Trades		
Pay 6mo GBP/Receive 5yr NZD	(2.92 – 0.47)/2 =	122.5 bps
Pay 6mo GBP/Receive 1yr MXN	(7.28 – 0.47)/2 =	340.5 bps

If she has confidence that Mexican rates will not rise, so avoiding deterioration of the carry, and the Mexican Peso will not depreciate sharply against the British Pound, then receiving one-year MXN and paying six-month GBP is the best available carry trade by a wide margin. This inter-market trade results in 340.5 bps of carry over six months. On the other hand, the intra-market MXN trade—which does not entail Mexican Peso risk—offers virtually no carry. In contrast, the New Zealand market provides attractive carry with or without the currency risk. In addition, the relatively steep slope of the NZD curve offers return from riding the curve down from 5 years to 4.5 years. If the NZD curve remains the same in six months, the rate on the five-year fixed swap will decline to 2.84% (the average of 2.92% and 2.76%), adding approximately 33 bps[11] of mark-to-market gain to the potential return. In contrast, if the NZD curve moves to reflect today's implied forward rates, the rate on the then 4.5 year swap will rise by 19 bps from 2.84% to 3.03%, the resulting mark-to-market loss will exactly offset the carry accrual, and the Pay 6mo NZD/Receive 5yr NZD swap will just break even. Alexis is initially surprised by this result but then realizes that all tenors on the NZD swap curve will just break even if the curve moves to reflect the forward rates. By construction, the forward rates are the sequence of future one-period discount rates imbedded in the value of all swap tenors today. At the end of the first period, the current short-term (6-month) rate will drop out of the sequence. If the rest of the series remains the same—which is what it means for the curve to move to the forward rates—then the fixed side of every swap will increase in value by exactly the current short rate. Of course, that is the rate being paid on the floating side of the swaps, so each tenor breaks even.

Crowding and the Yen Carry Trade

Japan has attempted to stimulate its economy by suppressing the value of the yen relative to the US dollar and other currencies. Hedge funds and others borrowed the yen at very low interest rates—close to zero—and converted the yen to US dollars. Those dollars were then invested in US Treasuries at a much higher yield than the interest cost for the borrowed yen. This creates "positive carry" because of the differential in interest rates. When executed in large volume, the buying drives up US bond prices.

Profits on the carry trade accrue from three aspects of the trade: the carry—or spread—between US and Japanese interest rates, a rise in US bond prices, and a rising US dollar versus the yen. Success is contingent on a stable yield curve and a lower (or at least stable) value of the yen.

Popular carry trades are subject to "crowding" risk, where the trades are done in such large volume by so many investors that the exit becomes crowded as all try to unwind the trade within a short span of time. The yen–Australian dollar carry trade is a good

11 With a stable yield curve and 4.5 years remaining, the fixed-rate side of the swap will have a modified duration of 4.218. An 8 bp decline in yield (from 2.92% to 2.84%) would increase the value by approximately (4.218 × 0.08) = 0.3374, or 33.74 bps. The actual increase, which reflects discounting each cash flow at maturity using specific rates from the spot rate curve (i.e., zero-coupon curve), is slightly lower.

example of this crowding risk. In early 2007, the Australian dollar offered an average interest rate of 6.4% while the Japanese yen yielded approximately 0.4%, creating an interest rate differential of 6%. Investors continued to pile into this trade through late 2007. When the global financial crisis hit in 2008, there was a massive unwinding of the trade, pushing the Australian dollar down almost 50%. Similarly, the emerging market carry trade of the mid-1990s was very popular as investors borrowed the currencies of lower-interest-rate countries such as Japan or the United States and invested in the much higher-yielding bonds of emerging countries. As fears of potential emerging market defaults spiked, investors rushed for the exit and huge outflows from emerging market currencies precipitated an emerging market crisis followed by a global market crash.

Since the 2008 global financial crisis, however, short-term interest rates have been close to zero in much of the developed world, dampening enthusiasm for the yen carry trade but making carry in general very popular and profitable.

3.2 Strategies for Changes in Market Level, Slope, or Curvature

Investors often hold individualized expectations about the yield curve that they generate from economic analysis, data mining exercises, following monetary policy and central bank actions, or other techniques. To the extent that investors position their portfolios based on these expectations, they are disagreeing with the forward expectations embedded in the yield curve. If their expectations turn out to be correct, they will earn superior returns. If their expectations are not met, however, they may suffer losses. There is no compelling evidence that any investor can consistently make superior directional calls. That is one reason why many fixed-income portfolio managers are assigned tight duration constraints. The following discussion covers the primary strategies portfolio managers may use in anticipation of a change in the level of interest rates or in the slope or shape of the yield curve.

3.2.1 *Duration Management*

In its simplest form, duration management shortens portfolio duration in anticipation of rising interest rates (decreasing bond prices) and lengthens portfolio duration in anticipation of declining interest rates (increasing bond prices). This strategy requires a manager to correctly anticipate changes in interest rates. If executed successfully, duration management offers a substantially greater opportunity for active return than most other strategies.

As Exhibit 3 illustrated, the long bull market in bonds was unmistakable. Being long duration (choosing a portfolio duration greater than that of the benchmark) during this nearly 35-year period was a winning active strategy, despite occasional periods of yield increases.

Despite the difficulty in predicting the direction or magnitude of interest rate changes, duration management is one of a fixed-income manager's primary tools—positioning the portfolio to enhance profit as yields decline or minimize losses as yields rise.

As Equation 2 shows, modified duration, D, can be used to estimate the percentage change in a security's price (or the portfolio's value), P, given a change in rates.

$$\% \, P \text{ change} \approx -D \times \Delta Y \text{ (in percentage points)} \tag{2}$$

Note that when ΔY is negative, the calculated price change is positive because of the leading negative sign in the equation.

So, for example, if a bond (or portfolio) has a duration of 5 and one expects a 1% (100 bp) change in rates, the expected price change will be 5%.

If a portfolio manager expects that rates will decline, she will likely want to extend duration so that the price change (profit) resulting from the decline in rates will be greater than it would have been had the portfolio duration remained unchanged. If she expects rates to rise, she will adopt a more defensive posture by reducing the portfolio duration.

It is not simply a matter of increasing or decreasing duration, however. How the portfolio manager reduces or extends duration will affect the final result. Because yield curves seldom shift in parallel, equivalent duration adjustments can result in varying outcomes. Although duration positioning relative to the benchmark will dominate, the manager's positioning as the yield curve steepens or flattens as yields change can enhance or diminish her returns.

For example, consider a simple portfolio (Current Portfolio) allocated to three positions: one-third in cash, one-third in a sovereign bond with a duration of four years, and one-third in a sovereign bond with a duration of eight years. The portfolio would have a market-weighted duration of approximately 4.0 years. Suppose the manager wants to increase the duration to 6.0 years. There are many ways to do this, and Exhibit 10 outlines two alternatives.

Exhibit 10 Similar-Duration Portfolios May Respond Very Differently to the Same Change in Yields

		Allocation		
	Duration	Current Portfolio	Alternative 1	Alternative 2
Position 1 (cash)	0	33%	0	33%
Sovereign 1	4	33%	50%	0
Sovereign 2	8	33%	50%	0
Sovereign 3	6	0	0	33%
Sovereign 4	12	0	0	33%
Market-weighted duration		4	6	6

One alternative would be to reduce the cash position to zero, adding half of the cash to the 4-year duration bond and the other half to the 8-year duration bond (Alternative 1). A second alternative would be to leave the cash position unchanged, sell the 4- and 8-year duration bonds, and buy in their place 6- and 12-year duration bonds (Alternative 2).

The two alternative portfolios would have identical market-weighted durations, but they would respond differently to non-parallel yield curve moves because of their different structures. Say that the long end of the yield curve—bonds with durations greater than 9—rallied (rates at the long end declined more than rates at the shorter end). Alternative 2 would outperform Alternative 1. With no exposure to bonds with durations greater than eight years, Alternative 1 would not participate in the rally. So you can see that duration positioning—the pattern of bonds across the maturity spectrum—is important for non-parallel changes in the yield curve.

For a straight bond, one with no embedded options, the relationship among duration, price change, and yield change is straightforward (see Equation 2). If all yields moved in parallel, we could simply sum the anticipated price changes of the bonds in a portfolio based on duration and the yield change to estimate our return based on our yield forecast. We could also predict the extra price volatility of our portfolio for a given change in duration. Our prediction would be quite accurate. We could incorporate convexity measures as well for more accuracy, especially if our forecast yield changes were large, although projections incorporating convexity are much less intuitive than the linear duration estimation.

When not all of the points on the curve move by the same amount, however, our forecast's accuracy deteriorates. As a result, some parts of the portfolio may perform better than expected, some parts as expected, and some parts worse than expected. The lack of perfect correlation among yield movements means the portfolio duration calculation should be thought of as an *estimate* rather than a precise measure of interest rate sensitivity, and portfolio managers must carefully monitor their duration distribution across the portfolio, especially relative to their benchmark. An essential tool in monitoring duration distribution is "key rate duration," which we will discuss further in Section 3.2.3.

3.2.1.1 Using Derivatives to Alter Portfolio Duration If a portfolio is fully invested, it is often easier to reduce duration than to increase it. Duration can be reduced by selling some securities and holding cash. To increase duration (without using derivatives), it is necessary to sell shorter-duration securities and simultaneously buy longer-duration securities. When altering duration through simultaneous purchases and sales of securities, the portfolio manager may find herself in a position of having to sell securities that she would have preferred to retain—securities that were hard to find or that have low liquidity and are costly to transact.

It is much easier to alter portfolio duration using interest rate derivatives.[12] A derivatives overlay keeps the lengthening or shortening of duration separate from security selection, and it does not require a change in basic portfolio structure. (An overlay strategy uses derivative instruments to either obtain, offset, or substitute for certain portfolio exposures beyond those provided by the physical investment portfolio.)

One way to adjust portfolio duration with derivatives is to use futures contracts. Fixed-income futures contracts are sensitive to changes in the price of the underlying bond. No cash outlay is required in futures contracts beyond posting and maintaining margin. There are two important concepts necessary to calculate the futures trade required to alter a portfolio's duration—money duration and price value of a basis point (PVBP).

Money duration is market value multiplied by modified duration, divided by 100.[13] PVBP is market value multiplied by modified duration, divided by 10,000. PVBP scales money duration so that it can be interpreted as money gained or lost for each basis point change in the reference interest rate. For example, a portfolio with \$10 million market value and a duration of 6 has PVBP = \$6,000.

$$(\$10 \text{ million} \times 6)/10{,}000 = \$6{,}000$$

In other words, for every 1 bp shift in the US Treasury curve (upward or downward), the portfolio loses (or gains) \$6,000. To extend the portfolio's duration to 7, we must add \$1,000 PVBP without changing the portfolio size. The duration extension could be accomplished using a US dollar fixed-income futures contract. Take, for example,

12 We specify "interest rate derivatives" here because the word "derivatives" alone has different meanings to different segments of the fixed-income population. For example, an MBS manager might use the term to mean interest-only strips and principal-only strips (also called IOs and POs). Others might think of collateralized mortgage obligations (CMOs), whose cash flows are derived from those of more basic MBS. Structured notes are also referred to as derivatives. In this paragraph, we are talking about simple interest rate derivatives, such as puts and calls on bonds and interest rate futures (themselves called derivatives). We are also including caps and floors (typically on Libor) and various swaptions (options on swaps).

13 Any time we use the term "duration" and are referring to a measure of bond price change, we are referring to either modified duration or effective duration (which is always calibrated in terms of a modified duration). Effective duration is used for securities with embedded options.

a US Treasury 10-year note futures contract that, in this example, is assumed to have a PVBP of \$85. To add \$1,000 PVBP to our \$10 million portfolio, we would need to buy 12 contracts:

Required additional PVBP ÷ PVBP of the futures contract
= Number of contracts required

1,000 ÷ 85 = 11.76 or 12 contracts

It is possible to extend portfolio duration using leverage rather than futures. Take the \$10 million portfolio with a duration of 6 from the example above. Again, to increase the effective portfolio duration to 7, we need to add \$1,000 PVBP. The portfolio manager can use leverage to purchase \$1.67 million of similar bonds with a duration matching the portfolio duration of 6. The following calculation estimates the value of bonds required:

Required additional PVBP	\$1,000
÷ Duration of bonds to be purchased and financed	÷ 6
× 10,000	× 10,000
Additional market value of bonds to be purchased using leverage:	≈ \$1.67 mil

To calculate the effective portfolio duration, use the following equation:

$$\frac{\text{Notional portfolio value}}{\text{Portfolio equity}} \times \text{Duration} \approx \text{Effective portfolio duration}$$

$$\frac{\$11.67 \text{ million}}{\$10 \text{ million}} \times 6 \approx 7$$

In this equation, "Duration" refers to the duration of the assets (including levered bonds) alone, without regard to the liabilities that funded them.[14] That adjustment is done by the first term of the equation (Notional value/Equity).

Assuming that bonds with the appropriate duration can be purchased and financed—in this example, bonds with a duration of 6—leverage alone can perform the duration extension; there is no need to use longer-duration bonds. This form of leverage highlights the importance of examining a position's PVBP (here, \$7,000) rather than merely its duration when seeking to modify portfolio duration. Of course, there is no requirement limiting us to the use of bonds with a duration of 6. We could have used bonds with a duration of 3, but doing so would have required adding twice as much in market value to achieve the desired PVBP, and the interest cost would have been higher. Or we could have chosen bonds with a longer duration and then used less market value and less borrowing to achieve the same result. Either of these approaches would add a bit of curve risk to the portfolio, because now it would own bonds subject to yield changes at a shorter or longer point on the curve.

Leverage adds interest rate risk because it increases the portfolio's sensitivity to changes in rates (its duration is higher, after all). Note that using leverage in portfolios which contain credit risk amplifies both credit risk and liquidity risk.

Interest rate swaps could also be used to achieve the increase in duration. Although swaps are not as liquid as futures, nor as flexible in the short term as using leverage, swaps can be created for virtually any maturity and are not limited to the standard maturities in note or bond futures. And, although the legal and liquidity considerations differ between swaps and either futures or leverage, theoretically they are hard

14 The implicit assumption here is that the position is funded with overnight loans so that the liability has zero duration. If term funding (say, three months) is used, then the duration of the liability must be netted against the duration of the additional bonds purchased in determining the amount of bonds needed to reach the duration target. The following example using swaps rather than additional bonds illustrates the mechanics of this calculation.

to distinguish from one another. A receive-fixed position (receive fixed, pay floating) in a swap is essentially a long position in a bond and a short position in a short-term security, much like the long bond/short financing position of leverage, or the long bond/short repo position of a futures contract.

Interest rate swaps share a feature with futures that some investors find disturbing—they lack a well-defined duration. If, when we use the term "duration," we mean "the percentage value change for a 100 bp rate shift," that measure is really undefined because a new futures position or a new swap has no market value. Both the future and the swap add dollar (or money) volatility to the portfolio, however, because their value changes as rates change. The money duration or PVBP measures capture this effect on a portfolio.

The process for determining the notional value of swaps to add to a portfolio (either to lengthen duration, by using a receive-fixed swap, or shorten duration, by adding a pay-fixed swap) is the same as that shown earlier for futures. We first determine the desired PVBP of the portfolio, and then we assess what size swap position would add the required amount. Because swaps do not have a standardized size like futures do, we instead calculate the amounts in $1,000,000, and scale accordingly.

Consider the following three interest rate swaps (all versus three-month Libor):

Maturity	Effective PVBP Receive Fixed	Effective PVBP Pay Floating	Net Effective PVBP	PVBP per Million
5-Year	0.0485	0.0025	0.0460	460
10-Year	0.0933	0.0025	0.0908	908
20-Year	0.1701	0.0025	0.1676	1,676

Using the same base example as previously, where the starting portfolio is $10 million with a duration of 6, resulting in a PVBP of $6,000, what swap position would we have to add to bring the portfolio duration up to 7 as before? Remember that in the earlier example, we determined that we needed to add PVBP of $1,000 to move the portfolio from a duration of 6.0 to a duration of 7.0.

- Using 5-year swaps, we would need to add 1,000/460 or $2.17 million in swaps.
- Using 10-year swaps, we would need to add 1,000/908 or $1.1 million in swaps.
- Using 20-year swaps, we would need to add 1,000/1,676 or $0.60 million in swaps.

Notice how these answers are consistent with the previous futures example. In that example, we had to add approximately 12 contracts, or $1.2 million face value. Using 10-year swaps, we would add $1.1 million. This slight difference arises because the futures contract was tracking a "cheapest to deliver" that is slightly shorter than the 10-year note. Naturally, the 20-year swaps have more volatility than the 10-year swaps, and a lower face amount would be needed for the same exposure. Similarly, the lower-volatility five-year swap would have to be added in larger size to achieve the same exposure.

Any of these three positions would add the same dollar volatility to the portfolio for a parallel shift in yields (assuming that swap spreads relative to Treasuries remain constant). But each would have its primary exposure to a different part of the curve, and therefore, if the curve moved in a non-parallel fashion, these swaps would not perform identically. Clearly, some curve risk is inherent in the selection process.

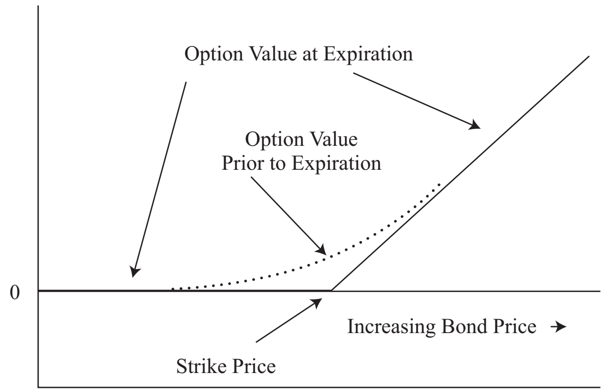
3.2.2 *Buy Convexity*

A portfolio manager may choose to alter portfolio convexity without changing duration in order to increase or decrease the portfolio's sensitivity to an anticipated change in the yield curve. Recall that convexity measures the sensitivity of duration to changes in yield. If yields rise, a portfolio of a given duration but with higher convexity will experience less of a price decline than a similar-duration, lower-convexity portfolio. Similarly, if yields fall, the higher-convexity portfolio will outperform a lower-convexity portfolio of the same duration. When a portfolio manager is operating under very tight duration constraints, convexity can be an important portfolio management tool.

Adding convexity by shifting the distribution of bonds in a portfolio, as illustrated in Exhibit 10, can enhance returns, but the effects of this strategy will likely be quite modest. Portfolios with broader mandates that include credit securities, and whose performance is evaluated relative to a benchmark, often have portfolios consisting of hundreds of securities; managers will find it difficult to alter the portfolio structure quickly. With the additional impediment of the illiquidity inherent in credit securities (and thus the likelihood that the portfolio contains bonds that the manager is reluctant to sell), altering portfolio structure to become more bulleted (characterized by concentrated maturities) or more barbelled (characterized by dispersed maturities) can be cumbersome. Portfolios with broader mandates can alter convexity using derivatives such as options and swaptions, callable bonds, and mortgage-backed securities.

We have previously stated that the goal of increasing convexity is to mitigate price declines and enhance price increases (beyond those provided by duration) resulting from changes in interest rates. Another way to state this concept is to say that the manager wants to add more curvature to the price–yield function of his portfolio. The most direct way to do this is to add instruments that have a lot of curvature in their price response to yield changes. Exhibit 11 shows the trajectory of the value of a call option on a bond relative to the bond price.

Exhibit 11 Call Option on a Bond



The option exhibits the curvature portfolio managers can find so valuable. As the price of the underlying bond declines, the option value also declines, although at a slower (and slowing) pace than the price of the bond itself. If the bond price falls below the option's strike price, the intrinsic value of the option is zero; any further decline in the bond price will have no effect on the (terminal) value of the option. When the price of the underlying bond rises, the option's value quickly increases and its performance will begin to match the underlying one-for-one (its "delta," the sensitivity of the option's price to changes in the price of the underlying bond, approaches 1.0). This rapid curvature, or acceleration and deceleration of price response, is very effective at adding convexity to a portfolio.

If the option's delta (measured in absolute price change) is calculated correctly into the duration of the portfolio, the rapid change in delta translates into increased portfolio duration as rates decline and prices rise, and into lower duration as prices fall. This dynamic is the essence of convexity.

For the portfolio to benefit from higher convexity, the anticipated decline in rates must occur within a short window of time. Recall that, all else being equal (i.e., same duration), a bond with higher convexity has a lower yield than a bond without that higher convexity. The lower yield creates a drag on returns. If the yield change unfolds over too long a period, the yield sacrificed will be larger than the expected price effect.

The next section discusses the use of portfolio structure—using bullets and barbells—to profit from a change in yield curve slope and curvature.

3.2.3 *Bullet and Barbell Structures*

Because yield curve moves are most frequently not parallel, managers often structure their portfolios to take advantage of a non-parallel move (a change in slope or curvature). The most common strategies used to capitalize on these non-parallel moves are bullet and barbell structures.

Two portfolios can have the same duration but be structured very differently in anticipation of a given yield curve change. A **bullet** portfolio is made up of securities targeting a single segment of the curve.[15] This structure is typically used to take advantage of a steepening yield curve—a bulleted portfolio will have little or no exposure at maturities longer or shorter than the targeted segment of the curve. If long rates rise (and the yield curve steepens), the bulleted portfolio will lose less than a portfolio of similar duration but composed of exposures distributed across the yield curve. If the yield curve steepens through a reduction in short rates, the bulleted portfolio has given up very little in profits given the small magnitude of price changes at the short end of the curve.

Barbells are portfolios combining securities concentrated in short and long maturities (and, consequently, owning less in the intermediate maturities) relative to the benchmark. They are typically used to take advantage of a flattening yield curve. If long rates fall more than short rates (and the yield curve flattens), the portfolio's long-duration securities will capture the benefits of the falling rates in a way that the intermediate-duration securities cannot. If the yield curve flattens through rising short-term rates, portfolio losses are limited by the lower price sensitivity to the change in yields at the short end of the curve, whereas the (non-barbell) benchmark's intermediate-duration securities will do poorly.

Key rate durations (KRDs) are often used to identify bullets and barbells. Also called partial durations, KRDs can be used to estimate a bond's sensitivity to changes in the shape of the benchmark yield curve. KRDs measure durations of fixed-income instruments at key points on the yield curve such as 2-year, 5-year, 7-year, 10-year, and 30-year maturities.

Of course, the sum of the KRDs must closely approximate the effective duration of a bond or portfolio. Otherwise, for parallel shifts in the benchmark yield curve, KRDs would indicate a different interest rate sensitivity and be inconsistent with the effective duration.[16]

Consider the two portfolios shown in Exhibit 12. These are Treasury portfolios constructed as temporary substitutes for a more inclusive Treasury index that includes off-the-run issues. The initial goal in the construction of Portfolio 1 was to match the general duration characteristics of the index. The goal in constructing Portfolio 2 was to modify Portfolio 1 in such a way as to keep the aggregate duration nearly the same while creating a slightly more barbelled portfolio.

15 When we use the term "bullet portfolio," we are talking about a portfolio with maturities near the center of some range, as opposed to a barbell, which concentrates its maturities at the ends of the range. Although it is possible to have a 30-year bullet portfolio or a 1-year bullet portfolio, we are focused here on *comparing* two portfolios with similar duration but vastly different maturity structures.

16 Indeed, for complex securities such as MBS, with significant modeling complexity, this check is required to see if the KRDs make sense in the overall modeling context.

Exhibit 12 Two Portfolios: Similar Duration, Different Convexity

Panel A: Portfolio 1

Ticker	Coupon	Maturity	YTM	Effective Duration	Par Amount (thousands)	Market Value	Effective Convexity
2 Year	0.75	31 Jan 2018	0.816	1.979	19,000	18,975	—
3 Year	0.75	15 Feb 2019	0.987	2.96	16,000	15,888	—
5 Year	1.375	31 Jan 2021	1.345	4.842	10,500	10,515	—
10 Year	2.25	15 Nov 2025	1.935	8.887	7,500	7,745	—
30 Year	3.00	15 Nov 2045	2.762	20.142	7,000	7,380	—
Portfolio 1	**1.325**		**1.333**	**5.834**	**60,000**	**60,503**	**0.779**
Index	**2.012**		**1.430**	**5.853**			**0.801**

Panel B: Portfolio 2

Ticker	Coupon	Maturity	YTM	Effective Duration	Par Amount (thousands)	Market Value	Effective Convexity
2 Year	0.75	31 Jan 2018	0.816	1.979	31,000	30,959	
3 Year	0.75	15 Feb 2019	0.987	2.96	9,000	8,937	
5 Year	1.375	31 Jan 2021	1.345	4.842	5,000	5,007	
10 Year	2.25	15 Nov 2025	1.935	8.887	7,000	7,228	
30 Year	3.00	15 Nov 2045	2.762	20.142	8,000	8,435	
Portfolio 2	**1.294**		**1.290**	**5.714**	**60,000**	**60,566**	**0.877**
Index	**2.012**		**1.430**	**5.853**			**0.801**

- The effective duration of both portfolios is close to that of the index (5.85).
- The convexity of Portfolio 1 is also close to that of the index (0.779 versus 0.801).[17]
- The convexity of Portfolio 2 is higher than that of Portfolio 1 (0.877 versus 0.779) and that of the index (0.877 versus 0.801).

In Exhibit 13, we compare the key rate duration-based PVBPs of each portfolio and the index. Exhibit 14 graphs the distribution of partial PVBPs for the two portfolios.

17 Convexity statistics must always be interpreted carefully because there is no convention for how they are scaled. As noted earlier, the convexity of a zero-coupon bond is approximately equal to its duration squared. A five-year zero-coupon bond has duration of roughly 5, so we should expect its convexity to be on the order of 25. Reported convexity numbers, however, frequently reflect dividing the "raw" number by 100. We follow that practice throughout this reading. Thus, the convexity shown here for the index (0.801) would correspond to 80.1 before rescaling. Properly accounting for the scaling of convexity numbers is especially important when they are used in approximating returns, as we do later in this reading.

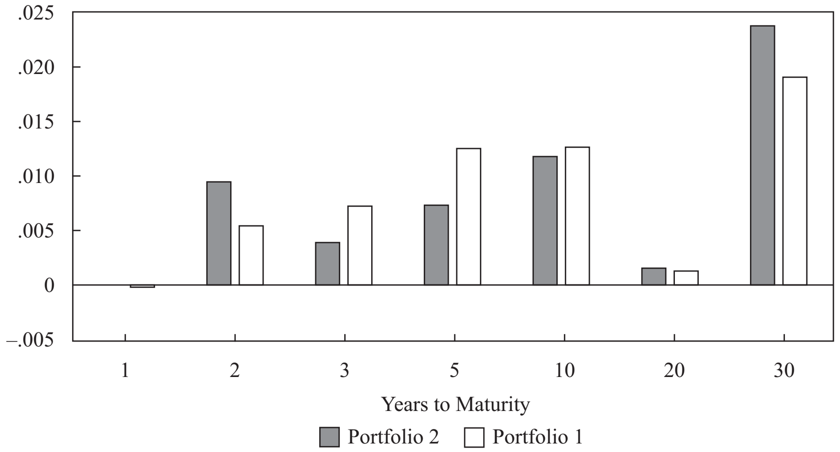
Exhibit 13 Partial PVBPs

	Partial or Key Rate PVBPs							
	Total	**1 Year**	**2 Year**	**3 Year**	**5 Year**	**10 Year**	**20 Year**	**30 Year**
Portfolio 1	0.059	0	0.0056	0.0073	0.0126	0.0127	0.0014	0.0191
Portfolio 2	0.059	0	0.0096	0.0040	0.0074	0.0119	0.0018	0.0238
Index	0.061	0.0017	0.0033	0.0063	0.0147	0.0093	0.0085	0.0173

Note that the sum of the partial PVBPs closely approximates the money duration of the portfolio (= Effective duration × Portfolio value per \$1 of par) divided by 100. For Portfolio 1, this equals [5.834 × (60,503/60,000)]/100 = 0.0588. The nominal key rate exposure at 20 years results from coupon payments on the longer-maturity bonds.

- The sums of the partial PVBPs for each of the two portfolios are the same (0.059) and close to the benchmark partial PVBPs (0.061).
- Portfolio 1 has key rate PVBPs distributed along the yield curve, underweighting the 5- and 20-year maturities relative to the index, but the 2-, 3-, 10-, and 30-year maturities are well represented, evidencing a bullet.
- Portfolio 2 materially overweights the 2s and 30s relative to the index and underweights the 3-, 5-, and 20-year segments, evidencing a barbell.

Exhibit 14 Distribution of Partial PVBPs for Each Portfolio



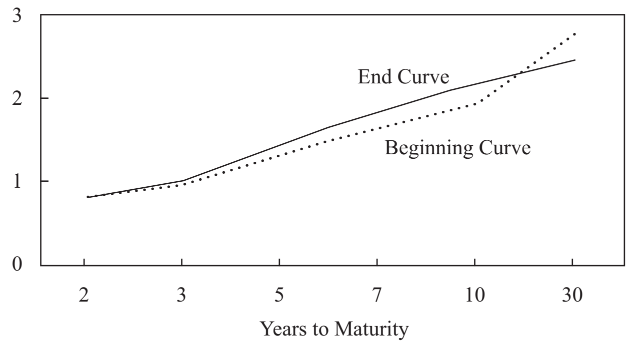
Portfolio 2 is likely to perform similarly to Portfolio 1 and the index for parallel shifts because of their similar overall durations. But in a curve flattening, especially one with added curvature such as that specified in Exhibit 15, Portfolio 2 will outperform based on its barbell structure.

Exhibit 15 Flattening Yield Curve Scenario

Panel A

Key Rate Curve Shift			
Maturity	**Beginning Curve**	**End Curve**	**Curve Shift**
2 Year	0.816	0.816	0.0
3 Year	0.987	1.037	5.0
5 Year	1.345	1.445	10.0
10 Year	1.935	2.185	25.0
20 Year	2.349	2.324	–2.5
30 Year	2.762	2.462	–30.0
2s–30s Spread	1.946	1.646	–30.0
Butterfly Spread	0.292	1.092	

Panel B



In Exhibit 16, we can see, as anticipated, that the barbelled portfolio (Portfolio 2) performed substantially better than the non-barbelled portfolio (Portfolio 1).

Exhibit 16 Change in Portfolio Values for Flattening Yield Curve

	Partial PVBP		Yield Curve	Par Amount of	Change in Value	
Maturity	**Portfolio 1**	**Portfolio 2**	**Change (bps)**	**Portfolios**	**Portfolio 1**	**Portfolio 2**
2 Year	0.0056	0.0096	0.0	$60,000,000	—	—
3 Year	0.0073	0.0040	5.0	$60,000,000	($21,900)	($12,000)
5 Year	0.0126	0.0074	10.0	$60,000,000	($75,600)	($44,400)
10 Year	0.0127	0.0119	25.0	$60,000,000	($190,500)	($178,500)
20 Year	0.0014	0.0018	–2.5	$60,000,000	$2,100	$2,700
30 Year	0.0191	0.0238	–30.0	$60,000,000	$343,800	$428,400
					$57,900	**$196,200**

EXAMPLE 1

Yield Curve Strategies

During a recent meeting of the investment committee of Sanjit Capital Management Company (Mumbai), the portfolio managers for the firm's flagship fixed-income fund were asked to discuss their expectations for Indian interest rates over the course of the next 12 months. Indira Gupta expects the yield curve to steepen significantly, with short rates falling in response to a government stimulus package and long rates rising as non-domestic investors sell their bonds in response to a possible sovereign credit rating downgrade. Vikram Sharma also sees short rates declining as the Reserve Bank of India substantially lowers its policy rate to stimulate economic growth, but he expects the long end of the curve to remain unchanged. He has only moderate conviction in his forecast for the long end of the curve. Ashok Pal disagrees with his co-workers. He believes the Indian economy is doing quite nicely and expects interest rates to remain stable during the next year.

From the following list, identify which yield curve strategy each of the three portfolio managers would most likely use to express his or her yield curve view. Justify your response.

Strategy:

- Sell convexity
- Duration management
- Buy convexity
- Bullet
- Barbell

Solution:

Based on her view that the yield curve will steepen significantly, with short rates falling and long rates rising, Gupta would most likely implement a bullet structure, concentrating the portfolio holdings in bonds whose duration are closely matched to the duration of the index. The bullet structure offers protection against a steepening yield curve.

Based on his view that short rates will decline significantly while long rates remain unchanged, Sharma is unlikely to shorten duration but would adopt a bullet portfolio structure. This approach avoids longer-maturity securities to insulate the portfolio against possible adverse moves at the long end of the curve. The duration of his portfolio holdings may be less concentrated than Gupta's given his more benign view of long rates.

Based on his view that interest rates will remain stable during the next 12 months, Pal is most likely to sell convexity for the year ahead. With an expectation for stable interest rates, he sees little value in the convexity that currently exists in his portfolio. Pal can sell convexity through the sale of options on bonds in his portfolio, or he could replace some of the current positions with callable bonds or mortgage backed securities.

4 FORMULATING A PORTFOLIO POSITIONING STRATEGY GIVEN A MARKET VIEW

We now move from describing these strategies to demonstrating how they can be used to position a portfolio given expectations for a given yield curve change. We will explore a variety of different scenarios.

Modifying a portfolio for the anticipated yield curve change requires the following:

- A clear understanding of the benchmark against which the portfolio is being evaluated and the role the portfolio is intended to fill in the client's portfolio;
- Understanding of any client-imposed constraints, such as duration, minimum and overall credit quality, diversification, or leverage;
- A detailed understanding of the current portfolio characteristics;
- A yield forecast (of course); and
- Knowledge of the portfolio positioning strategies most applicable to the anticipated yield curve environment.

We look at how one portfolio manager might approach the portfolio positioning challenge.

4.1 Duration Positioning in Anticipation of a Parallel Upward Shift in the Yield Curve

[In this section (4.1), the exhibits present expected return results as "given"—candidates are not expected to do the underlying analysis. Rather, candidates should understand how the results are used in making portfolio management decisions.]

Hillary Lloyd is a portfolio manager at AusBank. She manages a portfolio benchmarked to the XYZ Short- and Intermediate-Term Sovereign Bond Index, which has an effective duration of 2.00 (Exhibit 17). Her mandate allows her portfolio duration to fluctuate ±0.30 year from the benchmark duration. Her current portfolio of annual coupon-paying bonds is shown in Exhibit 18.

Exhibit 17 Benchmark Index Characteristics

Benchmark XYZ (Short/Intermediate Sovereign Index):	
Yield to Maturity	**Effective Duration**
2.30%	2.000

Exhibit 18 Current Portfolio

Maturity	Coupon	Price	YTM	Par Amount	Market Value	% Total Market Value	Beginning Effective Duration	Ending Effective Duration
1 Year	1.50	100	1.50	5,000	5,000	5%	0.985	0.000
2 Year	1.91	100	1.91	65,000	65,000	65%	1.944	0.979
3 Year	2.23	100	2.23	24,000	24,000	24%	2.871	1.930
4 Year	2.50	100	2.50	3,000	3,000	3%	3.762	2.846

Exhibit 18 (Continued)

Maturity	Coupon	Price	YTM	Par Amount	Market Value	% Total Market Value	Beginning Effective Duration	Ending Effective Duration
5 Year	2.74	100	2.74	2,000	2,000	2%	4.614	3.726
6 Year	2.95	100	2.95	1,000	1,000	1%	5.426	4.566
Portfolio	2.01%		2.01%		100,000	100%	2.261	1.305

Ending duration is after an anticipated 60 bps increase in yields. Portfolio duration is the market value–weighted average of duration of each bond.

Lloyd is highly confident that yields will increase by 60 bps across the curve in the next 12 months. Her research department has prepared a table of expected returns based on her forecast, shown in Exhibit 19. Lloyd must now select which securities to sell and which ones to buy to maximize her return during the next year while staying within her portfolio constraint.

Exhibit 19 Expected Returns under Conditions of (1) a Stable Yield Curve and (2) a +60 bp Parallel Yield Curve Shift

Security Descriptor (all are par bonds)			Next 12-Month Price and Return Expectations under Assumption of Stable Yield Curve		Implied Forward Yield and Implied Yield Change		Next 12-Month Yield Forecast and Holding Period Return Estimation under Forecast Interest Rate Change (+60 bps)	
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]
Maturity	Coupon	Current price	New Price with Rolldown[a]	Holding Period Return	Implied Forward Yield[b]	Implied Yield Change	Yield Curve Forecast	Holding Period Return[c]
1 Year	1.50%	100	100.00	1.50%	2.33%	0.83%	2.10%	1.50%
2 Year	1.91%	100	100.40	2.31%	2.61%	0.70%	2.51%	1.72%
3 Year	2.23%	100	100.62	2.85%	2.85%	0.62%	2.83%	1.69%
4 Year	2.50%	100	100.78	3.28%	3.07%	0.57%	3.10%	1.56%
5 Year	2.74%	100	100.90	3.64%	3.27%	0.53%	3.34%	1.41%
6 Year	2.95%	100	100.97	3.92%	3.46%	0.51%	3.55%	1.18%

[a] Although calculating the price of the bond given rolldown is not a focus of this reading, we demonstrate the approach here. The general formula for calculating a bond price given the market discount rate is as follows:

$$PV = \frac{PMT}{(1+r)^1} + \frac{PMT}{(1+r)^2} + \cdots + \frac{PMT + FV}{(1+r)^n}$$

where PV is the present value (the price of the bond); PMT is the coupon payment per period; FV is the future value paid at maturity (the par value of the bond); r is the market discount rate, or required rate of return per period; and n is the number of evenly spaced periods to maturity. For example, in Exhibit 19 (Column D), the new price with rolldown for the two-year (annual payment) bond *after* it "rolls down" to become a one-year bond is calculated using the following inputs: FV = 100, PMT = 1.91, r = 1.50%, and n = 1. The new price with rolldown is PV = 100.40.

(continued)

Exhibit 19 (Continued)

[b] The implied forward rate is the rate implied by the current term structure of interest rates at which investors would be indifferent to maturity. So, in the simplest case of zero-coupon bonds, we can buy the two-year zero bond with a yield of 1.91% or a one-year zero bond with a yield of 1.50%. If we buy the two-year zero, at the end of two years we would collect \$1.0386 ($[1 + 0.0191]^2$) for every \$1 invested. If we buy the one-year zero, at the end of one year we would have \$1.015 (1 + 0.015). What one-year rate one year from now would make us indifferent between buying the one-year zero and the two-year zero today? This is the one-year forward rate. Derivation of the forward yield requires the spot zero curve (which can be derived by "bootstrapping" from the par curve) as an input.

[c] The one-year holding period return for the two-year bond, assuming a 60 bp increase in yields (the one-year rate rises from 1.50% to 2.10%), can be determined using the following inputs: FV = 100, PMT = 1.91, r = 2.10%, and n = 1. The new price is PV = 99.81. The one-year holding period return is then calculated as [(99.81 – 100.00) + 1.91]/100 = 0.0172, or 1.72%.

Column E reflects the return from "riding the yield curve," assuming no change in the yield curve. Recall that the return of a sovereign bond over a one-year period (Column E at the one-year maturity), regardless of maturity, is always the one-year risk-free rate if the spot rates evolve as implied by the current forward curve at the end of the first year. If Lloyd's forecast was for a stable yield curve, she would likely own as much of the longer-maturity bonds as possible, because their returns are the highest in the stable curve scenario as they roll down the curve.

Consider the following, however:

- If Lloyd's forecast of a 60 bp move upward in rates is correct, then the two-year bond offers the highest return (1.72%).
- The five- and six-year bonds have forecast yields (as they become four- and five-year bonds) that are higher than the corresponding implied forward yields. Thus, they can be expected to return less than the one-year rate of 1.50%. (The implied yield change of the six-year bond is 51 bps in the stable yield curve environment. If yields move by more than the implied yield change—in this case, Lloyd is forecasting a 60 bp change in yield—there must be a downward price adjustment for the bond to reach its forecast yield. The move up in yield drives the price lower, resulting in a return lower than the one-year rate.)
- Bonds with two to three years to maturity all have forecast yields below their implied forwards and can be expected to return more than 1.50%. Any bond with an implied forward yield change greater than the forecasted increase in yield can be expected to have a return higher than the one-year rate if the forecast rates are realized.

The "best" bond is determined by a combination of the basis point difference in forward yield versus the forecast yield (or implied change versus forecast yield change) translated through the duration of the bond at the horizon. In our example, as bond maturity becomes shorter, the yield difference increases but the duration also decreases. The best bond has the highest product of these two terms.

For example, consider the two-year bond. If the yield on the bond evolves to its implied forward yield of 2.33% (column F) as a one-year bond one year from now, it will return 1.50%. But if, instead of changing in yield by 83 bps to reach the forward yield, it changes by only +60 bps to reach the forecast yield of 2.10% (column H), the 23 bps of "unused" forward migration can be thought of as a last-minute rally in the one-year bond at the horizon. For a duration just under one year (0.98) at the horizon, this 23 bp "rally" would add just under 23 bps to a bond priced near par. Using

Equation 3 to calculate the holding period return, we see that it does: The two-year bond has a holding period return of 1.72%, 22 bps higher than it would have if it simply moved to its implied forward yield.[18]

$$\begin{aligned}\text{Total return} &\approx -1 \times \text{Ending effective duration} \\ &\quad \times \left(\text{Ending yield to maturity} - \text{Beginning yield to maturity}\right) \\ &\quad + \text{ Beginning yield to maturity} \qquad (3) \\ &\approx -1 \times 0.98 \times \left(2.10 - 1.91\right) + 1.91 \\ &\approx 1.72\%\end{aligned}$$

Guided by the information obtained from the expected returns table, a manager facing no portfolio constraints would sell all current bond holdings except for the two-year bond. Then, he would use all of the sales proceeds to buy more two-year bonds, because these offer the highest one-year return. The portfolio duration would be 1.944 (see Exhibit 20) and would meet the requirement of being 2.00 ± 0.30.

Exhibit 20 Revised Portfolio

Maturity	Coupon	Price	Yield to Maturity	Par Amount (thousands)	Market Value (thousands)	% Total Market Value	Effective Duration
1 Year	1.50%	100.00	1.50%		—	0.0%	0.985
2 Year	1.91%	100.00	1.91%	100,000	100,000	100.0%	1.944
3 Year	2.23%	100.00	2.23%		—	0.0%	2.871
4 Year	2.50%	100.00	2.50%		—	0.0%	3.762
5 Year	2.74%	100.00	2.74%		—	0.0%	4.614
6 Year	2.95%	100.00	2.95%		—	0.0%	5.426
Portfolio	**1.91%**	**100.00**	**1.91%**	**100,000**	**100,000**	**100.0%**	**1.944**

4.2 Portfolio Positioning in Anticipation of a Change in Interest Rates, Direction Uncertain

Stephanie Joenk manages the emerging markets government bond portfolio for a major German bank. The investment mandate requires that the portfolio's effective duration match that of the benchmark, the Bloomberg Emerging Market Sovereign Bond Index. She expects Brazilian interest rates to be extremely volatile in the coming year, given the pending federal government elections. Based on her bank's internal economic forecasts and her own analysis, she expects that rates will move by 250 bps in the year ahead, although the direction of change will depend on the outcome of the elections.

To position the portfolio to profit from this view, Joenk plans to increase the portfolio's convexity. The portfolio would gain more in a declining rate environment and lose less in a rising rate environment than it would without the added convexity. She is willing to give up yield to improve her returns.

18 Ending duration is used in Equation 3 because the price change is assumed to occur instantaneously at the end of the one-year horizon.

Joenk currently holds a Brazilian 10-year bond with a duration that, combined with the other positions in her portfolio, keeps the effective duration aligned with the benchmark. Other securities that are readily available in the market include 6-month bills as well as 3-year notes and 30-year bonds. Exhibit 21 shows the details of these securities.

Exhibit 21 Brazilian Government Notes and Bonds

Security	Coupon	Maturity Date	Price	Yield to Maturity	Effective Duration	Effective Convexity
Brazil 6 month	6.000	17 Jan 2017	102.70	1.110	0.538	0.006
Brazil 3 year	8.875	14 Oct 2019	119.75	2.599	2.895	0.105
Brazil 10 year	6.000	7 April 2026	104.80	5.361	7.109	0.666
Brazil 30 year	5.000	27 Jan 2045	82.50	6.332	13.431	2.827

Joenk can add convexity by selling the 10-year Brazilian bonds and investing all of the proceeds in a duration-matched barbell position of shorter and longer bonds:

		Duration	Convexity
Sell:	Brazil 10 year	7.109	0.666
Buy:	Brazil 3 year	2.895	0.105
	Brazil 30 year	13.431	2.827

To maintain the effective duration match between the portfolio and the index, the weighted duration of the combined trade (buy 3-year notes and buy 30-year bonds) must equal the duration of the 10-year notes she is selling:[19]

$$7.109 = (\text{Duration of 3-year note} \times \text{Weight of 3-year note}) + (\text{Duration of 30-year bond} \times \text{Weight of 30-year bond})$$

$$7.109 = 2.895x + 13.431(1 - x)$$

Solving for x, we find $x = 0.60$

The proceeds from the sale of the 10-year note should be allocated 60% to the 3-year note and 40% to the 30-year bond:

(60% × 2.895) + (40% × 13.431) = 7.109

The gain in convexity will be 0.528:

(60% × 0.105) + (40% × 2.827) – (100% × 0.666) = 0.528

(Weight of the 3-year) × (Convexity of the 3-year) + (Weight of the 30-year) × (Convexity of the 30-year) – (Weight of the 10-year) × (Convexity of the 10-year) = 0.528

The give-up in yield will be –127 bps:

(60% × 2.599%) + (40% × 6.332%) – (100% × 5.361%) = –0.127, or –1.27%

(Weight of the 3-year) × (YTM of the 3-year) + (Weight of the 30-year) × (YTM of the 30-year) – (Weight of the 10-year) × (YTM of the 10-year) = 0.127

19 Of course, the market values must be equal as well in order to preserve the money duration of the portfolio.

If the forecast change in rates does not materialize, the "yield drag" will cause the returns of the higher-convexity portfolio to be less than that of the initial portfolio with its lower convexity.

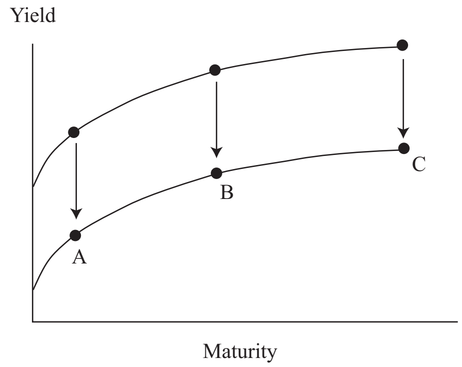
4.3 Performance of Duration-Neutral Bullets, Barbells, and Butterflies Given a Change in the Yield Curve

In this section, we compare the response of duration-neutral bullet and barbell portfolio structures to parallel shifts in the yield curve as well as changes in the slope of the yield curve.

4.3.1 *Bullets and Barbells*

Exhibit 22 displays a parallel shift of the yield curve with three bonds marked along the curve: A, B, and C. Our bulleted portfolio (Portfolio B) consists 100% of Bond B. The barbelled portfolio (Portfolio AC) consists of Bonds A and C, with 50% of the market value allocated to each.

Exhibit 22 A Parallel Downward Shift of the Yield Curve



Portfolio AC has greater convexity than Portfolio B. This convexity affects how each portfolio responds to parallel shifts and changes in the slope of the yield curve. To facilitate the discussion, we will use several zero-coupon bonds to construct portfolios AC and B. This does not limit the applicability of our conclusions to portfolios composed solely of zero-coupon bonds, but it does make the bond math much easier. For purposes of this example, we make the following assumptions, summarized in Exhibit 23:

- The semi-annual bond equivalent yields on the overnight risk free money market fund (Position A), the 5-year note (Position B), and the 10-year note (Position C) are 2%, 3%, and 3.4%, respectively.
- Position A has a duration of essentially zero.
- Position B is a 5.075-year zero-coupon bond, with a modified duration of 5 (5.075/1.015).[20]
- Position C is a 10.17-year zero-coupon bond, with a modified duration of 10 (10.17/1.017).

20 Recall that Macaulay duration of a zero-coupon bond is equal to its maturity. Modified duration is the Macaulay duration divided by one plus the yield per period. Modified duration provides an estimate of the percentage price change for a bond given a change in its yield to maturity.

- Portfolio AC, invested 50% in Position A and 50% in Position C, has a modified duration of 5 (50% × 0 + 50% × 10 = 5).

Exhibit 23 Position and Portfolio Characteristics

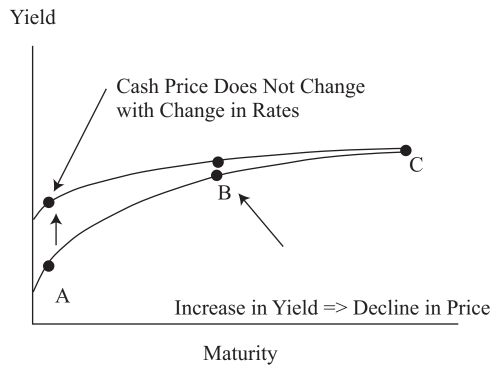
	Securities			Portfolios	
	A	**B**	**C**	**B**	**AC**
Maturity (years)	0.0027	5.075	10.17	5.075	5.086
Semi-annual, bond equivalent yield (%)	2.00%	3.00%	3.40%	3.00%	2.70%
Modified duration	0.00	5.00	10.00	5.00	5.00

We look now at how these portfolios perform when the curve experiences an instantaneous parallel downward yield curve shift, a curve flattening, or a curve steepening.

In an instantaneous downward parallel shift, as illustrated in Exhibit 22, the higher-convexity barbell portfolio AC will outperform bullet portfolio B slightly because of Portfolio AC's greater sensitivity to declining yields and rising prices. (Recall, however, that Portfolio AC's advantage resulting from its higher convexity deteriorates over time because Portfolio B accretes income at a higher rate—3.0% versus 2.7%. Under our assumption of an instantaneous shift, however, we can ignore yield differentials.)

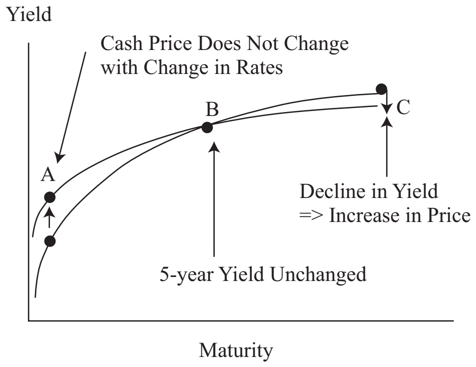
Suppose the curve flattens: The yield differential between A and C decreases. We assume that the long end of the curve is unchanged but that short rates rise, as illustrated in Exhibit 24. In this scenario, Bond A (the risk-free overnight money market fund) does not decline in value given its duration of near zero. Bond C (the 10-year notes) does not change in value because its yield does not change. Portfolio B loses money, however, because the yield on position B (the five-year notes) rises. In this flattening scenario, the barbell portfolio (AC) outperforms the bullet portfolio (B).

Exhibit 24 A Flattening of the Yield Curve: Short Rates Rise



Let us now look at another simple "flattener" scenario, illustrated in Exhibit 25. This time we assume the curve flattens via a rise in short rates and a decline in long rates—we will "pin" the curve at B:

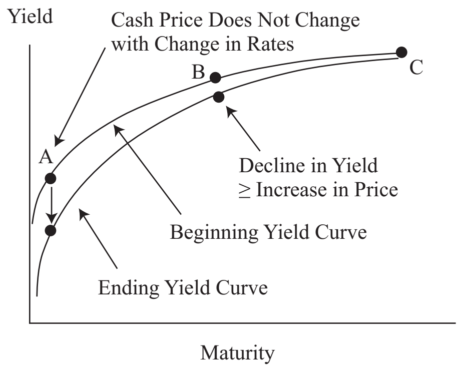
Exhibit 25 A Flattening of the Yield Curve: Short Rates Rise and Long Rates Fall



The price of Bond B is unaffected because the bond's yield is constant. The price of Bond A is unchanged given its zero (cash-like) duration. The price of Bond C increases as the bond's yield declines. In aggregate, the value of Portfolio AC rises while the value of Portfolio B remains unchanged. Again, the barbell portfolio (AC) outperforms the bullet portfolio (B).

We will now look at the behavior of these two portfolios if the yield curve steepens. Exhibit 26 illustrates this steepening scenario. The curve is "pinned" at C, and the yields of Bonds A and B decline.

Exhibit 26 A Steepening of the Yield Curve: Short and Intermediate Rates Fall



In this case, bullet Portfolio B outperforms barbell Portfolio AC, the opposite of what occurred when the curve flattened. Bonds A and C experience no change in price, while Bond B increases in value. (If portfolio managers say they are "positioned for a flattening," you can infer that their portfolios are somewhat barbelled versus the benchmark. If managers say they are "positioned for a steepener," their portfolios are somewhat bulleted versus the benchmark.)

Although our stylized barbell Portfolio AC and bullet Portfolio B represent extremes, they readily demonstrate two main points:

1 Barbell portfolios, given the location of their bonds along the curve, outperform bullet portfolios if the yield curve flattens.

2 For similar reasons, bullet portfolios outperform barbell portfolios if the yield curve steepens.

Let us consider an example of how a portfolio manager might use a barbell structure to increase portfolio convexity and to position for yield curve flattening. We will also make reference to key rate durations, or partial durations, and their related measures, partial DV01 and partial PVBP. We briefly review how these partials are calculated before we use them in an example.

How Are Partials Calculated?

Partial durations are calculated by moving a single point on the pricing yield curve, interpolating the change in rates for each adjacent maturity, calculating the new forward yields and resulting cash flows, and thus determining the price sensitivity of the bond resulting from the move at that point on the curve. This calculation is made for each maturity point on the pricing curve. The maturities used for the partial calculation must reflect the maturity range of the portfolio and the benchmark. For portfolios with maturities that range from 1 month to 30 years, the set of partials to be used must balance the need to have an adequate number of points to effectively represent the curve with the complexity of calculating each partial. The Yield Book, a fixed-income analytics system used for many examples in this reading, offers partials at 1, 2, 3, 5, 10, 20, and 30 years. Note that in some of our examples, the portfolio holds a position in 7-year notes and no position in 20-year bonds, and no partial is calculated for the 7-year point but one is calculated for the 20-year point. Although we have no partial for the 7-year maturity, the price response of bonds in the 7-year maturity range can reasonably be captured by interpolation between the 5-year and 10-year partials, whereas a 20-year partial is needed to reliably estimate the price sensitivity of portfolio holdings with maturities between 10 and 30 years.

A simple alternative to this process is to look at the price difference of the bond (or portfolio) in the up 10 bps and down 10 bps cases for one partial point on the curve, and normalize that to a 1 bp change (divide by 20). This procedure gives the measure known as partial price value of a basis point (PPVBP) or partial DV01 (PDV01). In some of the examples that follow, we use PPVBPs to look at curve exposure relative to a benchmark.

Haskell Capital Management Dan Haskell is the CEO and primary portfolio manager for Haskell Capital Management. His firm recently (and narrowly) lost a competition for a $60 million portfolio management assignment to Pyramid Capital Management. The sponsor commented favorably on Haskell's investment process and performance but noted that the consistency of Pyramid's returns was the deciding factor. The portfolio was due to be funded on Friday, 29 January. On Thursday evening, however, the primary portfolio manager at Pyramid announced that he was taking an extended leave of absence for health reasons. On Friday morning, the sponsor called Haskell to inform him that he was awarded the business. The portfolio will be funded with just over $60 million in cash that afternoon. The benchmark is a US investment-grade index similar to the Citi US Broad Investment Grade Index (USBIG). (USBIG tracks the performance of US dollar–denominated bonds issued in the US investment-grade bond market.) Haskell intends to overweight the corporate, MBS, and asset-backed securities (ABS) components of the index because he believes these instruments are priced "cheap" to Treasuries. The performance record is to begin immediately upon funding.

Haskell considers the investment situation:

- A credit/collateralized portfolio consisting of corporates, MBS, and ABS cannot be assembled on a Friday afternoon.
- The market has been very volatile lately, and leaving the $60 million in cash has the potential to lead to severe underperformance if the market were to rally next week while the non-Treasury portion of the portfolio was being assembled.

- Haskell knows he has to temporarily invest the credit portion of the portfolio, but he is sensitive to transaction costs.
- He also believes that a "flattening twist" of the yield curve was highly likely, with yields on maturities shorter than 2024 rising and yields on longer maturities falling.

With those considerations in mind, Haskell decides to purchase a portfolio of highly liquid on-the-run Treasury securities that would approximately match the duration of the benchmark. On-the-run Treasuries trade with almost no bid–offer spread, so any portfolio re-positioning Haskell might look to do in the weeks ahead could be accomplished with minimal transaction cost effect. The all-Treasury portfolio would have a lower yield than the benchmark because it would have no credit exposure, but he also expected that it would have higher convexity because it did not own MBS or callable bonds.

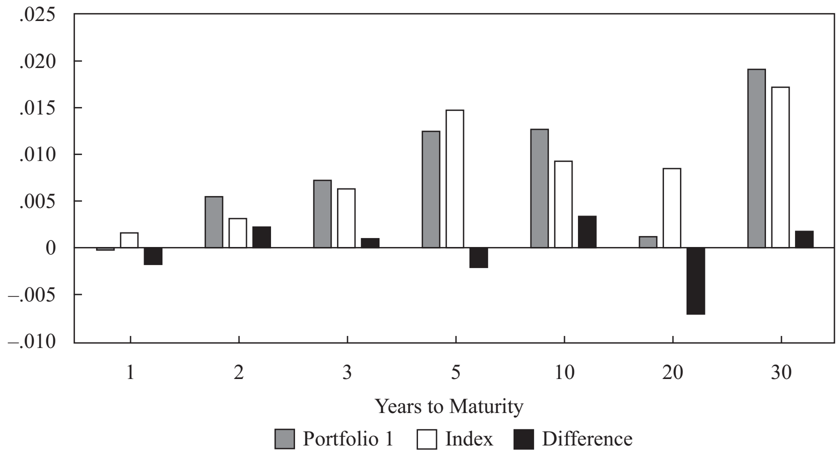
Exhibit 27 shows the pro forma portfolio:

Exhibit 27 Pro Forma Portfolio Consisting of On-the-Run Treasury Securities (Portfolio 1)

Security	Coupon	Maturity	YTM	Effective Duration	Par Amount (thousands)	Market Value	Effective Convexity
2 Year	0.75	31 Jan 2018	0.816	1.979	17,000	16,978	—
3 Year	0.75	15 Feb 2019	0.987	2.960	14,700	14,597	—
5 Year	1.375	31 Jan 2021	1.345	4.842	9,500	9,514	—
7 Year	1.75	31 Jan 2023	1.649	6.629	6,300	6,342	—
10 Year	2.25	15 Nov 2025	1.935	8.887	6,500	6,712	—
30 Year	3.00	15 Nov 2045	2.762	20.142	6,000	6,326	—
Portfolio	**1.355**		**1.356**	**5.821**	**60,000**	**60,469**	**0.779**
Index	**2.012**		**1.430**	**5.853**			**0.801**

Haskell realizes that he will have to adjust this portfolio as it was assembled so as not to exceed the $60 million in funding. The effective duration and convexity of the pro forma portfolio nearly matches that of the benchmark. The yield curve exposure also closely matches that of the benchmark at most maturities, as shown by the key rate duration comparison shown in Exhibit 28.

Exhibit 28 Partial PVBP vs. the Benchmark: Pro Forma Portfolio (1)



Key rate PVBPs	Total	1 Year	2 Year	3 Year	5 Year	10 Year	20 Year	30 Year
Pro forma portfolio (1)	0.059	0	0.0056	0.0073	0.0126	0.0127	0.0014	0.0191
Index	0.061	0.0017	0.0033	0.0063	0.0147	0.0093	0.0085	0.0173

Haskell noted that his pro forma portfolio is similar to the benchmark in yield curve exposure, as measured by partial PVBPs, except for the 20-year area. The index has significant exposure to 30-year bonds that had been issued some time ago, whereas the pro forma portfolio has none. (The small “exposure” shown in the chart is from coupons of the longer bonds.) But Haskell is slightly overweight in the 10-year area and the 30-year area, so he is comfortable with the structure versus the benchmark.

Because he expects that the yield curve is likely to flatten, Haskell is seeking to create a more barbell-like portfolio structure while continuing to match the duration of the benchmark. His revised portfolio is shown in Exhibit 29. He also compares the KRDs of this new portfolio with those of his original portfolio (Exhibits 30 and 31).

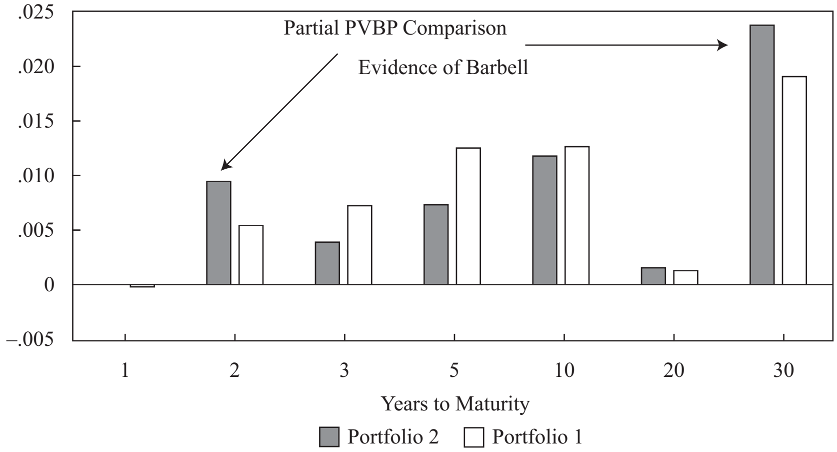
Exhibit 29 More Barbelled Portfolio (2)

Security	Coupon	Maturity	YTM	Effective Duration	Par Amount	Market Value	Effective Convexity
2 Year	0.75	31 Jan 2018	0.816	1.979	29,000	28,962	
3 Year	0.75	15 Feb 2019	0.987	2.960	8,000	7,944	
5 Year	1.375	31 Jan 2021	1.345	4.842	4,700	4,707	
7 Year	1.75	31 Jan 2023	1.649	6.629	4,300	4,329	
10 Year	2.25	15 Nov 2025	1.935	8.887	6,500	6,712	
30 Year	3.00	15 Nov 2045	2.762	20.142	7,500	7,908	
Portfolio	**1.330**		**1.317**	**5.800**	**60,000**	**60,562**	**0.877**
Index	**2.012**		**1.430**	**5.853**			**0.801**

Exhibit 30 Key Rate Durations: Pro Forma Portfolio (1) vs. More Barbelled Portfolio (2)

Key Rate PVBPs	Total	1 Year	2 Year	3 Year	5 Year	10 Year	20 Year	30 Year
Pro forma portfolio (1)	0.059	0	0.0056	0.0073	0.0126	0.0127	0.0014	0.0191
More barbelled portfolio (2)	0.059	0	0.0096	0.0040	0.0074	0.0119	0.0018	0.0238

Exhibit 31 Key Rate Durations: Evidence of the Barbell



In this comparison of the two prospective portfolios, Haskell's barbell structure can be seen in the higher columns for the 2-year and 30-year partials, with lower partials through the middle of the maturity spectrum.

The effective duration of this revised (more barbelled) portfolio is nearly identical to that of the original (5.80 versus 5.82). The effective convexity has increased as expected in light of the barbell—from 0.779 to 0.877. The revised portfolio has more duration in the 2- and 30-year maturities than the original and less duration through the middle maturities, consistent with the barbelled structure Haskell was seeking.

How would the portfolios perform if the curve flattens as Haskell expects?

Portfolio 2 is expected to outperform Portfolio 1 in the flattening because of its more barbelled structure. Exhibit 32 shows the results on a bond-level basis.

Exhibit 32 Market Value Changes from Analytical Software

			Pro Forma Portfolio (1)				More Barbelled Portfolio (2)			
Security	Coupon	Maturity Date	Par	Beginning Market Value	Horizon Market Value	Change	Par	Beginning Market Value	Horizon Market Value	Change
2 Year	0.75	31 Jan 2018	17,000	16,978	16,916	–62	29,000	28,962	28,857	–105
3 Year	0.75	15 Feb 2019	14,700	14,597	14,527	–70	8,000	7,944	7,906	–38
5 Year	1.38	31 Jan 2021	9,500	9,514	9,466	–48	4,700	4,707	4,683	–24
7 Year	1.75	31 Jan 2023	6,300	6,342	6,313	–29	4,300	4,329	4,309	–20
10 Year	2.25	15 Nov 2025	6,500	6,712	6,727	15	6,500	6,712	6,727	15

(continued)

Exhibit 32 (Continued)

			Pro Forma Portfolio (1)				More Barbelled Portfolio (2)			
Security	Coupon	Maturity Date	Par	Beginning Market Value	Horizon Market Value	Change	Par	Beginning Market Value	Horizon Market Value	Change
30 Year	3.00	15 Nov 2045	6,000	6,326	6,557	231	7,500	7,908	8,196	288
Total			**60,000**	**60,469**	**60,506**	**37**	**60,000**	**60,562**	**60,678**	**116**

Exhibit 33 shows that using partial PVBPs to assess the portfolio structure is a reasonable approach to take.

Exhibit 33 Market Value Changes Estimated Using Partial PVBPs

			Pro Forma Portfolio (1)		More Barbelled Portfolio (2)	
Maturity	Key Rate Curve Shift (bps)	Portfolio Par Amount ($ thousands)	Partial PVBP	Predicted Portfolio Impact ($ thousands)	Partial PVBP	Predicted Portfolio Impact ($ thousands)
2 Year	18.3	60,000	0.0056	–61.5	0.0096	–105.4
3 Year	16.3	60,000	0.0073	–71.4	0.0040	–39.1
5 Year	10.4	60,000	0.0126	–78.6	0.0074	–46.2
7 Year		60,000	—	—	—	—
10 Year	–3.5	60,000	0.0127	26.7	0.0119	25.0
20 Year	–11.3	60,000	0.0014	9.5	0.0018	12.2
30 Year	–19.1	60,000	0.0191	218.9	0.0238	272.7
Total				**43.5**		**119.2**

As seen in Exhibit 16, the predicted change using partials is calculated as follows:

Predicted change = Portfolio par amount × Partial PVBP × (–Curve shift)

The predicted change of $43,500 for the original portfolio and $119,200 for the modified portfolio can be compared to the actual portfolio changes for the original and modified portfolios—$37,000 and $116,000, respectively (shown in Exhibit 32). These results are close enough to validate the use of partials as an indicator of portfolio structure and likely portfolio performance in our flattening yield curve scenario.

Note that Exhibit 33 does not provide a key rate duration at the 7-year maturity, whereas it does provide one for the 20-year maturity, even though Haskell's proposed portfolio does not hold 20-year bonds. Refer to the boxed sidebar "How Are Partials Calculated?" and recall that we can pick the curve segments to shift without specifically aligning a KRD with each maturity in the portfolio.

EXAMPLE 2

Using Partial Durations to Estimate Portfolio Sensitivity to a Curve Change

Assume Haskell revises his yield curve forecast as shown in Exhibit 34: Yields for the 2-year through 10-year maturities each decline by 5 bps, and the yield for the 30-year maturity increases by 23 bps.

Exhibit 34 A Steeper and Less Curved Yield Curve

	Yield Curve Shift		
Maturity	Beginning Curve	Ending Curve	Curve Shift
2 Year	0.816	0.767	–5.0
3 Year	0.987	0.937	–5.0
5 Year	1.345	1.296	–5.0
7 Year	1.649	1.600	–5.0
10 Year	1.935	1.885	–5.0
30 Year	2.762	2.991	23.0
2s–30s Spread	1.946	2.224	28.0
2/10/30 Butterfly spread	0.292	0.012	

Using the data from Exhibit 34, we compare the partial durations of the two portfolios Haskell is considering:

Key Rate PVBPs	Total	1 Year	2 Year	3 Year	5 Year	10 Year	20 Year	30 Year
Pro forma portfolio (1)	0.0587	0	0.0056	0.0073	0.0126	0.0127	0.0014	0.0191
More barbelled portfolio (2)	0.0585	0	0.0096	0.0040	0.0074	0.0119	0.0018	0.0238

Which portfolio would Haskell prefer to own under this scenario?

Solution:

If the curve becomes steeper and less curved, intuitively Haskell should prefer Portfolio 1. Portfolio 1 has significantly more partial duration at the intermediate maturities of 3 and 5 years, as well as substantially less partial duration at the shorter (2-year) and longer (30-year) maturities compared with Portfolio 2. Portfolio 1 thus would be expected to outperform Portfolio 2 under a scenario in which the yield curve steepens and its curvature decreases. This is confirmed as shown in the following table, which estimates the portfolio change using the portfolio's key rate durations:

Market Value Changes Estimated Using Partial Key Rate Durations

			Pro Forma Portfolio (1)		More Barbelled Portfolio (2)	
Maturity	Actual Shift (bps)	Portfolio Par Amount ($000)	Partial PVBP	Change ($000)	Partial PVBP	Predicted Change ($000)
2 Year	–5.0	60,000	0.0056	16.8	0.0096	28.8
3 Year	–5.0	60,000	0.0073	21.9	0.0040	12.0

(continued)

(Continued)

			Pro Forma Portfolio (1)		More Barbelled Portfolio (2)	
Maturity	Actual Shift (bps)	Portfolio Par Amount ($000)	Partial PVBP	Change ($000)	Partial PVBP	Predicted Change ($000)
5 Year	–5.0	60,000	0.0126	37.8	0.0074	22.2
7 Year	–5.0	60,000	0	—	0	—
10 Year	–5.0	60,000	0.0127	38.1	0.0119	35.7
20 Year	9.0	60,000	0.0014	–7.5	0.0018	–9.7
30 Year	23.0	60,000	0.0191	–263.5	0.0238	–328.4
Total				–156.5		–239.5

4.3.2 *Butterflies*

Bullet and barbell portfolio structures can be combined in a long–short structure. A butterfly trade is a combination of a barbell (wings of the butterfly) and a bullet (body of the butterfly). As such, the butterfly involves taking positions in three securities with varying maturities: short term, intermediate term, and long term. Recall our securities and portfolios from Exhibit 23:

	Securities			Portfolios	
	A	B	C	B	AC
Maturity (years)	0.0027	5.075	10.17	5.075	5.086
Semi-annual, bond equivalent yield (%)	2.00%	3.00%	3.40%	3.00%	2.70%
Modified duration	0.00	5.00	10.00	5.00	5.00

The butterfly consists of either a long barbell (long Portfolio AC) and a short bullet (short Portfolio B) or a short barbell and a long bullet. Portfolio weights are selected so that the butterfly position is money duration neutral—the money durations of the long and the short portfolios are equal but opposite in sign, so changes in value of these portfolios would offset each other in the event of a parallel yield curve shift. Butterflies often entail leverage. In an unlevered portfolio, shorting the wings (or body) entails underweighting the corresponding segment of the yield curve relative to the portfolio's benchmark.

Because the butterfly structure is money duration neutral, the butterfly portfolio's value should be unchanged given a small parallel shift in the reference yield curve.

A butterfly that is long in the wings and short in the body has positive convexity (it is long the higher convexity barbell and short the lower convexity bullet). It can be expected to benefit from a flattening of the yield curve. Because convexity is more valuable in more volatile rate environments, the long wings/short body butterfly will also generate a small additional profit if interest rates are more volatile than the market is currently pricing.[21]

A butterfly that is short in the wings (the barbell portfolio) and long in the body (the bullet portfolio) is a trade predicated on a view of stable interest rates (it is selling convexity) or on a yield curve steepening (based on its portfolio structure).

21 Volatility must be greater than the market expects, resulting in greater curvature of the curve and/or a large move in interest rates in general. It is not the volatility by itself that adds to the butterfly's profits.

If the market is pricing in an expectation for volatility while the portfolio manager believes that rates will be stable, convexity will be of little value to the manager. He likely believes that convexity is overpriced and would be willing to sell the convexity by being short the wings (barbell portfolio) and long the body (bullet portfolio). By doing so, he would earn the additional yield of the less convex portfolio.

There are various ways to structure (i.e., weight) the wings of a butterfly portfolio; among the most common are (1) duration-neutral weighting, (2) 50/50 weighting, and (3) regression weighting.[22]

Duration-neutral weighting selects the weights so that the duration of the wings equals the duration of the body and the market values are also the same. Thus, the positions are also money duration neutral.

Portfolios that can use leverage might adopt a 50/50 weighting, shorting the body and allocating the proceeds of the short sale to the wings such that half the duration value (market value multiplied by modified duration) is allocated to each wing of the barbell portfolio. The overall structure would be money neutral only by coincidence. Such an approach is used primarily by market participants who finance their positions (e.g., dealer firms). The portfolio manager may believe that the body (bullet portfolio) is too expensive relative to the wings (barbell portfolio) but may lack a view on how that pricing anomaly will be resolved.

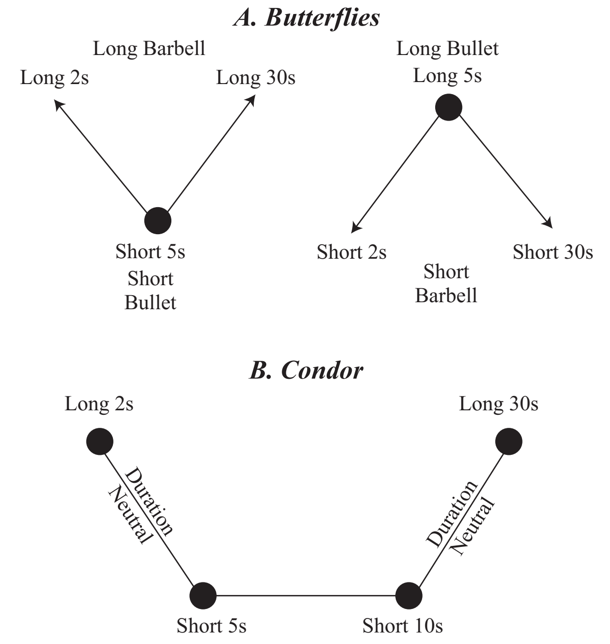
Suppose, for example, that a portfolio manager believes that the yield on the 5-year note is too low relative to the 2s and 10s. (Its price is too high, and thus it is "rich" relative to the 2s and 10s.) By extension, we can say that she believes the yield curve is too straight or linear. If her view is correct, the pricing anomaly can be resolved by the 5s moving up in yield, the 2s moving down in yield, or the 10s moving down in yield—or some combination of these three.

There are additional ways in which these various trades might be structured. For example, another version of the curvature trade uses four positions, much like a butterfly with an elongated body (see Exhibit 35). For example, the portfolio manager can put on a duration-neutral trade at the short end of the curve that will profit if that end of the curve steepens, and he can simultaneously put on a duration-neutral trade at the long end of the curve that will profit if that end of the curve becomes flatter (i.e., money duration neutral long the 2-year note and short the 5-year note, and money duration neutral short the 10-year note and long the 30-year bond).

Each pair will produce profits if the yield curve adds curvature. There is no single formula for allocating the funds to these positions—the relative weights of the two positions are discretionary. If the yield curve does add curvature, a long–short position in only the 2s/5s should produce profits, and a short–long position in only the 10s/30s should also produce profits. The degree of leverage (and therefore the size of the overall trade) is also discretionary. This four-position trade is sometimes called a condor, probably because of its similarities to (and despite large differences from) the four-strike options position also known as a condor.

22 Some portfolio managers use regression analysis to arrive at weightings adjusted for differences in yield volatilities between the long end and the short end of the curve. Typically, a relatively short look-back period (30 to 45 days) is used for the analysis to capture the securities' behavior in the recent environment rather than some longer-term relationship that might be irrelevant to the trade today.

Exhibit 35 Butterflies and Condors



EXAMPLE 3

Bullets and Barbells

Observe the three US government Treasury bond portfolios in Exhibit 36—Base Portfolio, Portfolio A, and Portfolio B. Each has the same market value of \$60 million. These portfolios differ significantly in terms of key characteristics, however—including yield to maturity, effective duration, and effective convexity—because of their different portfolio structures.

Exhibit 36 Three US Treasury Bond Portfolios

Base Portfolio

Security	Coupon	Maturity	Market Price	Market Value	Weight	Yield to Maturity	Effective Duration	Effective Convexity
US 2 year	0.750	2/28/2018	99.836	17,000,000	0.28	0.840	1.920	0.046
US 3 year	1.000	3/15/2019	99.992	14,500,000	0.24	1.000	2.940	0.101
US 5 year	1.125	2/28/2021	99.008	9,500,000	0.16	1.330	4.810	0.259
US 7 year	1.500	2/28/2023	99.000	6,500,000	0.11	1.650	6.630	0.485
US 10 year	1.625	2/15/2026	97.781	6,500,000	0.11	1.870	9.220	0.936
US 30 year	2.500	2/15/2046	96.453	6,000,000	0.10	2.670	21.850	5.959
				60,000,000	**1.00**	**1.339**	**5.918**	**0.828**

Exhibit 36 (Continued)

Portfolio A

Security	Coupon	Maturity	Market Price	Par Amount	Weight	Yield to Maturity	Effective Duration	Effective Convexity
US 2 year	0.750	2/28/2018	99.836	45,000,000	0.75	0.840	1.920	0.046
US 3 year	1.000	3/15/2019	99.992		0.00	1.000	2.940	0.101
US 5 year	1.125	2/28/2021	99.008		0.00	1.330	4.810	0.259
US 7 year	1.500	2/28/2023	99.000	—	0.00	1.650	6.630	0.485
US 10 year	1.625	2/15/2026	97.781	—	0.00	1.870	9.220	0.936
US 30 year	2.500	2/15/2046	96.453	15,000,000	0.25	2.670	21.850	5.959
				60,000,000	**1.00**	**1.298**	**6.903**	**1.524**

Portfolio B

Security	Coupon	Maturity	Market Price	Par Amount	Weight	Yield to Maturity	Effective Duration	Effective Convexity
US 2 year	0.750	2/28/2018	99.836	—	0.00	0.840	1.920	0.046
US 3 year	1.000	3/15/2019	99.992	—	0.00	1.000	2.940	0.101
US 5 year	1.125	2/28/2021	99.008	5,000,000	0.08	1.330	4.810	0.259
US 7 year	1.500	2/28/2023	99.000	45,000,000	0.75	1.650	6.630	0.485
US 10 year	1.625	2/15/2026	97.781	10,000,000	0.17	1.870	9.220	0.936
US 30 year	2.500	2/15/2046	96.453	—	0.00	2.670	21.850	5.959
				60,000,000	**1.00**	**1.660**	**6.910**	**0.541**

Discuss which portfolio (A or B) would be preferred to the base portfolio under each of the following yield curve scenarios.

- Scenario 1: The 2s–30s spread is expected to widen by 100 bps as short and intermediate rates fall and long rates remain stable. Also, interest rate volatility is expected to be low during the next year.
- Scenario 2: The 2s–30s spread is expected to narrow by 100 bps as short and intermediate rates rise and long rates fall. Also, interest rate volatility is expected to be high during the next year.

Your answer should make reference to the expected shape of the yield curve; the allocation of notes and/or bonds in the selected portfolio; and the effective duration, effective convexity, and yield to maturity of the selected portfolio.

Solution for Scenario 1:

- A widening spread indicates a steepening yield curve.
- A steeper yield curve and low volatility favors a bulleted portfolio (concentrated in the intermediate maturities—the 5-, 7-, and 10-year notes) because the intermediate maturities should perform better than the combination of the short-end and long-end positions in the expected steepening environment.
- Portfolio B is the portfolio best positioned for this scenario.

- The higher effective duration (6.910) of Portfolio B relative to the base portfolio will benefit Portfolio B as intermediate interest rates decline.
- Portfolio B will also benefit through the yield pickup of 32.1 bps (1.660% – 1.339%) received in exchange for giving up convexity of 0.287 (0.541 – 0.828).

Solution for Scenario 2:

- A narrowing spread defines a flattening yield curve.
- A flatter yield curve and high volatility favors a barbelled portfolio (concentrated in the short and long maturities—the 2-year notes and 30-year bonds, respectively).
- Portfolio A is the portfolio best positioned for this scenario.
- Together, the short and long ends of the curve should perform better than the intermediate maturities in the expected flattening environment. Note that for the same rate rise, the short end will lose less money than the intermediate maturities in Portfolio B.
- The higher effective duration (6.903) of Portfolio A relative to the base portfolio will benefit Portfolio A as long-term interest rates decline.
- The small give-up in yield (1.298% – 1.339%) is a reasonable exchange for the added convexity of 0.696 (1.524 – 0.828).

4.4 Using Options

Because the convexity of shorter maturities is relatively small, as Exhibit 37 shows, it is hard to add convexity to a portfolio without buying longer-maturity securities. It is much simpler to extend duration and add convexity with options. In this example, we will use options on bond futures.

For our starting portfolio, we will use a laddered portfolio of equal par amounts of recently issued (on-the-run) Treasury bonds: 2-year, 3-year, 5-year, 7-year, 10-year, and 30-year bonds, as shown in Exhibit 37.[23]

Exhibit 37 Pre-Trade Portfolio (as of 18 March 2016)

				Market		Duration		Amount (thousands)	
Security	Coupon	Maturity	Effective Convexity	Yield to Maturity	Price	Modified	Effective	Par Value	Market Value
US 2 year	0.750	28 Feb 2018	0.046	0.84	99.836	1.92	1.92	10,000	9,988
US 3 year	1.000	15 Mar 2019	0.101	1.00	99.992	2.93	2.94	10,000	10,001
US 5 year	1.125	28 Feb 2021	0.259	1.33	99.008	4.78	4.81	10,000	9,908
US 7 year	1.500	28 Feb 2023	0.485	1.65	99.000	6.56	6.63	10,000	9,909
US 10 year	1.625	15 Feb 2026	0.936	1.87	97.781	9.08	9.22	10,000	9,794
US 30 year	2.500	15 Feb 2046	5.959	2.67	96.453	20.72	21.85	10,000	9,670
Total portfolio	**1.417**	**9.4 Yrs.**	**1.276**	**1.55**	**98.693**	**7.59**	**7.82**	**60,000**	**59,270**

23 All data and analytics are from the Yield Book, as of 18 March 2016.

To demonstrate the convexity of options, we will:

- sell a portion of the 30-year bond position to fund the purchase of the options;
- sell an additional portion of the 30-year bond position to ensure that the money duration (and therefore the portfolio duration) remains unchanged; and
- establish a cash position with the excess proceeds from the securities sale.

We will use short-maturity at- or near-the-money options to illustrate this trade because they contain a great deal of convexity. On 18 March 2016, the June 2016 30-year Treasury bond futures contract was trading at 163.22. The May 2016 expiration call option on the 30-year future (US161F6) carries a strike price of 161. As we are placing the trade, the cheapest-to-deliver security for the June futures is the 4.50% of 15 February 2036. Here is some useful information:

Instrument	PVBP	Price	Delta	Convexity
Call option	0.149	3.97	0.644	826.041
June 2016 30-year bond future	0.2354	163.22		
30-Year bond	0.2113	106.82		

The PVBP of the call option is substantially less than that of the 30-year bond. We will therefore need more par value of the option than of the bond it replaces if we are to maintain the portfolio duration. To derive the needed par value of the option, we multiply the par value of the bonds we are selling by the ratio of the bond's PVBP to the option's PVBP: 0.2113/0.149 = 1.418. Thus, we sell 6,800 par of the 30-year bond and buy 9,640 underlying par amount of the option (approximately equal to 6,800 × 1.418). The resulting portfolio is shown in Exhibit 38; with equivalent market value and duration, it has an effective money duration equal to that of the pre-trade portfolio.

Exhibit 38 Bond Portfolio with Call Option

						Market		Amount (thousands)	
Security	Coupon	Maturity	Effective Convexity	Effective Duration	Yield to Maturity	Price	Accrued Interest	Par Value	Market Value
Cash	0.508	23 Mar 2016	0	0	0.508	100.000	0	6,193	6,193
US161F6	0	20 May 2016	826.041	375.30	n/a	3.970	0	9,640	383
US 2 Year	0.750	28 Feb 2018	0.046	1.92	0.835	99.836	0.045	10,000	9,988
US 3 Year	1.000	15 Mar 2019	0.101	2.94	1.003	99.992	0.019	10,000	10,001
US 5 Year	1.125	28 Feb 2021	0.259	4.81	1.333	99.008	0.067	10,000	9,908
US 7 Year	1.500	28 Feb 2023	0.485	6.63	1.653	99.000	0.090	10,000	9,909
US 10 Year	1.625	15 Feb 2026	0.936	9.22	1.871	97.781	0.161	10,000	9,794
US 30 Year	2.500	15 Feb 2046	5.959	21.85	2.673	96.453	0.247	3,200	3,094
Total Portfolio:	**1.031**	**5.3 years**	**5.952**	**7.82**	**1.32**	**85.791**	**0.067**	**69,033**	**59,270**

Note: Note the extremely high value for the convexity of the option (826.041).

We analyzed the relative performance of the two portfolios under yield curve changes ranging from +75 bps to –75 bps, in 25 bp increments. The change is assumed to occur over a relatively short time horizon, prior to the expiration of the option we are using for illustrative purposes (1 month and 25 days). Total holding period returns (un-annualized) are shown in Exhibit 39.

Exhibit 39 Total Returns under Alternative Yield Scenarios

Yield Scenario	–75	–50	–25	0	+25	+50	+75
				Total Return:			
Pre-trade portfolio	6.495	4.358	2.309	0.344	–1.542	–3.354	–5.097
Post-trade portfolio	7.321	4.820	2.417	0.113	–1.645	–2.920	–4.149
Difference	+0.826	+0.462	+0.108	–0.231	–0.103	+0.434	+0.948

Exhibit 40 illustrates the higher convexity of the post-trade portfolio with the option position relative to the pre-trade portfolio, and Exhibit 41 plots the return differential between the two portfolios (performance of the portfolio with options minus the performance of the portfolio without options).

Exhibit 40 Adding Convexity with Options

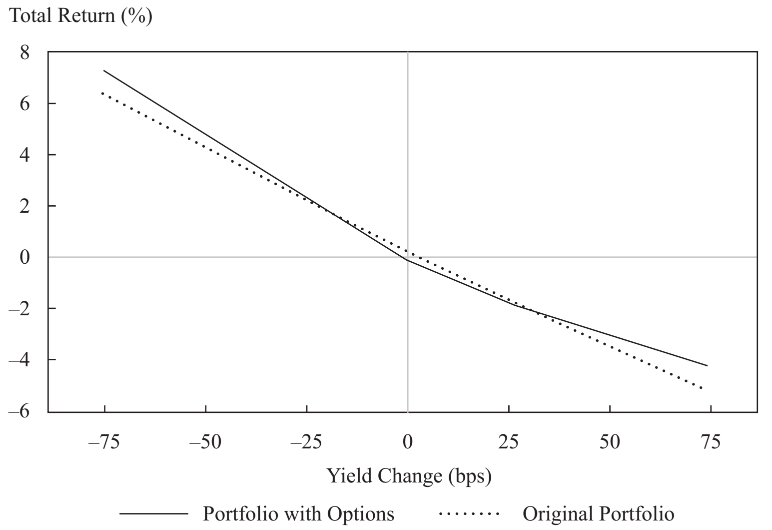
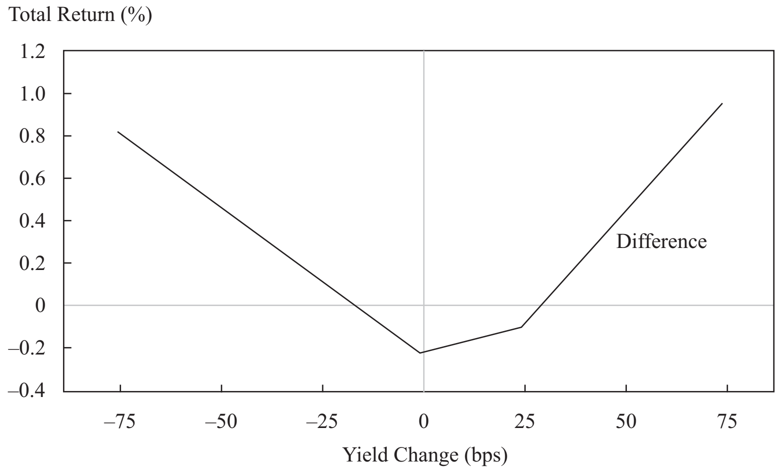


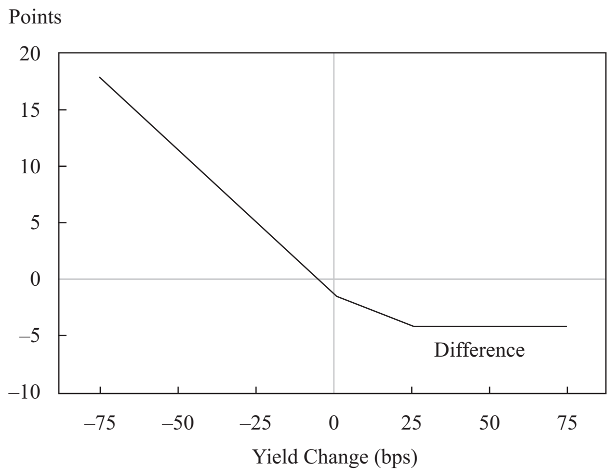
Exhibit 41 Return Differential



In Exhibit 41, we can see the drag on performance created by owning convexity when interest rates do not move up or down in a meaningful fashion. Costs involved include the initial purchase price of the options and the forgone interest income on the \$6.8 million of 30-year bonds. It is also evident that the post-trade portfolio materially outperforms the pre-trade portfolio irrespective of the direction of rate change—as long as the movement is greater than 25 bps in either direction.

In a rising interest rate scenario, even if the call options expire worthless, total performance of the portfolio with the options is greater than the performance of the pre-trade portfolio. If rates decline, the options' own convexity adds value—the options outperform the 30-year bond, enhancing overall portfolio performance. Exhibit 42 shows the accelerating rate of performance as yields continue to decline.

Exhibit 42 Option Dollar Return



We deliberately chose an extreme example to illustrate the effect of adding convexity using options. Convexity is not free, but it is obtainable. If everyone is concerned about extreme interest rate movements and unsure of the direction of such movements, option premiums—and thus the cost of obtaining convexity—can be very high.

4.4.1 *Changing Convexity Using Securities with Embedded Options*

In the previous example, we purchased options to enhance convexity. To reduce convexity, we might sell options or buy MBS. A manager might choose to sell convexity if he holds the view that yields will be relatively stable for the duration of the trade.

In this example, we will sell options indirectly by buying MBS, which have embedded call options that belong to the homeowners who have "issued" the underlying mortgages.

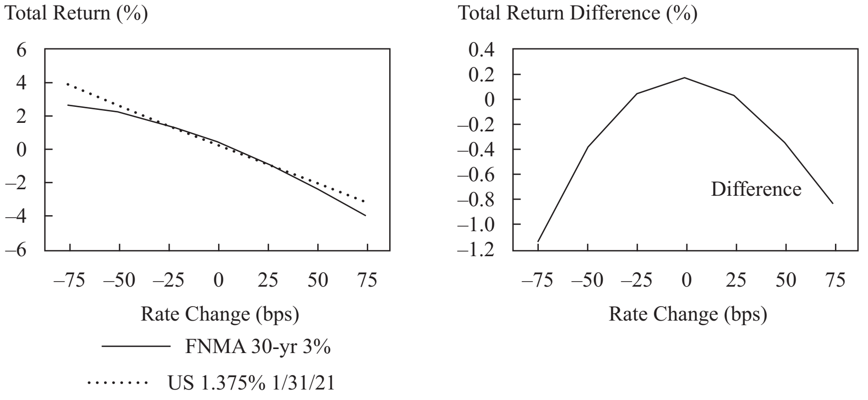
Our starting position is \$10 million in the US Treasury Note 1.375% maturing 31 January 2021 (the "old" five-year note as this is being written[24]). This note has an effective duration of 4.72. Given the manager's expectation of low yield volatility over a short horizon, she decides to sell convexity by selling the Treasury and buying the 30-year Federal National Mortgage Association (FNMA) 3% MBS, which has a slightly shorter effective duration of 4.60.

The returns over a short horizon (1 month and 20 days) are as shown in Exhibit 43. Those returns are graphed in the left panel of Exhibit 44, and the return differential is shown in the right panel.

Exhibit 43 MBS vs. Treasury: Total Returns under Alternative Yield Scenarios

Yield Scenario	–75	–50	–25	0	+25	+50	+75
FNMA 30-year 3%	2.647	2.204	1.458	0.432	–0.855	–2.340	–3.941
US 1.375% 31 Jan 2021	3.774	2.588	1.417	0.262	–0.879	–2.005	–3.117
Difference	–1.127	–0.384	0.041	0.17	0.024	–0.335	–0.824

Exhibit 44 MBS vs. Treasury: One-Month and 20-Day Horizons



As seen in Exhibit 44, the yield advantage of MBS boosts returns in scenarios where there is little change in rates. If, however, the rate moves are more pronounced (in this case, greater than 25 bps in either direction), the performance of the MBS suffers. The negative convexity of MBS means it is more sensitive to increases in rates and

24 The Treasury bond sold just prior to the current on-the-run bond is known as the "old" bond or note, and the one sold before that is called the "old-old" bond or note. In March 2016, as this is being written, the 28 Feb 2021 maturity is the current five-year note, and the 31 Jan 2021 is the "old" five-year note.

less sensitive to declines in rates than the Treasury it replaced. (As interest rates rise, prepayments of the underlying mortgages decline, lengthening the duration of the MBS and making it more sensitive to rising rates. As interest rates fall, prepayments of the underlying mortgages rise, shortening the effective duration of the MBS and decreasing its sensitivity to declining rates. These behaviors are diametrically opposed to the behavior of securities with positive convexity.) In addition, because the horizon is short, there is little opportunity to accumulate the yield premium offered by MBS, which might have offset some of the negative relative price performance. As expected, selling convexity (or equivalently, buying negative convexity) works well if interest rates do not move much, and it works poorly if interest rates move significantly.

INTER-MARKET CURVE STRATEGIES

5

As noted in the discussion of carry trades (Section 3.1.4), inter-market trades involve more than one yield curve and require the investor to either accept or somehow hedge currency risk.[25] The trade may or may not involve explicit positions in multiple markets. Simply making an investment outside one's home market should be viewed as an inter-market trade since it reflects a judgment that the foreign position is more attractive than alternatives at home. Indeed, this is probably the most common type of inter-market investment for managers of long-only portfolios.

Any of the strategies discussed in previous sections can be employed in either market or both markets of an inter-market trade. The new element introduced by the inter-market perspective is the relationship among the yield curves and the currencies.

Aside from inter-market carry trades, discussed earlier, the primary driver of inter-market trades is a view on narrowing or widening of yield spreads between markets. Differential changes in the slopes or shapes of the curves can be included within this broad characterization. If we think of the investor having positions, or at least potential positions, all along the maturity spectrum, then at each maturity the investor wants to invest in the market(s) for which the combination of carry, riding the curve, and anticipated spread changes is most favorable. Over most investment horizons any significant spread changes will dominate the carry and riding the curve components of relative return and hence dominate the choice of markets.

Focusing on spreads between markets begs the question of whether such spreads can persist, and if so, why? Why is there not a global yield curve common to all (default-free) markets? To put it another way, under what conditions would two markets share a yield curve? First, there must be perfect capital mobility between the markets, ensuring that risk-adjusted expected returns will be equalized. One might argue that, at least among the major world markets, that condition is reasonably well satisfied. The second condition is more onerous: The exchange rate between the currencies must be credibly fixed—forever.[26] That is, investors must believe there is no risk that the currencies will exchange at a different rate in the future. Otherwise, yield differentials will emerge (likely starting at longer maturities) giving rise to differential risk and return expectations in the two markets and allowing each market to trade on its own fundamentals.

25 For the purposes of this discussion, a "market" is identified with the currency in which instruments are denominated and "the" yield curve in that market reflects either the debt of the sovereign issuer in its own currency or the "Libor flat" swap curve.

26 These conditions are necessary and sufficient for permanent convergence. See Chapter 10 of Scott D. Stewart, Christopher D. Piros, and Jeffrey C. Heisler, *Running Money: Professional Portfolio Management* (New York: McGraw-Hill, 2011) for a full exposition.

Thus, it is the lack of credibly fixed exchange rates that allows (default-free) yield curves, and hence bond returns, to be less than perfectly correlated across markets. In this sense, it is really all about the currency and interestingly, as shall be seen, that is still true if we hedge the currency exposure.

EXAMPLE 4

A Convergence Trade

Michael Costos, CFA, manages assets for a large life insurance company in Frankfurt. He believes European economic growth is on the verge of accelerating and that this growth will enable Greece to stabilize its finances, remain a viable member of the European Economic and Monetary Union (EMU), and pay its outstanding Euro-denominated debt. He expects yield spreads on Greek bonds relative to those of other member countries to tighten substantially over the next few years. With Euro rates extraordinarily low, however, a significant portion of the spread tightening may result from a general rise in the Euro yield curve. When Costos checks the markets he sees the following yields, as reported in Exhibit 45.

Exhibit 45 Government Bond and EUR Swap Yields for Various Maturities

	3 Month	6 Month	2 Year	10 Year
Greek Government	1.56%	—	5.21%	5.91%
German Government	–0.92%	–0.72%	–0.66%	0.43%
EUR Swap	–0.33%	–0.25%	–0.15%	0.79%

Bonds and the fixed side of swaps pay annually. The floating side of swaps pays semi-annually at the six-month rate. Yields are annual with annual compounding.

Costos is thinking of buying either the Greek 2-year (4.75% coupon of 4/17/19 at a price of 99.18) or the Greek 10-year (3% coupon of 2/17/27 priced at 78.86). He may simply buy the bond, but he is also considering doing an asset-swap. In the case of the 10-year this would mean paying fixed at 3% timed to match the 3% annual coupon from the bond and receiving a spread to the 6-month floating rate. A dealer has indicated the 10-year asset swap can be done at a spread of 220 basis points.

A member of the investment committee has posed the following questions:

1 Could this trade be considered an inter-market trade?

2 What are the advantages and disadvantages of each maturity (2-year and 10-year) of Greek bonds?

3 What are the costs and benefits of doing the asset swap?

How should Costos respond?

Solution to 1:

Yes. This is a classic convergence trade, just like those involving so-called peripheral markets when the EMU was being formed in the 1990s. The question then was whether those countries could align their economies well enough to join the EMU. Now the question is whether Greece can realign its economy sufficiently to stay in the EMU. Some financial economists would say its bonds are trading as if Greece may pay its debt in "new drachma" rather than in euros. Implicitly, there are two currencies—the euro and the new drachma—and two yield curves here. They would posit that Greece's outstanding obligations implicitly trade on the new drachma curve. As long as Greece remains in the EMU the new drachma is at parity (one-to-one) with the euro. However, if Greece were to leave the EMU and pays its debts in new drachma the parity would be broken. The higher yields being demanded on Greek bonds reflect the market's assessment that a new drachma would be worth substantially less than one euro.

Solution to 2:

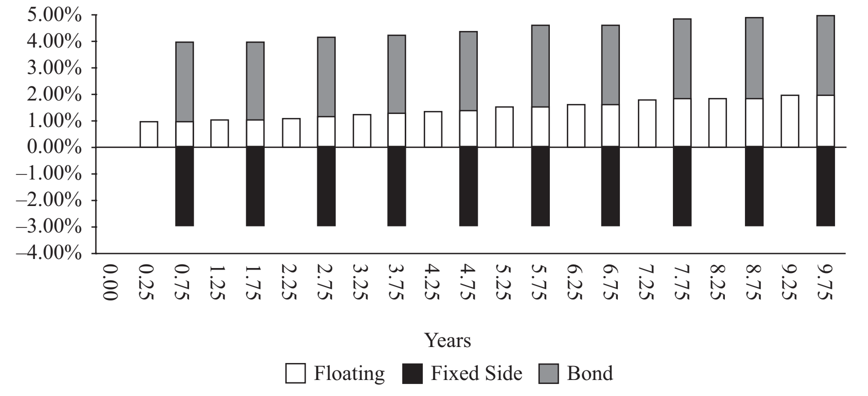
Buying the 2-year bond would appear to be safer than buying the 10-year. It provides higher cash flow (4.75% versus 3% coupons), shorter duration, and a shorter period of exposure to Greece's uncertainties. In addition, the 2-year bond offers a higher spread over the German bond (5.87% for the 2-year versus 5.48% for the 10-year) and the EUR swap (5.36% for the 2-year versus 5.12% for the 10-year). On the other hand, the 10-year offers a higher yield and greater opportunity to benefit from the view that spreads will tighten. Longer duration translates into greater potential gains if Greek yields decline, even if German yields and EUR swap rates rise. Correspondingly, the longer maturity means that the 10-year bond can capture the currently high Greek yield for 10 years, either by accruing it over time or by sale of the bond early if/when market yields decline. In contrast, the two-year earns the current high yield for a much shorter period.

Solution to 3:

Doing the asset swap allows Costos to make separate decisions with respect to overall duration and spread duration. Since he expects the Euro yield curve to rise, he does not want to add overall duration to his portfolio. On the other hand, he wants to reap as much benefit as he can from his view that Greek spreads will tighten. To do that, he should buy the 10-year Greek bond and pay fixed/receive floating on the swap to neutralize the overall duration impact. In addition, doing the asset swap allows the position to profit on both sides of the expected spread tightening—lower Greek yields and/or higher EUR swap rates. The asset swap does, however, entail giving up cash flow since even with a 220 basis point spread to the six-month rate, the floating payments will initially be well below the 3% coupon on the 10-year bond: Libor + spread = –0.25% + 2.20% = 1.95%.

The interest payments on the asset swap are shown in Exhibit 46. Since the Greek bond actually matures in 9.75 years and pays an annual coupon (shown in green), the fixed rate side of the swap (shown in red) also pays on those dates so that the interest payments offset. The first fixed payments on the bond and the swap occur in 0.75 year. The floating side of the swap (shown in blue) pays semi-annually, with every other payment timed to correspond to the bond and swap fixed rate payments. So the first floating payment is in 0.25 year, and the second is in 0.75 year. Each floating payment is one-half the Libor rate at the beginning of that period plus one-half the spread (220 bps/2 = 110 bps). Since the fixed rate swap payments offset the coupons on the bond, the floating rate payments are also the net interest flow. For purposes of Exhibit 46, the Libor rate was assumed to follow the path of forward rates.

Exhibit 46 Asset Swap Interest Payments



The investor buys the bond for 78.86% of par and, in the absence of default, receives 100% of par at maturity. There are no principal payments on the swap.

Since yield curves are not perfectly correlated across markets, currency hedging does not eliminate the opportunity to add value via inter-market trades. To put it another way, currency-hedged foreign bonds and domestic bonds are not perfect substitutes. There is, however, an important caveat. Covered Interest Arbitrage implies that if each of the bond's cash flows were hedged in the forward FX market to the date it will be received, then exposure to both the foreign yield curve and the foreign currency will have been eliminated.[27] In that case, cash flows from the foreign bond and its hedges will behave as if the foreign bond were denominated in the domestic currency and trading off the domestic yield curve.

In practice, a portfolio manager typically buys a bond—say a 10-year maturity—and hedges the currency by selling an equal amount of the foreign currency forward—say three months.[28] The hedge position would then be rolled every three months to maintain the hedge. Covered Interest Arbitrage implies that the manager is effectively borrowing at a three-month floating rate in the foreign currency, is lending at a three-month floating rate in his base currency, and is long the foreign yield curve out to 10 years. To a first approximation, changes in the spot FX rate will have no impact on the return.[29] But the rolling hedge will generate a profit (loss) if the spread between the three-month base currency rate and the three-month foreign currency rate increases (decreases) over time. Thus, the currency hedge introduces a bet on the spread at the short end of the curves.

27 The synthetic instrument created in this way will not, in general, have level coupons in the investor's base currency since the coupons will have been converted at different forward FX rates. So it will not behave exactly like a fixed-rate bond.

28 In practice, portfolio managers do not usually hedge currency exposure on an asset-by-asset basis. Instead, they hedge based on their aggregate exposure to a particular currency. FX dealers post forward rate quotes for standard maturities out to perhaps 180 days, but the market is most active and the bid–ask spreads are tightest at relatively short maturities. A 90-day (three-month) tenor is attractive because it corresponds to a regularly quoted and heavily traded point on the yield curve and it is long enough that maintaining hedges does not require rolling the contract frequently.

29 The future foreign currency values of the bond are uncertain and hence cannot be perfectly hedged with discretely adjusted sales of FX quantities fixed in advance. Quantity-adjusting instruments, known as quantos, can eliminate this residual currency risk. More precisely, the risk is transferred to the counterparty. Quantos, as well as how to value them, are explained in Christopher D. Piros, "The Perfect Hedge: To Quanto or Not to Quanto," in *Currency Derivatives: Pricing Theory, Exotic Options, and Hedging Applications*, edited by David F. DeRosa (New York: John Wiley & Sons, 1998).

Whether or not foreign currency exposure will actually be hedged into the portfolio's base currency, it is important that inter-market asset decisions be made on the basis of prospective hedged returns (based on *forward FX rates* rather than projected spot FX rates). By definition, local market returns are denominated in different currencies and hence are not comparable. Unhedged returns, converted at the spot FX rate but not hedged into a common currency using the forward FX rate, are not comparable either. These unhedged returns entail differential currency risks and do not reflect the cost or benefit of removing those risks.

When all assets are hedged into a common currency, the portfolio's base currency becomes irrelevant for inter-market decisions. The best assets are the best assets regardless of one's base currency. Given a choice of assets, currency exposure decisions should be based on projected appreciation or depreciation relative to forward FX rates rather than on the basis of projected spot FX appreciation/depreciation alone. This approach ensures proper accounting for the cost/benefit of adding or eliminating currency exposure.[30]

EXAMPLE 5

Inter-Market Positioning

Simon Millsap manages international bond portfolios benchmarked against an index of developed market sovereign bonds. The base currency is the US dollar. Over the next six months, he expects US rates to rise and the yield curve to flatten modestly as the Federal Reserve continues to tighten monetary policy. He believes that UK yields will be pulled upward along with US yields and that spreads relative to the US will widen uniformly across the curve. Meanwhile, he expects the ECB to bring its policy rate back up to zero and German yields to become positive across the curve. The current yields on bonds in these three markets are as shown in Exhibit 47.

Exhibit 47 Yields on US, UK, and German Government Bonds of Various Maturities

	2 Yr	5 Yr	10 Yr	30 Yr
US	1.30%	1.90%	2.40%	3.00%
UK	0.15%	0.55%	1.10%	1.80%
Germany	–0.65%	–0.30%	0.45%	1.25%

Exhibit 48 presents the modified durations for these government bonds.

30 A full exposition of these issues can be found in Chapter 10 of Scott D. Stewart, Christopher D. Piros, and Jeffrey C. Heisler, *Running Money: Professional Portfolio Management* (New York: McGraw-Hill, 2011).

Exhibit 48 Modified Durations for US, UK, and German Government Bonds

	2 Yr	5 Yr	10 Yr	30 Yr
US	1.48	4.29	8.42	11.69
UK	1.50	4.44	9.03	12.75
Germany	1.50	4.48	9.27	13.22

Exhibit 49 shows two numbers for each market and maturity. The first is Millsap's projected change in the constant maturity (CM) yield over the next six months. The second is the yield change due to roll down projected for a bond purchased today and held for six months. As an example, a US five-year purchased today is projected to experience a 25 bp increase in the constant maturity five-year yield, partially offset by rolling down the curve by 15 bps, resulting in a net 10 bp increase in yield.

Exhibit 49 Expected Change in CM Yield and Yield Change Due to Roll Down for US, UK, and German Bonds

	2 Yr	5 Yr	10 Yr	30 Yr
US	+35 bps/–10 bps	+25 bps/–15 bps	+20 bps/–5 bps	+15 bps/0 bps
UK	+25 bps/0 bps	+15 bps/–10 bps	+10 bps/–10 bps	+ 5 bps/0 bps
Germany	+80 bps/0 bps	+60 bps/–5 bps	+25 bps/–15 bps	0 bps/0 bps

The spot and six-month forward exchange rates for EUR and GBP against the US dollar are presented in Exhibit 50.

Exhibit 50 Spot and Forward Exchange Rates for EUR and GBP vs. USD

	Spot Rate	6-Month Forward Rate
USD per EUR	1.0998	1.1091
USD per GBP	1.2982	1.3045

The investment policy statement governing this portfolio prohibits outright short positions, but the portfolio holds sufficient amounts of each bond that there is no real constraint on sales of any particular bond.

In preparation for the next strategy meeting, Millsap asks you to summarize the available opportunities and to suggest potential trades. The first step is to create the breakdown of the local currency return for each bond, as illustrated in Exhibit 51.

Exhibit 51 Components of Local Currency 6-Month Horizon Return for US, UK, and German Bonds

		Income	Roll Down	CM Yield Changes	Total Local 6-Month Return
US	2 Yr	0.65%	0.15%	−0.52%	0.28%
	5 Yr	0.95%	0.64%	−1.07%	0.52%
	10 Yr	1.20%	0.42%	−1.68%	−0.05%
	30 Yr	1.50%	0.00%	−2.87%	−1.37%
UK	2 Yr	0.07%	0.00%	−0.37%	−0.30%
	5 Yr	0.27%	0.45%	−0.67%	0.05%
	10 Yr	0.55%	0.91%	−0.91%	0.55%
	30 Yr	0.90%	0.00%	−1.14%	−0.24%
Germany	2 Yr	−0.35%	0.00%	−1.19%	−1.51%
	5 Yr	−0.15%	0.22%	−2.65%	−2.58%
	10 Yr	0.23%	1.40%	−2.32%	−0.70%
	30 Yr	0.63%	0.00%	0.00%	0.63%

To examine how these results were derived, consider the US five-year note, which has a 2.0% coupon, matures in exactly 5 years, and is currently priced at 100.4748 to yield 1.90%. It will pay a 1% coupon (= 2%/2) at the end of the six-month horizon. To calculate the various components of return, we need its price at the end of the period at three yield levels: unchanged yield (1.90%), rolldown on a stable curve (1.75% = 1.90 – 0.15), and move to the projected yield level (2.00% = 1.90 – 0.15 + 0.25). With 4.5 years remaining to maturity, the corresponding prices would be as follows:

Price @ 1.90% = 100.4293

Price @ 1.75% = 101.0773

Price @ 2.00% = 100.0000

The return components are calculated as follows:

$$\text{Income return} = \frac{\text{Coupon} + \text{Price at } 1.90\%}{100.4748} - 1 = \frac{1.00 + 100.4293}{100.4748} - 1 = 0.95\%$$

$$\text{Rolldown} = \frac{\text{Price at } 1.75\% - \text{Price at } 1.90\%}{100.4748} = \frac{101.0773 - 100.4293}{100.4748} = 0.64\%$$

$$\text{CM yield change} = \frac{\text{Price at } 2.00\% - \text{Price at } 1.75\%}{100.4748} = \frac{100.000 - 101.0773}{100.4748} = 1.07\%$$

Notice that the income return includes both the coupon and a small reduction in price. At a constant yield, the price is gradually "pulled to par" as the remaining maturity declines.

1 Briefly describe how the projected local currency returns are influenced by the current configuration of the yield curves.

2 Considering only the projected changes in each constant maturity yield curve, identify whether a barbell or bullet structure would be more advantageous among 2s/5s/10s and among 5s/10s/30s.

3 Considering each market in isolation and all components of return, identify the most attractive cash-neutral, duration-neutral trade. Set the maximum position in any bond at ± $1 million.[31]

4 Considering all the markets and maturities together, identify the most attractive cash-neutral, duration-neutral trade.

[Hint: Be sure you use the correct returns—the UK and German returns hedged into US dollars (using six-month forward rates)—then follow these steps:

- As in problem 3 set the maximum position for any bond at ± $1 million.
- Start with market-specific best buys and sells from problem 3 but in $1 million amounts (i.e., ignore the ratios).
- At each maturity, look for all inter-market trades that increase return.
- Compute net duration at each maturity, then look for a trade across maturities that achieves duration neutrality and increases return.]

5 Should the currency exposure inherent in the UK and German bonds be hedged?

Solution to 1:

Since US yields are considerably higher than UK and German yields at every maturity, the US market offers significantly higher income return regardless of maturity. The negative yields on two- and five-year German bonds represent an unusual situation in which the income return is actually negative. The US curve is relatively steep between two years and five years, so the US five-year offers the best roll down return on that curve and among the two- and five-year maturities across markets. In contrast, the 5-year to 10-year segment of the German curve is particularly steep, and the German 10-year offers the best roll down return across the markets.

Solution to 2:

Considering only the projected changes in the constant maturity yields, every section of each curve—2s/5s, 5s/10s, 10s/30s—is expected to flatten. Therefore, a 2s/10s barbell would be better than a 5-year bullet and a 5s/30s barbell would be better than a 10-year bullet over an investment horizon sufficiently short that both income and roll down returns can be ignored.

Solution to 3:

In each market, we want to find a zero-cost (i.e., cash-neutral) combination that increases return as much as possible without changing duration. Start with the US market. Using the total returns from Exhibit 51, the potential return impact of buying/selling each maturity against each of the others is as follows:

31 In practice, a problem such as this one would involve many more securities and could be solved only by using optimization software (for example, the Solver add-in in Excel). For the specific problem posed here, the solution for each country is fairly easy to recognize. In each case, it consists of two zero-cost pairwise trades, one that very clearly increases return and one involving the other two maturities that neutralizes the impact on duration. It should be noted that in general the very best combination of trades is likely to involve positions of various sizes that are zero cost only in the aggregate. Indeed, that would be the case here if we dropped either the lower bound or the upper bound on position size.

United States: Potential Change in Return from Pairwise Trades

	SELL			
BUY	**2s**	**5s**	**10s**	**30s**
2s	—	–0.24%	0.33%	1.65%
5s	0.24%	—	0.58%	1.89%
10s	–0.33%	–0.58%	—	1.31%
30s	–1.65%	–1.89%	–1.31%	—

Each entry is simply the difference between the corresponding total returns in Exhibit 51. Note that the trades below the diagonal—for example, buying 5s and selling 2s—increase duration while the trades above the diagonal reduce duration. Buying 5s and selling 30s promises the biggest absolute increase in return (1.89%), though the increase is still substantial if 2s or 10s are purchased against 30s instead. Of course, we also need to consider the impact on duration. Using the durations from Exhibit 48, above, along with the total returns from Exhibit 51, we can compute the change in return per change in duration from each potential pairwise trade.

United States: Change in Return/Change in Duration from Pairwise Trades

	SELL			
BUY	**2s**	**5s**	**10s**	**30s**
2s	—	–0.0854%	0.0476%	0.1616%
5s	0.0854%	—	0.1380%	0.2554%
10s	–0.0476%	–0.1380%	—	0.4037%
30s	–0.1616%	–0.2554%	–0.4037%	—

As an example, buying 5s and selling 2s increases return by 0.24% and increases duration by 2.81 (= 4.29 – 1.48), which implies an increase in return of 0.0854% (= 0.24%/2.81) per unit of duration increase. Duration changes are always treated as positive in these ratios so that the entries in the table reflect the sign of the change in return.

While buying 5s/selling 30s offers the biggest absolute increase in return (1.89%), buying 10s/selling 30s offers the biggest increase per unit of duration (0.4037%). Either one reduces duration, so it will have to be combined with a trade that increases duration by the same amount. Buying 5s/selling 30s would be combined with buying 10s/selling 2s, which decreases returns, by –0.0476% per unit of duration. Buying 10s/selling 30s would be combined with buying 5s/selling 2s, which increases return by 0.0854% per unit of duration. Consider each trade:

Buy 10s/Sell 30s and Buy 5s/Sell 2s

Buying $1 million 10s and selling $1 million 30s reduces duration by 3.27 (8.42 – 11.69 = –3.27). Buying $1 million 5s and selling $1 million 2s increases duration by 2.81 (= 4.29 – 1.48), which is not enough to offset the 10s/30s position. Due to the limitation of trades to ± \$1 million sizes, we cannot do a bigger 5s/2s trade, so we would have to reduce the size of the 10s/30s position to \$0.8593 million (= 2.81/3.27) instead. The increase in return for this combination of trades would be

(0.8593 × 1.31%) + 0.24% = 1.3657%

Buy 5s/Sell 30s and Buy 10s/Sell 2s

Buying \$1 million 5s and selling \$1 million 30s reduces duration by 7.40 (4.29 – 11.69 = –7.40). Buying \$1 million 10s and selling \$1 million 2s increases duration by 6.94 (= 8.42 – 1.48), which is not enough to offset the 5s/30s position. Since we cannot do a bigger 10s/2s trade, we would have to reduce the size of the 5s/30s position to \$0.9378 million (= 6.94/7.40) instead. The increase in return for this combination of trades would be

(0.9378 × 1.89%) + (–0.33%) = 1.4424%

The combination of buying 5s/selling 30s and buying 10s/selling 2s offers a bigger increase in return and is therefore the best trade in the US market.[32]

Next, consider the UK market. The return changes associated with each pairwise trade are as follows:

United Kingdom: Potential Change in Return from Pairwise Trades

	SELL			
BUY	**2s**	**5s**	**10s**	**30s**
2s	—	–0.35%	–0.85%	–0.06%
5s	0.35%	—	–0.50%	0.29%
10s	0.85%	0.50%	—	0.79%
30s	0.06%	–0.29%	–0.79%	—

Clearly, the biggest increases in return will again come from buying 5s and 10s and selling 2s and 30s. The only question is how to pair them up.

Buy 10s/Sell 30s and Buy 5s/Sell 2s

Buying \$1 million 10s and selling \$1 million 30s reduces duration by 3.72 (9.03 – 12.75 = –3.72). Buying \$1 million 5s and selling \$1 million 2s increases duration by 2.94 (= 4.44 – 1.50), which is not enough to offset the 10s/30s position. Since we cannot do a bigger 5s/2s trade, we would have to reduce the size of the 10s/30s position to \$0.7903 million (= 2.94/3.72) instead. The increase in return for this combination of trades would be

(0.7903 × 0.79%) + 0.35% = 0.9744%

Buy 5s/Sell 30s and Buy 10s/Sell 2s

Buying \$1 million 5s and selling \$1 million 30s reduces duration by 8.31 (4.44 – 12.75 = –8.31). Buying \$1 million 10s and selling \$1 million 2s increases duration by 7.53 (= 9.03 – 1.50), which is not enough to offset the 5s/30s position. Since

32 There is a third possibility: Buy 2s/Sell 30s and Buy 10s/Sell 5s. The reader can confirm that this combination of trades does not give a better result. As a reminder, in general, the best combination could, and usually will, involve various position sizes rather than just zero-cost pairs of maturities.

we cannot do a bigger 10s/2s trade, we would have to reduce the size of the 5s/30s position to $0.9061 million (= 7.53/8.31) instead. The increase in return for this combination of trades would be

(0.9061 × 0.29%) + (0.85%) = 1.1128%

The combination of buying 5s/selling 30s and buying 10s/selling 2s offers a bigger increase in return and is therefore the best trade in the UK market.

The potential return changes from pairwise trades in Germany are as follows:

Germany: Potential Change in Return from Pairwise Trades

	SELL			
BUY	**2s**	**5s**	**10s**	**30s**
2s	—	1.07%	–0.81%	–2.14%
5s	–1.07%	—	–1.88%	–3.21%
10s	0.81%	1.88%	—	–1.33%
30s	2.14%	3.21%	1.33%	—

It is apparent that we will want to buy 30s and sell 5s. We cannot achieve duration neutrality if we buy both 30s and 10s. Hence, we know that we will buy 30s and 2s and sell 5s and 10s. Again, it is a question of how to pair them up.

Buy 30s/Sell 10s and Buy 2s/Sell 5s

Buying $1 million 30s and selling $1 million 10s increases duration by 3.95 (= 13.22 – 9.27). Buying $1 million 2s and selling $1 million 5s reduces duration by 2.98 (1.50 – 4.48 = –2.98), which is not enough to offset the 30s/10s position. Since we cannot do a bigger 2s/5s trade, we would have to reduce the size of the 30s/10s position to $0.7544 million (= 2.98/3.95) instead. The increase in return for this combination of trades would be

(0.7544 × 1.33%) + 1.07% = 2.0734%

Buy 30s/Sell 5s and Buy 2s/Sell 10s

Buying $1 million 30s and selling $1 million 5s increases duration by 8.74 (= 13.22 – 4.48). Buying $1 million 2s and selling $1 million 10s reduces duration by 7.77 (1.50 – 9.27 = –7.77), which is not enough to offset the 30s/5s position. Since we cannot do a bigger 2s/10s trade, we would have to reduce the size of the 30s/5s position to $0.8890 million (= 7.77/8.74) instead. The increase in return for this combination of trades would be

(0.8890 × 3.21%) + (–0.81%) = 2.0437%

The combination of buying 30s/selling 10s and buying 2s/selling 5s offers a slightly better return and is therefore the best trade in the German market.

Solution to 4:

The local currency returns given above are not directly comparable. To make them comparable, the UK and German returns need to be hedged into US dollars. Buying the GBP at the spot FX rate and selling it at the six-month forward FX rate generates a gain of 0.49% (= 1.3045/1.2982 – 1). For the EUR, the pickup is 0.85% (= 1.1091/1.0998 – 1). Hedged returns in US dollars are determined by adding these gains to the respective local market returns. For example, the UK 10-year return hedged into US dollars is 1.04% (= 0.55% + 0.49%). Exhibit 52 presents the local currency returns hedged into US dollars.

Exhibit 52 Hedged Returns in US Dollars for UK and German Bonds

	2 Yr	5 Yr	10 Yr	30 Yr
US	0.28%	0.52%	–0.05%	–1.37%
UK	0.19%	0.54%	1.04%	0.25%
Germany	–0.66%	–1.73%	0.15%	1.48%

Taking account of the currency hedge makes both foreign markets more attractive, although the short end of the German market is still projected to generate substantial losses.

Using the results of problem 3, above, we start by assuming purchases of $1 million each in US 5s and 10s, UK 5s and 10s, and German 2s and 30s, and corresponding sales of all the others. The hedged returns indicate that it is better to buy US 2s and sell German 2s. Similarly, it is better to sell US 10s and buy German 10s. There are no good switches within the 5s or the 30s. Exhibit 53 combines these adjustments with the initial country-by-country trade decisions from problem 3 to show the tentative trade decisions at this stage. Note that there is an equal number of buys and sells, so the combination is cash neutral. It is not, however, duration neutral yet.

Exhibit 53 Summary of Tentative Inter-Market Trade Decisions

	2 Yr	5 Yr	10 Yr	30 Yr
US	Sell → Buy	Buy	Buy → Sell	Sell
UK	Sell	Buy	Buy	Sell
Germany	Buy → Sell	Sell	Sell → Buy	Buy

The net duration impacts of these trades are as follows:

- 2s: –1.52; buy US, sell UK, and sell Germany (= 1.48 – 1.50 – 1.50)
- 5s: +4.25; buy US, buy UK, and sell Germany (= 4.29 + 4.44 – 4.48)
- 10s: +9.88; sell US, buy UK, and buy Germany (= –8.42 + 9.03 + 9.27)
- 30s: –11.22; sell US, sell UK, and buy Germany (= –11.69 – 12.75 +13.22)

The overall duration increase is 1.39 [= –1.52 + 4.25 + 9.88 + (–11.22)].

To reduce duration back to neutrality, we will need to reduce the position in a relatively long-duration bond. Starting from the tentative trades summarized above, we look for an additional trade that will achieve the requisite reduction in duration. Once we have determined that trade, we can establish the final net changes for each bond.

At this point, the only long bonds that are being purchased are the German 10s, UK 10s, and German 30s. (Note: We cannot sell more of the other long duration bonds due to our limit on trade size.) Since the expected return on the German 10s (at 0.15%) is by far the lowest of the three, that is the bond to sell.[33] What shorter-duration bonds should be purchased instead of sold? Only the German 2s, German 5s, and UK 2s are being sold at this point, so those are the only ones we can consider buying as part of our duration-adjusting trade. The German 2s and 5s offer very poor (negative) returns, so the short-duration bond to buy is the UK 2s. A one-for-one sale of German 10s and purchase of UK 2s will shorten duration by too much: 1.50 – 9.27 = –7.77. We could, of course, simply select a smaller amount (1.39/7.77 = $0.1789 million) on each side of this trade to achieve the target duration reduction of 1.39. But there is a more advantageous alternative.

The tentative plan calls for selling the UK 30-year. But this bond has a higher expected return (0.25%) than either the UK 2-year (0.19%) or the German 10-year (0.15%). Therefore, it makes sense to sell as much of the German 10s as we can and use the proceeds to buy a combination of the UK 2s and UK 30s instead of just buying the 2s.

Changing from buying $1 million German 10s (per the tentative plan) to selling $1 million would free up $2 million in funds to be invested elsewhere and reduce duration by 2 × 9.27 = 18.54. Buying an amount "X" of UK 30s and an amount ($2 million – X) of UK 2s would increase duration by

$$12.75X + 1.50\,(2 - X) = 3.00 + 11.25X$$

Since the net reduction in duration needs to be 1.39, the amount invested in the UK 30s must satisfy

$$-18.54 + (3.00 + 11.25X) = -1.39$$

Solving for X gives X = 1.2578, which means that our duration-adjusting trade entails buying $1.2578 million of the UK 30s, buying $0.7422 million (= 2.0 – 1.2578) of the UK 2s, and selling $2 million of the German 10s. We can now determine the final net trades to be done in each of these three bonds. Instead of the tentative decision to sell $1 million UK 30s, the final solution involves buying $0.2578 million (–1 + 1.2578 = 0.2578) of these bonds. Similarly, instead of selling $1 million of the UK 2s, the final decision is to sell only $0.2578 million (–1 + 0.7422 = –0.2578). Instead of buying $1 million of the German 10s, the final decision is to sell $1 million (+1 – 2 = –1) of them.

Exhibit 54 provides a summary of all the trade decisions that have been considered. The starting point is the solution to problem 3. Arrows indicate subsequent trade decisions based on the criteria outlined in problem 4. Seven trade decisions remain unchanged (white cells), four are reversed (dark shaded cells), and one trade decision—involving the German 10s—is reversed to "Buy," then switched back to the initial "Sell".

33 Note that one of our prior adjustments involved switching from selling the German 10s to buying them. Now we find we need to sell them after all. Did something go wrong? Not really. The prior adjustment—reversing the buy/sell decisions (from problem 3) for US and German 10-year bonds—was approximately duration neutral, but it increased return. A clear improvement. Now we see that we need to reduce overall duration, and switching back to selling the German 10s turns out to be a clear way to do it. We are not, however, reversing the other side of our earlier adjustment—selling US 10s instead of buying them. As in this case, the solving of complex problems need not progress in a straight line.

Exhibit 54 Summary of Final Inter-Market Trade Decisions

	2 Yr	5 Yr	10 Yr	30 Yr
US	Sell → Buy	Buy	Buy → Sell	Sell
UK	Sell	Buy	Buy	Sell → Buy
Germany	Buy → Sell	Sell	Sell → Buy → Sell	Buy

Note: This table incorporates the results of problem 3, which is the starting point for problem 4.

Putting everything together, Exhibit 55 summarizes all of the positions taken for the best inter-market trade.

Exhibit 55 Summary of Final Inter-Market Trade Positions

	2 Yr	5 Yr	10 Yr	30 Yr	Net
US	+1.000 M	+1.000 M	–1.000 M	–1.000 M	**0**
UK	–0.258 M	+1.000 M	+1.000 M	+0.258 M	**+2.000 M**
Germany	–1.000 M	–1.000 M	–1.000 M	+1.000 M	**–2.000 M**
Net	**–0.258 M**	**+1.000 M**	**–1.000 M**	**+0.258 M**	

The net result is to buy the UK market, sell the German market, buy 5s and 30s, and sell 2s and 10s. Imposing the duration-neutrality and cash-neutrality conditions across all markets instead of market by market allows the trade to capture the best opportunities at each maturity and the best maturities on each curve. The trade moves money to the short end of the US curve (2s and 5s), the middle of the UK curve (5s and 10s), and the long end of the German curve (30s).

Solution to 5:

Hedging exposure to GBP and EUR results in a six-month gain of 49 bps and 85 bps, respectively, as shown in the beginning of problem 4. The currency exposure should be hedged unless these currencies are expected to appreciate against the USD by more than these amounts over the next six months.

6 COMPARING THE PERFORMANCE OF VARIOUS DURATION-NEUTRAL PORTFOLIOS IN MULTIPLE CURVE ENVIRONMENTS

Throughout this reading, we have been discussing convexity as a useful tool in active yield curve strategies. Is convexity overrated? In this section, we evaluate the performance of portfolios with more and less convexity (barbells and bullets) relative to a baseline, laddered portfolio under a variety of yield curve scenarios.

6.1 The Baseline Portfolio

Assume we have a portfolio that consists of six equally weighted positions in the current on-the-run US Treasuries. It is similar to a classic laddered portfolio in which securities are spread out evenly across the maturity spectrum. Exhibit 56 shows the details of this portfolio.[34]

Exhibit 56 Laddered Portfolio

Bond	Nominal	Market Value (millions)	Coupon	Maturity	Price	Yield to Maturity	Effective Duration
1	2 year	10	0.875	30 Nov 2017	99.828	0.964	1.939
2	3 year	10	1.250	15 Dec 2018	99.891	1.287	2.946
3	5 year	10	1.625	30 Nov 2020	99.672	1.694	4.785
4	7 year	10	2.000	30 Nov 2022	99.656	2.053	6.550
5	10 year	10	2.250	15 Nov 2025	99.859	2.266	8.992
6	30 year	10	3.000	15 Nov 2045	100.172	2.991	20.364
Portfolio		60				1.876	7.596

The yield on the portfolio is 1.876%. The portfolio has a market value of $60 million and an effective duration of 7.596. We will consider this as the neutral duration point, and when we restructure the portfolio for various scenarios, we will always target the same duration. This will be the benchmark portfolio against which we evaluate alternative portfolio structures.

6.2 The Yield Curve Scenarios

We define six yield curve scenarios in Exhibit 57. The starting yield curve is shown in column 2, and the six scenarios are shown in columns 3–8.

Exhibit 57 Yield Curve Scenarios

		Curve Move					
1	2	3	4	5	6	7	8
Maturity (years)	Starting Yield	Parallel –100	Parallel +100	Flatter	Steeper	Less Curvature	More Curvature
2	0.964	0.010	1.964	**0.964**	**0.964**	0.892	1.036
3	1.287	0.287	2.287	1.269	1.305	1.174	1.400
4	1.490	0.490	2.490	1.455	1.526	1.337	1.644
5	1.694	0.694	2.694	1.640	1.748	1.499	1.889
7	2.053	1.053	3.053	1.964	2.142	1.776	2.330
10	2.266	1.266	3.266	2.123	2.409	1.866	2.666

(continued)

34 This analysis was run on The Yield Book using prices for 15 December 2015, and assumes same-day settlement.

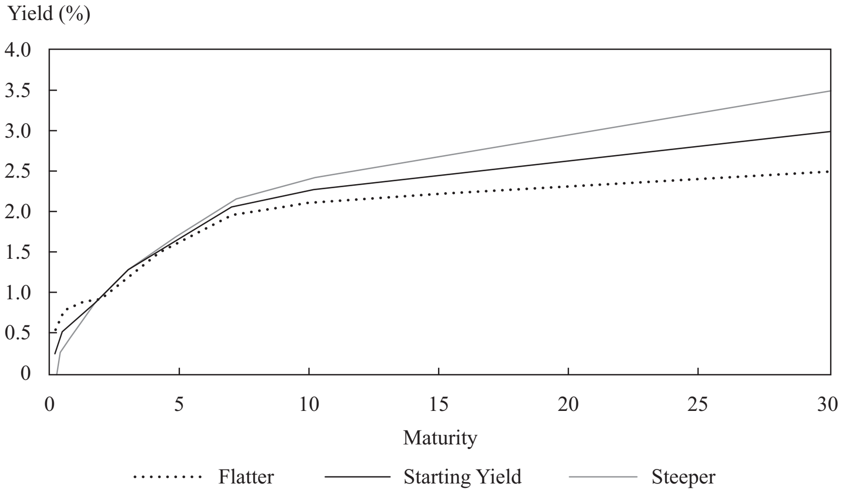
Exhibit 57 (Continued)

		Curve Move					
1	2	3	4	5	6	7	8
Maturity (years)	Starting Yield	Parallel –100	Parallel +100	Flatter	Steeper	Less Curvature	More Curvature
20	2.629	1.629	3.629	2.308	2.950	2.429	2.829
30	2.991	1.991	3.991	2.491	3.491	2.991	2.991

Columns 3 and 4 depict a commonly used scenario of a parallel shift down or up 100 bps. At the time this analysis was run, the Yield Book put limits on yield changes that would force rates to be negative, and it floored rates at 1 bp. The two-year note is affected by this limitation, and its yield declines by 95 bps instead of 100 bps. In this example, missing the last 5 bps on the two-year has little effect on either the answer or the lesson in the example. As an aside, Yield Book has changed its code to now allow most rates to go negative.[35]

Columns 5 and 6 define flatter and steeper yield curves, as illustrated in Exhibit 58. These curves are pinned at the two-year maturity.

Exhibit 58 Flatter and Steeper Yield Curve Scenarios

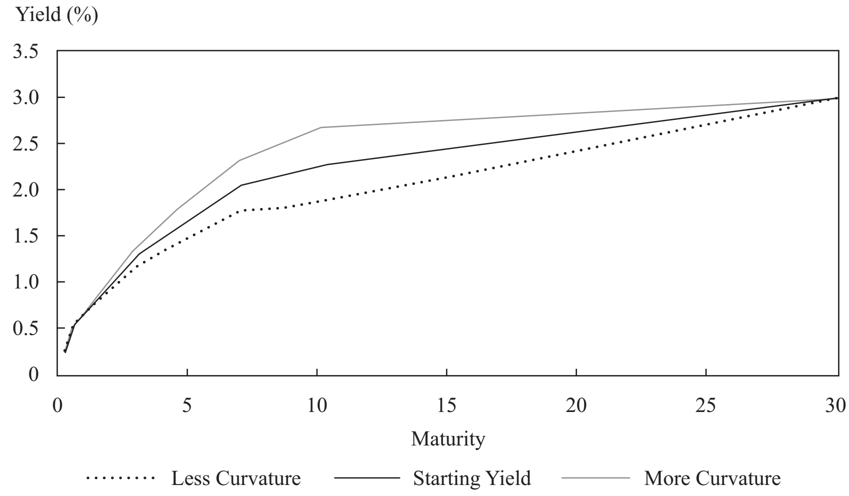


2s–30s Spread	2s	30s	Spread
Starting yield curve	0.964	2.991	2.027
Flatter	0.964	2.491	1.527
Steeper	0.964	3.491	2.527

Finally, Columns 7 and 8 define yield curves that have less curvature and more curvature, respectively, as displayed in Exhibit 59. The reduction of curvature and the addition of curvature can also be confirmed by calculating the changes in the butterfly spread.

35 At this time (2016) the Yield Book's MBS prepayment model cannot process negative rates.

Exhibit 59 Yield Curves with More Curvature and Less Curvature



Butterfly spread	2s	10s	30s	Spread
Starting yield curve	0.964	2.266	2.991	0.577
Less curvature	0.892	1.866	2.991	–0.151
More curvature	1.036	2.666	2.991	1.305

Butterfly spread = – 2-Year yield + (2 × 10-Year yield) – 30-Year yield

To evaluate the effect of convexity, we construct two extreme portfolios—one barbelled and one bulleted—and examine the behavior of each under our various yield curve scenarios.

6.3 Extreme Barbell vs. Laddered Portfolio

Our extreme barbell portfolio in Exhibit 60 consists of only the 2-year note and 30-year bond, weighted to achieve virtually the same effective duration as our benchmark portfolio. This barbell portfolio possesses the maximum convexity that can be achieved given our portfolio constraints. The portfolio has an effective duration of 7.595 (versus 7.596 for the benchmark portfolio) and a convexity of 1.578 (versus the benchmark portfolio's convexity of 1.134). The barbell portfolio gives up nearly 30 bps in yield. Although we are using an instantaneous yield curve shift for this analysis, note that over a longer horizon, the barbell portfolio would be penalized for the give-up in yield.

Exhibit 60 An Extreme Barbell Portfolio

Bond	Nominal	Market Value (millions)	Coupon	Maturity	Price	Yield to Maturity	Effective Duration
1	2 year	41.58	0.875	30 Nov 2017	99.828	0.964	1.939
2	3 year		1.250	15 Dec 2018	99.891	1.287	2.946
3	5 year		1.625	30 Nov 2020	99.672	1.694	4.785
4	7 year		2.000	30 Nov 2022	99.656	2.053	6.550
5	10 year		2.250	15 Nov 2025	99.859	2.266	8.992

(continued)

Exhibit 60 (Continued)

Bond	Nominal	Market Value (millions)	Coupon	Maturity	Price	Yield to Maturity	Effective Duration
6	30 year	18.42	3.000	15 Nov 2045	100.172	2.991	20.364
Portfolio		60.00				1.586	7.595

Recall that a portfolio with higher convexity will outperform in a parallel move. This is confirmed in Exhibit 61. The return advantage arising from the convexity inherent in a barbell structure is relatively minor for a parallel move, just 22 to 28 bps. The reward of the barbell structure is more significant for changes in slope and curvature—provided the portfolio manager correctly forecasts the direction of the change. Note in our example how effective the barbell portfolio is in capitalizing on more curvature. It outperforms the benchmark by more than 100 bps, primarily because it does not hold the bonds that go up in relative yield. (When the yield curve is adding curvature in a rising rate environment, yields on the 5s to 10s may be expected to rise more than the yields on the 2s and the 30s, and when adding curvature in a declining rate environment, the yields on the 5s to 10s will fall less than the yields on the 2s and 30s.)

Exhibit 61 Return Comparisons: Extreme Barbell Portfolio vs. Benchmark Portfolio

	Extreme Barbell Portfolio	Benchmark Portfolio	
Duration	7.595	7.596	
Convexity	1.578	1.134	
Yield Curve Scenario	**Return**	**Return**	**Return Difference**
−100	8.517	8.241	0.276
+100	−6.823	−7.041	0.218
Flatter	3.243	2.125	1.118
Steeper	−2.971	−1.974	−0.997
Less curvature	0.107	1.146	−1.039
More curvature	−0.107	−1.124	1.017

In restructuring the portfolio to take on the barbell structure, the portfolio manager must be highly certain that the yield curve will not steepen or lose curvature—those particular curve changes could lead to underperformance rather than the anticipated outperformance.

6.4 Extreme Bullet

We showed that the barbell portfolio does poorly when the curve gives up some curvature, primarily because it does not own the middle of the curve, which are the bonds that perform relatively well as the curve loses curvature. Therefore, if a manager expects the curve to become less curved over the forecast horizon, he will want to adopt a bulleted portfolio structure. In our example, the bullet is constructed with two bonds—the closest on either side of the 7.596 duration target, as seen in Exhibit 62. (If, by chance, the target duration equals the duration of one of the available bonds, then all funds can be invested in that one bond. That is the ultimate bullet portfolio, other than a portfolio of zeros with no interim cash flows).

Exhibit 62 An Extreme Bullet Portfolio

Bond	Nominal	Market Value (millions)	Coupon	Maturity	Price	Yield to Maturity	Effective Duration
1	2 year		0.875	30 Nov 2017	99.828	0.964	1.939
2	3 year		1.250	15 Dec 2018	99.891	1.287	2.946
3	5 year		1.625	30 Nov 2020	99.672	1.694	4.785
4	7 year	34.25	2.000	30 Nov 2022	99.656	2.053	6.550
5	10 year	25.75	2.250	15 Nov 2025	99.859	2.266	8.992
6	30 year		3.000	15 Nov 2045	100.172	2.991	20.364
Portfolio		60.00				2.144	7.598

The returns on this bullet portfolio are as expected, as shown in Exhibit 63.

- For parallel shifts in the yield curve (±100 bps), the lack of convexity in the bullet portfolio causes it to lag behind the benchmark return regardless of the direction of rates.
- Whereas we saw earlier that the barbell portfolio does well in a flattening environment, here we see how much the bullet portfolio lags in that same environment.
- The bullet portfolio does perform well if the yield curve steepens, producing 110 bps of relative outperformance. Concentrating all of the assets in the middle of the yield curve (in this case, the 7s and 10s) produces an extremely positive relative return if the curve loses curvature. If the yield curve adds curvature, however, the concentration of assets in the middle of the curve produces poor relative performance.

Exhibit 63 Return Comparisons: Extreme Bullet Portfolio vs. Benchmark Portfolio

	Extreme Bullet Portfolio	Benchmark Portfolio	
Duration	7.598	7.596	
Convexity	0.643	1.134	
Yield Curve Scenario	**Return**	**Return**	**Return Difference**
−100	7.939	8.241	−0.302
+100	−7.277	−7.041	−0.236
Flatter	0.881	2.125	−1.244
Steeper	−0.875	−1.974	1.099

(continued)

Exhibit 63 (Continued)

Yield Curve Scenario	Return	Return	Return Difference
Less curvature	2.590	1.146	1.444
More curvature	−2.534	−1.124	−1.410

6.5 A Less Extreme Barbell Portfolio vs. Laddered Portfolio

Exhibit 61 demonstrated the limited (≈25 bp) return advantage to convexity in the extreme barbell portfolio given a parallel shift in the curve. It also uncovered the large potential underperformance in the steepening and less curvature scenarios, where the barbell underperformed by ≈100 bps. If these exposures represent a level of risk too high given the portfolio manager's confidence in his yield forecast, a modified barbell portfolio as shown in Exhibit 64 may be more appropriate. This less extreme barbell portfolio uses four securities instead of two, having exposure to the middle of the yield curve through the 3-year and 10-year notes, which were absent in the extreme barbell. It maintains an effective duration of 7.601, very close to the target duration.

Exhibit 64 A Less Extreme Barbell

Bond	Nominal	Market Value (millions)	Coupon	Maturity	Price	Yield to Maturity	Effective Duration
1	2 year	17.66	0.875	30 Nov 2017	99.828	0.964	1.939
2	3 year	12.65	1.250	15 Dec 2018	99.891	1.287	2.946
3	5 year		1.625	30 Nov 2020	99.672	1.694	4.785
4	7 year		2.000	30 Nov 2022	99.656	2.053	6.550
5	10 year	19.35	2.250	15 Nov 2025	99.859	2.266	8.992
6	30 year	10.34	3.000	15 Nov 2045	100.172	2.991	20.364
Portfolio		60.00				1.801	7.601

This four-security portfolio produces a profile much closer to the original benchmark portfolio in terms of yield, effective duration, and effective convexity. Its convexity (1.183) is significantly lower than that of the extreme barbell (1.578).

The performance of this less extreme barbell portfolio under our six yield curve scenarios, shown in Exhibit 65, diverges from the benchmark in a relatively minor way: +14 bps to −13 bps. Although this less extreme barbell minimizes the magnitude of potential shortfall relative to the benchmark, it also reduces the opportunity to add value relative to the benchmark.

Exhibit 65 Return Comparisons: Less Extreme Barbell Portfolio vs. Benchmark Portfolio

	Less Extreme Barbell Portfolio	Benchmark Portfolio
Duration	7.601	7.596
Convexity	1.183	1.134

Exhibit 65 (Continued)

Yield Curve Scenario	Return	Return	Return Difference
−100	8.269	8.241	0.028
+100	−7.012	−7.041	0.029
Flatter	2.239	2.125	0.114
Steeper	−2.083	−1.974	−0.109
Less curvature	1.287	1.146	0.141
More curvature	−1.256	−1.124	−0.132

6.6 Comparing the Extreme and Less Extreme Barbell Portfolios

In this section, we compare the two barbell portfolios with each other rather than with the benchmark portfolio to see what insights we can gather from their differences. Exhibit 66 shows the returns.

Exhibit 66 Return Comparisons: Extreme Barbell Portfolio vs. Less Extreme Barbell Portfolio

	Extreme Barbell	Less Extreme Barbell	
Duration	7.595	7.601	
Convexity	1.578	1.183	
Yield Curve Scenario	**Return**	**Return**	**Return Difference**
−100	8.517	8.269	0.248
+100	−6.823	−7.012	0.189
Flatter	3.243	2.239	1.004
Steeper	−2.971	−2.083	−0.888
Less curvature	0.107	1.287	−1.180
More curvature	−0.107	−1.256	1.149

- The extreme barbell portfolio has convexity of 1.578 versus that of the less extreme barbell at 1.183.
- As expected given its greater convexity, the extreme barbell outperforms the less extreme barbell slightly in the parallel shifts.
- If the curve flattens, the extreme barbell has the advantage of a large position in the longest bond (30-year Treasury), which results in 100 bps of outperformance.
- That advantage disappears if the yield curve steepens, when the extreme barbell is hurt by that long bond position, lagging the return of the less extreme barbell by 89 bps.

- Under the curvature scenarios, the less extreme barbell portfolio has more "participation" in the middle part of the yield curve (through positions in the 3-year and 10-year Treasury notes).
  - If there is less curvature (a relative rally in the middle of the curve), then the less extreme barbell outperforms the extreme barbell by 118 bps.
  - If there is an increase in curvature, that same exposure to the inside of the yield curve causes the less extreme barbell portfolio to underperform the extreme barbell portfolio by about 115 bps.

As illustrated in these examples, convexity is valuable, but in order to reap its rewards, the portfolio manager must be willing to add a meaningful degree of convexity. The change in convexity will often be accomplished by changing the portfolio structure to become more barbelled, and this new structure introduces its own risks and rewards. With this barbell, the portfolio manager runs the risk of underperformance if she incorrectly forecasts the direction of the yield curve change. This is a good example of the tradeoffs that must be made in positioning a bond portfolio for anticipated changes in the yield curve.

Exhibit 67 provides a recap of the relative performance of bullet and barbell portfolios under various yield curve scenarios.

Exhibit 67 Relative Performance of Bullets and Barbells under Different Yield Curve Scenarios

Yield Curve Scenario		Barbell	Bullet
Level change	Parallel shift	Outperforms	Underperforms
Slope change	Flattening	Outperforms	Underperforms
	Steepening	Underperforms	Outperforms
Curvature change	Less curvature	Underperforms	Outperforms
	More curvature	Outperforms	Underperforms
Rate volatility change	Decreased rate volatility	Underperforms	Outperforms
	Increased rate volatility	Outperforms	Underperforms

EXAMPLE 6

Positioning for Changes in Curvature and Slope

Heather Wilson, CFA, works for a New York hedge fund managing its US Treasury portfolio. Her role is to take positions that profit from changes in the curvature of the yield curve. Wilson's positions must be duration neutral, and the maximum position that she can take in 30-year bonds is $100 million. On-the-run Treasuries have the characteristics shown in the following table:

Maturity	Coupon	Price	Yield to Maturity	Duration	PVBP/$ Million
2 Year	1.0%	100	1.0	1.98	198
5 Year	1.5%	100	1.5	4.80	480
10 Year	2.5%	100	2.5	8.80	880
30 Year	3.0%	100	3.0	19.72	1,972

If Wilson takes the maximum allowed position in the 30-year bonds and all four positions have the same (absolute value) money duration, what portfolio structure involving 2s, 5s, 10s, and 30s will profit from a decrease in the curvature of the yield curve?

Solution:

To profit from a decrease in yield curve curvature, Wilson should structure a condor: short 2s, long 5s, long 10s, and short 30s. If the curvature decreases, the short positions in the 2s and 30s will profit as rates at either end of the curve rise, and the long positions in 5s and 10s will maintain their value. If curvature decreases as a result of a decline in intermediate (5s and 10s) yields, the long positions at the intermediate maturities are likely to profit while the short positions in the 2s and 30s maintain their value.

To determine the portfolio positioning:

- 100 million 30-year bonds have a money duration of 100 × 1,972 = 197,200 (the maximum allowed position).
- To establish the remaining positions, each with the same money duration:
  - The 10s position should be 197,200/880 = 224.09 or 224 million (long).
  - The 5s position should be 197,200/480 = 410.83 or 411 million (long).
  - The 2s position should be 197,200/198 = 995.96 or 996 million (short).

Wilson's position should be short 996 million 2s, long 411 million 5s and long 224 million 10s, short 100 million 30s. Details of the portfolio positioning are shown in the following table:

Treasury Instrument	2s	5s	10s	30s
PVBP (per $1 million)	198	480	880	1,972
Position constraint ($)	NA	NA	NA	100,000,000
$ Duration constraint	NA	NA	NA	197,200
Direction	Short	Long	Long	Short
$ Positions	(995,959,596)	410,833,333	224,090,909	(100,000,000)
$ Durations	(197,200)	197,200	197,200	(197,200)
$ Duration (2s and 5s versus 10s and 30s)	0		0	

A FRAMEWORK FOR EVALUATING YIELD CURVE TRADES 7

[In this section (7), the exhibits present portfolio assumptions and characteristics as "given"—candidates are not expected to do the underlying analysis. Rather, candidates should understand how the results are used in decomposing a portfolio's expected return into its component parts.]

Using an expanded version of the expected return decomposition model, we can develop an understanding of the relative contributions of the various components of return to the success or failure of the strategy.

Expected returns using the full model can be decomposed as shown in Equation 4:

$$\begin{aligned} E(R) \approx\ & \text{Yield income} \\ & + \text{Rolldown return} \\ & + E\left(\begin{matrix}\text{Change in price based on investor's} \\ \text{views of yields and yield spreads}\end{matrix}\right) \\ & - E(\text{Credit losses}) \\ & + E(\text{Currency gains or losses}) \end{aligned} \tag{4}$$

where *E*(..) indicates the analyst's expectations based on his forecast. The following scenarios demonstrate the model's application for the purpose of analyzing yield curve portfolio strategies.

Victoria Lim Victoria Lim is a fixed-income portfolio manager in the Singapore office of a large US wealth management company. Her company's clients are mostly US high-net-worth individuals. Lim specializes in yield curve strategies on the short end of the curve using Asia-Pacific Emerging Market sovereign securities. Her investment horizon is one year, and she is considering two strategies: (1) buy and hold and (2) riding the yield curve. The buy and hold strategy consists of buying a portfolio of baht-denominated, one-year, zero-coupon notes issued by the Thai government (currently yielding 1.0%). The alternative strategy of riding the yield curve consists of buying a portfolio of two-year zero-coupon Thai government notes and selling them in one year. The two-year zero-coupon notes are also denominated in baht (currently yielding 2.0%). The baht proceeds under each yield curve strategy will be converted into US dollars at the end of the one-year investment horizon. Her company's economic forecasting unit has published its 12-month forecast, which projects that the yield curve for Thai government securities will be stable and that the baht will appreciate relative to the US dollar by 1.5%. Exhibit 68 summarizes the key information for the two yield curve strategies Lim is considering.

Exhibit 68 Assumptions for Stable Yield Curve

Portfolio Strategies	Buy-and-Hold Portfolio	Ride the Yield Curve Portfolio
Investment horizon (years)	1.0	1.0
Bonds maturity at purchase (years)	1.0	2.0
Coupon rate	0.00%	0.00%
Yield to maturity	1.00%	2.00%
Current average bond price for portfolio	99.0090	96.1169
Expected average bond price in one year for portfolio	100.00	99.0090
Expected currency gains or losses	1.5%	1.5%

The expected return for Lim's portfolio under each of the yield curve strategies can be determined using the foregoing model.

Because the securities being considered for purchase are baht-denominated zero-coupon notes, the expected returns on the portfolio include expected currency gains and losses, as shown in Exhibit 69.

Exhibit 69 Expected Return for Stable Yield Curve Strategies

Return Component	Formula	Portfolio Performance: Buy and Hold	Portfolio Performance: Ride the Yield Curve
Yield income	Annual coupon payment ÷ Current bond price	0	0
+ Rolldown return	$\frac{(\text{Bond price}_{\text{End-of-horizon}} - \text{Bond price}_{\text{Beginning-of-horizon}})}{\text{Bond price}_{\text{Beginning-of-horizon}}}$	(100.00 – 99.009) ÷ 99.009 = 1.00%	(99.0090 – 96.1169) ÷ 96.1169 = 3.01%
= Rolling yield	Yield income + Rolldown return	0 + 1.00% = 1.00%	0 + 3.01% = 3.01%
+ *E*(currency gains or losses)	Given	+ 1.50%	+ 1.50%
= Total expected return		= 2.50%	= 4.51%

Note: Formulas are provided for reference; details and explanations can be found in the reading "Introduction to Fixed-Income Portfolio Management."

The expected return from simply riding the yield curve is higher than the expected return from the buy-and-hold strategy. This results from the greater price appreciation (rolldown return) of the two-year zero-coupon note over the investment horizon (3.01% for the two-year zero versus 1.00% for the one-year zero) as its time to maturity shortens to one year and its yield declines from 2.0% to 1.0%.

Why does the ride-the-yield-curve strategy so significantly outperform the buy-and-hold strategy in a stable interest rate environment? From the information given earlier, we can compute the implied one-year rate, one year forward:

$$(1.02)^2 \big/ 1.01 - 1 = 3.01\%$$

The one-year rate one year forward implied by the current yield curve is 3.01%. Thus, the yield curve contains an expectation that one-year rates will rise over the 12-month horizon. Contrast this information with the bank's forecast for a 1% one-year rate one year from now. The implicit assumption in the bank's forecast is a decline in rates relative to the expectations embedded in the yield curve. Thus, the two-year zero-coupon note will experience price appreciation as a result of the implicit decline in rates. (Simply put, if the forecast ending yield on a particular bond is lower [higher] than the forward rate, then it can be expected to earn a return greater than [less than] the one-period rate.)

The next scenario shows expected returns for bond portfolios when the government yield curve is expected to change over the investment horizon. In addition to the rolldown return, now the investor's yield curve view results in a value effect on the portfolio—in this case, an expected capital loss due to the expected yield increase.

Lamont Cranston Lamont Cranston is a trader on the government securities desk of a US investment bank. He has a view on interest rates and thinks the US Treasury security zero-coupon yield curve will experience an upward shift by 50 bps in the next 12 months. Cranston is considering two strategies for the year ahead: a bullet portfolio and a barbell portfolio. The bullet portfolio would have 100% of its funds invested in five-year Treasury zero-coupon notes, currently priced at 94.5392. The barbell portfolio would have 62.97% of its funds invested in two-year Treasury zero-coupon notes, priced at 98.7816, and the remaining 37.03% of funds invested in 10-year Treasury zero-coupon bonds, priced at 83.7906. In addition, he uses other key assumptions summarized in Exhibit 70.

Exhibit 70 Assumptions for Bullet and Barbell Portfolio Strategies

	Bullet	Barbell
Investment horizon (years)	1.0	1.0
Average bond price for portfolio currently	94.5392	92.6437
Average bond price for portfolio in one year (assuming stable yield curve)	96.0503	94.3525
Current modified duration for portfolio	4.97	4.93
Expected effective duration for portfolio (at the horizon)	3.98	3.98
Expected convexity for portfolio (at the horizon)*	17.82	32.57
Expected change in US Treasury zero-coupon yield curve	0.50%	0.50%

* We said earlier that there is no single convention for how convexities are scaled. The numbers shown in this exhibit are the "raw" convexity numbers and, as such, the scale is different than that used throughout the rest of this reading. We show the raw numbers here because they are the numbers used in the return estimation formula.

The objective is to find the expected return over the one-year investment horizon for each of the portfolios he is considering.

The effect of the trader's interest rate view on the total expected return of the portfolio can be estimated using the portfolios' modified durations and convexities. The higher convexity of the barbell portfolio should mitigate the capital loss. With an expectation of a 50 bp upward shift at all points along the curve, we can calculate the expected loss from the increase in rates as follows:

$$[-\text{MD} \times \Delta\text{Yield}] + [½ \times \text{Convexity} \times (\Delta\text{Yield})^2]$$

Bullet portfolio: $(-3.98 \times 0.005) + [1/2 \times 17.82 \times (0.005)^2] = -1.9677\%$

Barbell portfolio: $(-3.98 \times 0.005) + [1/2 \times 32.57 \times (0.005)^2] = -1.9493\%$

Combining the sources of expected returns for each portfolio gives us the total expected return for each strategy. Because both portfolios contain only zero-coupon bonds, there is no yield income. We calculate the rolldown return as follows:

$$\frac{\left(\text{Bond price}_{eh} - \text{Bond price}_{bh}\right)}{\text{Bond price}_{bh}}$$

where the subscript *bh* indicates the bond price at the beginning of the horizon and the subscript *eh* indicates the bond price at the end of the horizon.

Bullet portfolio: (96.0503 – 94.5392) ÷ 94.5392 = 1.5984%

Barbell portfolio: (94.3525 – 92.6437) ÷ 92.6437 = 1.8444%

The total expected return over the one-year investment horizon for the bullet portfolio is therefore –0.369%, and the expected return for the barbell portfolio is –0.105%. The derivation of the expected return is summarized in Exhibit 71.

Exhibit 71 Expected Return for Bullet and Barbell Strategies

Return Component	Formula	Portfolio Performance: Bullet	Portfolio Performance: Barbell
Yield income	Annual coupon payment ÷ Current bond price	0	0
+ Rolldown return	$\frac{(\text{Bond price}_{eh} - \text{Bond price}_{bh})}{\text{Bond price}_{bh}}$	= 1.5984%	= 1.8444%
= Rolling yield	Yield income + Rolldown return	= 1.5984%	= 1.8444%
+ E(Change in price based on yield view)	$[-MD_{eh} \times \Delta\text{Yield}]$ + $[½ \times \text{Convexity} \times (\Delta\text{Yield})^2]$	= –1.9677%	= –1.9493%
= Total expected return		**= –0.3693%**	**= –0.1049%**

Note: Formulas are provided for reference.

If the trader's yield view materializes, the barbell portfolio will outperform the bullet portfolio by 26 bps. The greater convexity of the barbell portfolio contributed just under 2 bps of outperformance, whereas the rolldown return contributed nearly 25 bps. The strong rolldown contribution is driven by the stronger price appreciation (under the stable yield curve assumption) of the 10-year zeros (3.4%) in the barbell portfolio relative to the price appreciation of the 5-year zeros (1.6%) in the bullet portfolio as the bonds ride the curve over the one-year horizon to a shorter maturity and a lower yield.

EXAMPLE 7

Components of Expected Returns

In Section 4.1, we introduced Hillary Lloyd, a fixed-income portfolio manager at AusBank, and demonstrated how she might choose to position her portfolio in anticipation of a 60 bp parallel upward shift in the yield curve. Recall that she has a strong conviction that interest rates will increase. Comparing the implied forward rates with the expected yields and returns on the bonds in her portfolio given her interest rate forecast, she concludes the best expected return will be earned with a portfolio invested 100% in the two-year bonds. We now look to evaluate that decision.

Exhibit 72 provides information on the characteristics of Lloyd's ending portfolio under such a scenario. Information is also shown for her initial portfolio (with no restructuring) assuming it is held over the investment horizon given both a stable yield curve and the +60 bp curve shift.[36]

Using the return decomposition framework provided, calculate the expected return for each portfolio and discuss the factors that contribute to the differences.

36 Practically speaking, if Lloyd were to hold the portfolio of 100% two-year bonds for the full one-year horizon, she would fall below the lower bound of the duration constraint within the first three to four months of the year.

Exhibit 72 Characteristics of Hillary Lloyd's Beginning and Ending Portfolios

		Yield Curve Shift	
	Initial Portfolio	Initial Portfolio	Revised Portfolio
Investment horizon (years)	1.0	1.0	1.0
Average annual coupon rate for portfolio	2.01%	2.01%	1.91%
Average beginning bond price for portfolio	100.000	100.000	100.000
Average ending bond price for portfolio (assuming roll-down and stable yield curve)	100.463	100.463	100.404
Expected effective duration for portfolio (at the horizon)	1.313	1.305	0.979
Expected convexity for portfolio (at the horizon)	3.586	3.545	1.920
Expected change in government bond yield curve	—	0.60%	0.60%

Exhibit 73 shows the decomposition of the portfolios' expected returns into yield income, rolldown return, and expected price change based on yield view. The initial portfolio holds all six (short- to intermediate-term) bonds. The ending portfolio holds only the two-year bonds, the ones with the highest expected holding-period return.

Exhibit 73 Expected Return for Hillary Lloyd's Initial and Revised Portfolios

Return Component	Formula	Initial Portfolio (stable yield curve)	Initial Portfolio (+ 60 bps)	Revised Portfolio (+ 60 bps)
Yield income	Annual coupon payment ÷ Current bond price	2.01/100.00 = 2.01%	2.01/100.00 = 2.01	1.91/100.00 = 1.91%
+ Rolldown return	(Bond price$_{eh}$ – Bond price$_{bh}$) ÷ Bond price$_{bh}$	(100.463 – 100.00) ÷ 100.00 = 0.463%	(100.463 – 100.00) ÷ 100.00 = 0.463%	(100.404 – 100.00) ÷ 100.00 = 0.404%
= Rolling yield	Yield income + Rolldown return	= 2.473%	= 2.473%	= 2.314%
+ E(change in price based on yield view)	$[-\text{MD} \times \Delta\text{Yield}] + [\frac{1}{2} \times \text{Convexity} \times (\Delta\text{Yield})^2]$	—	$[-1.305 \times 0.006] + [\frac{1}{2} \times 3.545 \times (0.006)^2] = -0.7766\%$	$[-0.979 \times 0.006] + [\frac{1}{2} \times 1.920 \times (0.006)^2] = -0.5839\%$
= Total expected return		**= 2.47%**	**= 1.70%**	**= 1.73%**

Under Lloyd's rising interest rate scenario, the revised portfolio generates a total expected return of 1.73% versus the initial portfolio's expected return of 1.70%.

The portfolio holding only two-year bonds gave up 10 bps of yield income and 6 bps of rolldown return in exchange for 19 bps of price protection from the shorter duration, resulting in 3 bps of outperformance relative to the initial portfolio.

Yield income is 2.01% for the initial portfolio and 1.91% for the revised portfolio. This difference is the result of the higher coupon income from the six-bond portfolio, because it holds the intermediate-maturity, higher-coupon bonds.

The rolldown return for the initial portfolio is 0.463%, slightly higher than the 0.404% rolldown return for the revised portfolio. The intermediate-term bonds in the initial portfolio contribute to this portfolio's higher rolldown return—these intermediate-maturity bonds experience a larger price increase than the shorter-term bonds (2s), which are the only bonds in the revised portfolio.

The price change attributable to the yield view is –0.5839% for the revised portfolio, versus –0.7766% for the initial portfolio. Due primarily to the revised portfolio's shorter duration (0.979) relative to the initial portfolio (1.305), its losses are more moderate than those of the initial portfolio.

Taken together, these components explain the revised portfolio's outperformance of 3 bps under the anticipated rise in interest rates.

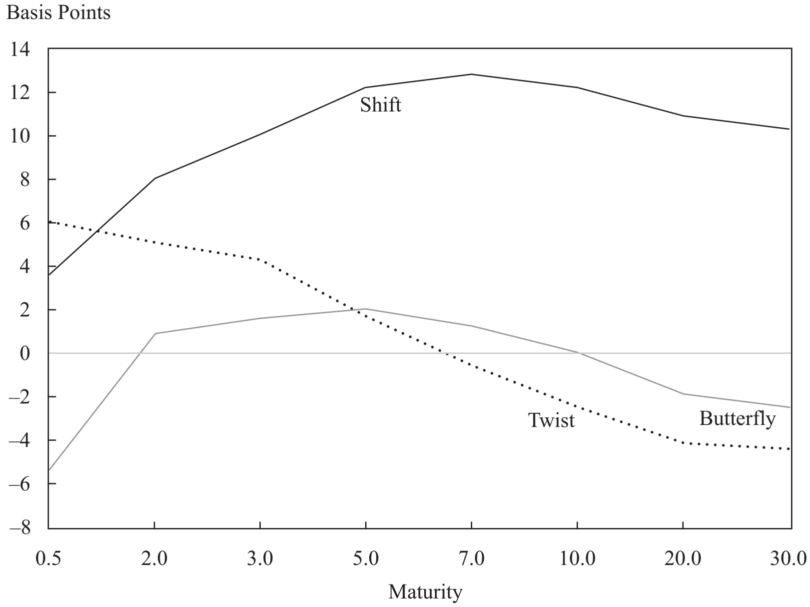
The decomposition of return used above also provides a useful starting point for the consideration of risk. The crucial difference is that risk is not about what is expected to happen; rather, it is about deviations from the expected. By construction, yield income and rolldown return do not contribute to risk since they can be determined with certainty in advance. Credit losses are not generally related to the yield curve per se; hence, for present purposes, they are set aside. As highlighted in the discussion of inter-market trades, currencies and yield curves are inherently related. If the uncovered interest rate parity hypothesis did hold, currency depreciation and capital losses should offset any yield advantage. So, for example, if yields are 3% higher in the United States than in Japan, the market expectations should be a 3% depreciation in the USD/JPY spot exchange rate. In practice, however, the link between yield curve movements and concurrent currency movements is too variable to warrant attributing a specific currency risk to a particular yield curve movement. That leaves only the direct impact of deviations from the investor's views with respect to the yield curve.

Armed with a bond pricing model virtually any set of risk scenarios can be evaluated. However, not all scenarios are equally relevant. Furthermore, individual scenarios quickly lose significance once the set expands beyond a small number. Large numbers of scenarios are useful for generating summary statistics—standard deviations, percentiles, and the like—but may not provide as much insight as a few, more distinctly relevant scenarios.

If only a small number of alternative scenarios are to be used, how should they be selected? One approach is to customize the alternatives to the specific trade or positioning under consideration. The more narrowly defined the trade and/or the more leveraged it is to a particular view, the more important it is to focus on specific, idiosyncratic drivers of success or failure. Perhaps the single most useful risk scenario for narrowly targeted trades is one in which the thesis for the trade breaks down entirely.

Every trade has some exposure to idiosyncratic movements at particular points or within particular segments of the curve. But for trades or portfolios spanning reasonably broad segments of the curve, most of the yield curve risk can be adequately captured by a small set of standard scenarios. Exhibit 74 shows yield curve movements labeled "shift" (non-parallel level change), "twist" (slope change), and "butterfly" (curvature change), which respectively account for (roughly) 82%, 12%, and 4% of *weekly changes* in US Treasury yields.[37] Together, they account for 98% of the weekly changes in these yields. Each of the curves reflects a "positive" one standard deviation move of that type. A "negative" one standard deviation move is just the mirror image.[38] The positive (negative) "shift" factor is a non-parallel increase (decrease) in all yields. A positive (negative) "twist" is a flattening (steepening) of the curve, while in a positive (negative) "butterfly," the two ends of the curve move downward (upward) and the middle of the curve moves upward (downward). These three empirically derived movements correspond well with the more stylized movements emphasized in the earlier discussion of trading strategies.[39]

Exhibit 74 Key Components of US Yield Curve Movements



By construction, these three movements are uncorrelated (in the historical data), so we can simply combine them to create composite scenarios. The impact of a scenario on a particular bond is a combination of the bond's responses to each of these basic types of movements. The impact on a trade or portfolio is a combination of the impacts on the constituent bonds.

37 These movements were extracted using the method of principal components on weekly changes in constant maturity yields published by the Federal Reserve. The period spanned 15 February 2006, when the 30-year bond was reintroduced, to 26 April 2017. Decompositions of this type have become a staple of yield curve analysis, due largely to the fact that the qualitative results are reliably robust. Three factors explain almost all of the movement in the curve: The most important factor is a non-parallel "shift," the second most important factor is a flattening/steepening "twist," and the third factor is a "butterfly" pattern. It should be noted, however, that the non-parallel nature of the "shift" found in this data—higher yields being associated with steepening and more curvature—runs counter to what was described as typical in Section 2.1. The sample period, the maturities included, the frequency of observations, and whether the data reflect yield levels or yield changes can all affect decomposition returns.

38 The assignment of "positive" and "negative" labels is arbitrary.

39 Note that the stylized "shift" would be parallel and the stylized "twist" would be a downward sloping straight line. The empirical shift is not parallel, and the empirical twist is not quite linear. But in each case, the key feature is present: "Shift" means all yields move in the same direction, and "twist" means the longest and shortest maturity yields move in opposite directions, with intermediate maturity yields moving by roughly pro rata amounts.

EXAMPLE 8

Assessing the Risk of Yield Curve Movements

Aspen Summit LLC uses laddered portfolios as the core fixed-income component of its client portfolios. This approach was adopted many years ago, when yields were much higher and there was little pressure to enhance other components of fixed-income returns. On the whole, Aspen's clients have been comfortable with this approach, in part because short-term volatility could always be dismissed on the grounds that the bonds would be held to maturity. The new chief investment officer wants to adopt an active approach, including actively managing yield curve exposure. Before doing so, she wants to gauge the risks from yield curve movements and asks you to analyze those risks for the three US Treasury portfolios shown in Exhibit 75. Each portfolio has an effective (modified) duration of 7.01.

Exhibit 75 Aspen Summit LLC US Treasury Portfolios

	Portfolio Weights		
	Ladder	Barbell	Bullet
1.250% 4/30/19 (2s)	16.7%	31.0%	
1.500% 4/15/20 (3s)	16.7%	24.0%	
1.875% 4/30/22 (5s)	16.7%		10.0%
2.000% 4/30/24 (7s)	16.7%		48.0%
2.250% 2/15/27 (10s)	16.7%	25.0%	42.0%
3.000% 2/15/47 (30s)	16.7%	20.0%	

The first step is to calculate the impact of each of the three main types of yield curve movements—each one a positive one standard deviation move—on the value of each portfolio. These impacts are provided in Exhibit 76.

Exhibit 76 Impact of Yield Curve Movements on Value of US Treasury Portfolios

	Ladder	Barbell	Bullet
Shift	–0.855%	–0.834%	–0.895%
Twist	0.090%	0.118%	0.085%
Butterfly	–0.001%	0.032%	–0.057%

1 Summarize and explain the pattern of returns resulting from each type of movement.

2 Calculate the impact of the eight composite scenarios arising from combinations of +/– Shift, +/– Twist, and +/– Butterfly.

[Hint: For the + Shift state, there are four scenarios, including + Twist/+ Butterfly, + Twist/– Butterfly, – Twist/+ Butterfly, and – Twist/– Butterfly. The same four scenarios arise under the – Shift state.]

3 Calculate the standard deviation and range of returns for each portfolio.

4 Assess the relative riskiness of the three portfolios.

Solution to 1:

Although the portfolios all have the same effective duration, the impact of the shift factor is largest (in absolute value) for the Bullet and smallest for the Barbell. This result reflects the fact that actual shifts in the curve are not parallel. Yields on the intermediate maturities (5s, 7s, and 10s) rise the most, which hurts the Bullet relative to the Ladder and the Barbell. As expected, a flattening twist favors the Barbell. A "positive" butterfly also favors the Barbell. Reversing the direction of each move reverses the sign on the corresponding returns.

Solution to 2:

Since the three movements are uncorrelated, the impact of each composite scenario is the sum of the impacts of the individual components. As an example, the impact of a positive shift (a one standard deviation upward, non-parallel move) combined with a negative twist (a one standard deviation steepening move) and a positive butterfly (a one standard deviation added curvature move) is as follows:

Ladder portfolio: –0.855 – 0.090 + (–0.001) = –0.946%

Barbell portfolio: –0.834 – 0.118 + 0.032 = –0.920%

Bullet portfolio: –0.895 – 0.085 + (–0.057) = –1.037%

Calculating the impact of all composite scenarios in the same way gives the results presented in Exhibit 77.

Exhibit 77 Impact of Composite Yield Curve Scenarios on Value of US Treasury Portfolios

	+ Shift				– Shift			
	+ Twist + Bfly	+ Twist – Bfly	– Twist + Bfly	– Twist – Bfly	+ Twist + Bfly	+ Twist – Bfly	– Twist + Bfly	– Twist – Bfly
Ladder	–0.766%	–0.764%	–0.946%	–0.944%	0.944%	0.946%	0.764%	0.766%
Barbell	–0.684%	–0.748%	–0.920%	–0.984%	0.984%	0.920%	0.748%	0.684%
Bullet	–0.867%	–0.753%	–1.037%	–0.923%	0.923%	1.037%	0.753%	0.867%

Solution to 3:

The ranges of returns are ±0.946% for the Ladder, ±0.984% for the Barbell, and ±1.037% for the Bullet portfolio. The mean for each portfolio is zero since the returns for the eight composite scenarios across each portfolio sum to zero. So, to compute the standard deviation, simply square and sum the returns, divide by 8, and take the square root. Note that the eight returns for each portfolio are actually four pairs of plus/minus the same number. The standard deviation for the Ladder portfolio is

$$\sqrt{\frac{2\left(0.766^2\right)+2\left(0.764^2\right)+2\left(0.944^2\right)+2\left(0.946^2\right)}{8}}=0.860\%$$

Plugging in the returns for the other two portfolios gives standard deviations of 0.843% for the Barbell and 0.901% for the Bullet.

Solution to 4:

Overall, the Bullet portfolio has the highest risk. It has the highest standard deviation (0.901%) and the widest range of returns (+/–1.037%). The Barbell has the lowest standard deviation (0.843%), but the Ladder has the narrowest range of returns (+/–0.946%). The higher risk exhibited by the Bullet portfolio is driven primarily by its greater exposure to the shift factor. As noted above, this result is due to the non-parallel, humped nature of the empirical curve shift factor. In effect, duration understates the relative impact on the Bullet portfolio. Isolating the combined effect of twist and butterfly, the range of outcomes is ±0.300% [0.984% – 0.684% and (–0.984%) – (–0.684%)] for the Barbell portfolio, ±0.284% for the Bullet portfolio, and only ±0.182% for the Ladder. From this perspective, the Barbell and the Bullet have very similar risk with respect to reshaping of the yield curve (twist and butterfly factors)—though clearly different responses to specific movements—while the Ladder is relatively immune by virtue of being spread equally across the curve.

Using Structured Notes in Active Fixed-Income Management

There is a class of fixed-income securities that can provide highly customized exposures to alter a portfolio's sensitivity to yield curve changes. These securities fall under the broad heading of structured notes. Among the many types of structured notes used in fixed-income portfolio management are the following:

- Inverse floaters
- Deleveraged floaters
- Range accrual notes
- Extinguishing accrual notes
- Interest rate differential notes
- Ratchet floaters

Structured notes can offer significantly lower all-in costs compared with traditional financing. When used by sophisticated investors, structured notes allow the packaging of certain risks or bets. Some structured notes can be extremely complicated, with complex formulas for coupon payments and redemption values. For example, consider the following:

- Inverse floaters have coupons that rise as the index rate to which the coupons are linked declines (and vice versa), and many of these are "levered" in that the coupon changes by a multiple (2×, 3×, etc.) of the index rate change.
- The coupon of the deleveraged floater floats with the change in its reference rate, but the change applied to the coupon is based on a multiplier that is less than one.
- Range accrual notes specify a daily accrual (coupon) rate within a set of pre-defined constraints. For example, the accrual occurs only if the reference rate, such as three-month Libor, is within a pre-determined range for that day. If the reference rate is outside of that range, then no accrual occurs.
- Extinguishing accrual notes cancel all future accruals if the reference rate trades outside the specified range. This feature is beneficial if interest rates decline but creates a drag on returns if rates move up. The investor is compensated by receiving a higher "floor" or minimum interest rate.

- Interest rate differential notes pay a coupon based on the difference between the rates from two different points on the yield curve.
- Ratchet floaters are floating-rate notes that typically include a provision preventing the coupon from ever declining.
- Dual-currency notes are denominated in one currency but pay interest in a different currency. A version of this note was a "power-reverse dual" note—inverse floaters (sold when rates were close to zero and seemingly could only rise) that paid coupons in one currency and principal in another currency.

Most of these structures focus on the front end of the yield curve.

Structured notes can be complicated and often lack liquidity. Thorough due diligence and a high level of investment expertise are essential to effectively invest in these securities. Many unsophisticated investors have purchased these securities without truly understanding their idiosyncratic characteristics and risks. The Orange County, California, debacle of 1994 is one notable example.

The county had issued debt securities and used those proceeds to increase the size of an investment pool it managed on behalf of area schools—a fund that was promoted as a low-risk investment. The investment pool then pledged those securities in the repo market, using the proceeds of the repo loan to buy structured notes with complicated coupon formulas, many of which were predicated on a forecast of flat to declining interest rates. As the Federal Reserve raised interest rates throughout 1994, the county's losses mounted. The fund lost $1.5 billion out of its $7.5 billion portfolio and, in December 1994, Orange County, California declared bankruptcy, largely as a result of the losses on its investment portfolios.

SUMMARY

This reading focused on the strategies a fixed-income portfolio manager may use to position his portfolio in anticipation of the future state of yield curves.

- Macaulay duration is a weighted average of time to receive the bond's cash flows.
- Modified duration is the Macaulay duration statistic divided by one plus the yield to maturity per period. It provides an estimate of the percentage price change for a bond given a 100 bps change in its yield to maturity.
- Effective duration is the sensitivity of the bond's price to a change in a benchmark yield curve, as opposed to the price response to a change in the bond's own yield. It is similar to modified duration, but its calculation is flexible to allow for its use in cases when the bond has an embedded option.
- Key rate duration is a measure of a bond's sensitivity to a change in the benchmark yield curve at a specific maturity point or segment. Key rate durations help identify a portfolio's sensitivity to changes in the shape of the benchmark yield curve.
- The money duration of a bond is a measure of the bond's price change in units of the currency in which the bond is denominated.
- The price value of a basis point scales money duration so that it can be interpreted as money gained or lost for each basis point change in the reference interest rate.
- The three primary yield curve movements of importance to the fixed-income manager are changes in level, slope, and curvature of the yield curve.

- Curvature of the yield curve can be measured using the butterfly spread, which describes the relationship between yields at short, intermediate, and long maturities.
- Duration management is the primary tool used by fixed-income portfolio managers.
- Convexity supplements duration as a measure of a bond's price sensitivity for larger movements in interest rates. Adjusting convexity can be an important portfolio management tool.
- Adding convexity to a portfolio using physical bonds typically requires a give-up in yield.
- For two portfolios with the same duration, the portfolio with higher convexity has higher sensitivity to large declines in yields and lower sensitivity to large increases in yields.
- Interest rate derivatives can be used effectively to add convexity to a portfolio.
- The four major strategies used when the yield curve is expected to remain stable are buy and hold; ride the yield curve; sell convexity; and the carry trade.
- A carry trade involves buying a security and financing it at a rate that is lower than the yield on that security.
- There are three basic ways to implement a carry trade to exploit a stable, upward-sloping yield curve: (a) Buy a bond and finance it in the repo market, (b) receive fixed and pay floating on an interest rate swap, and (c) take a long position in a bond (or note) futures contract.
- Inter-market carry trades may or may not involve a duration mismatch.
- Among the ways to implement an inter-market carry trade subject to currency exposure are the following: (a) Borrow from a bank in the lower interest rate currency, convert the proceeds to the higher interest rate currency, and invest in a bond denominated in that currency; (b) borrow in the higher rate currency, invest the proceeds in an instrument denominated in that currency, and convert the financing to the lower rate currency via the FX forward market; and (c) enter into a currency swap, receiving payments in the higher rate currency and making payments in the lower rate currency.
- Inter-market carry trades can be implemented without currency risk by (a) receiving fixed/paying floating in the steeper market and paying fixed/receiving floating in the flatter market or (b) taking a long position in bond (or note) futures in the steeper market and a short futures position in the flatter market.
- The major strategies used when changes are expected in the level, slope, or curvature of the yield curve are duration management; buying convexity; and bullet and barbell structures.
- Selling convexity can be accomplished by selling calls on bonds owned, selling puts on bonds one would be willing to own, or buying securities with negative convexity, such as callable bonds or mortgage-backed securities.
- Duration should not be extended or shortened without considering the manner in which the changed duration will be distributed throughout the portfolio. The same duration change can be effected with any number of trades, each of which has its own sensitivity to changes in the curve.
- Portfolio duration can be modified using futures, options, or leverage.
- A bullet portfolio holds securities targeting a single segment of the curve, with the bonds clustered around the portfolio's duration target. A bullet is typically used to take advantage of a steepening yield curve.

- A barbell portfolio combines securities with short and long maturities (and fewer intermediate maturities) compared with the duration target. A barbell is typically used to take advantage of a flattening yield curve.
- A barbell portfolio structure has higher convexity than a bullet portfolio structure.
- Key rate durations can be used to estimate a bond or portfolio's sensitivity to changes in the shape of the yield curve as well as to identify bullets and barbells.
- A butterfly trade combines a bullet and a barbell in a duration-neutral long–short structure. (This trade is distinct from the butterfly spread measure used to determine curvature.)
- A butterfly long in the wings and short in the body is long (has positive) convexity and benefits from volatile interest rates. This butterfly also benefits from a yield curve flattening (unrelated to its convexity).
- A butterfly short in the wings and long in the body is short convexity and benefits from stable interest rates. This butterfly also benefits from a yield curve steepening (unrelated to its convexity).
- Comparing forward yields (implied yield change) with a manager's yield forecast (forecast yield change) can help determine which bonds are likely to perform the best over the forecast horizon.
- Options can be used to add or reduce convexity in a portfolio.
- Inter-market trades involve more than one yield curve and require the investor to either accept or somehow hedge currency risk.
- In addition to carry, the primary driver of inter-market trades is a view on the narrowing or widening of yield spreads between markets.
- The lack of credibly fixed exchange rates allows (default-free) yield curves, and hence bond returns, to be less than perfectly correlated across markets.
- Currency hedging does not eliminate the opportunity to add value via inter-market trades.
- Inter-market asset decisions should be made on the basis of prospective currency-hedged returns. Currency exposure decisions should be based on projected appreciation or depreciation relative to forward FX rates rather than on projected spot FX appreciation/depreciation alone.
- The expected return of a fixed income portfolio can be estimated using the following formula:

$$\begin{aligned} E(R) \approx{} & \text{Yield income} + \text{Rolldown return} \\ & + E(\text{Change in price}) - E(\text{Credit losses}) + E(\text{Currency gains or losses}) \end{aligned}$$

- Changes in the level and shape of the yield curve can be decomposed into three types of movements that explain nearly all of the variation in yields: (1) a non-parallel increase/decrease in all yields ("shift"), (2) a steepening/flattening ("twist"), and (3) a change in curvature in which the long and short ends of the curve move in the direction opposite to that of the intermediate maturities ("butterfly").
- The risk of a yield curve trade or, more generally, portfolio positioning on the curve, can be described and measured based on exposures to combinations of the three basic components: shift, twist, and butterfly.

Relative Performance of Bullets and Barbells under Different Yield Curve Scenarios

Yield Curve Scenario		Barbell	Bullet
Level change	Parallel shift	Outperforms	Underperforms
Slope change	Flattening	Outperforms	Underperforms
	Steepening	Underperforms	Outperforms
Curvature change	Less curvature	Underperforms	Outperforms
	More curvature	Outperforms	Underperforms
Rate volatility change	Decreased rate volatility	Underperforms	Outperforms
	Increased rate volatility	Outperforms	Underperforms

PRACTICE PROBLEMS

The following information relates to Questions 1–6

Amy McLaughlin is a fixed-income portfolio manager at UK-based Delphi Investments. One year ago, given her expectations of a stable yield curve over the coming 12 months and noting that the yield curve was upward sloping, McLaughlin elected to position her portfolio solely in 20-year US Treasury bonds with a coupon rate of 4% and a price of 101.7593, with the expectation of selling the bonds in one year at a price of 109.0629. McLaughlin expected the US dollar to depreciate relative to the British pound by 1.50% during the year. McLaughlin chose the 20-year Treasury bonds because they were on the steepest part of the yield curve.

McLaughlin and Michaela Donaldson, a junior analyst at Delphi, are now discussing how to reposition the portfolio in light of McLaughlin's expectations about interest rates over the next 12 months. She expects interest rate volatility to be high and the yield curve to experience an increase in the 2s/10s/30s butterfly spread, with the 30-year yield remaining unchanged. Selected yields on the Treasury yield curve, and McLaughlin's expected changes in yields over the next 12 months, are presented in Exhibit 1.

Exhibit 1 Current Treasury Yield Curve and Forecasted Yields

Maturity (years)	Starting Yield (Current)	Forecasted Change in Yield	Ending Yield
2	1.01%	+0.04%	1.05%
5	1.55%	+0.40%	1.95%
10	2.75%	+0.50%	3.25%
30	3.50%	+0.00%	3.50%

Based on these interest rate expectations, McLaughlin asks Donaldson to recommend a portfolio strategy. Donaldson considers the following three options.

Bullet portfolio:	Invest solely in 10-year Treasury government bonds
Barbell portfolio:	Invest solely in 2-year and 30-year Treasury government bonds
Laddered portfolio:	Invest equally in 2-year, 5-year, 10-year, and 30-year Treasury government bonds

After recommending a portfolio strategy, McLaughlin tells Donaldson that using a duration-neutral, long/short structure may be a better strategy for attempting to enhance portfolio return. McLaughlin suggests that Donaldson consider a butterfly trade or a condor trade using some combination of 2-year, 5-year, 10-year, and 30-year bonds.

Donaldson suggests they also consider altering the portfolio's convexity to enhance expected return given McLaughlin's interest rate expectations. Donaldson tells McLaughlin the following.

Statement 1 Portfolios with larger convexities often have higher yields.

Statement 2 If yields rise, a portfolio of a given duration with higher convexity will experience less of a price decrease than a similar-duration, lower-convexity portfolio.

1 The portfolio strategy implemented by McLaughlin last year is *mostly likely* to be described as:

A a carry trade.

B a barbell structure.

C riding the yield curve.

2 At the start of last year, the expected return on the portfolio strategy implemented by McLaughlin was *closest* to:

A 9.61%.

B 9.68%.

C 12.61%.

3 Using the yield curve forecast shown in Exhibit 1, which portfolio strategy should Donaldson recommend for the year ahead?

A The bullet portfolio

B The barbell portfolio

C The laddered portfolio

4 Given McLaughlin's interest rate expectations over the next 12 months, which long/short structure would be most appropriate?

A Condor: short wings, long body

B Butterfly: short barbell, long bullet

C Butterfly: long barbell, short bullet

5 Given McLaughlin's interest rate expectations over the next 12 months, one way that Donaldson and McLaughlin could alter convexity to enhance expected return would be to:

A sell call options on bonds held in the portfolio.

B buy call options on long-maturity government bond futures.

C sell put options on bonds they would be willing to own in the portfolio.

6 Which of Donaldson's statements is correct?

A Only Statement 1

B Only Statement 2

C Both Statements 1 and 2

The following information relates to questions 7–14

Sanober Hirji is a junior analyst with Northco Securities, which is based in Canada. The institutional clients of Northco are active investors in Canadian coupon-bearing government bonds. Client portfolios are benchmarked to a Canadian government bond index, which is a diverse maturity index portfolio. After reviewing the portfolio of a French institutional client, Hirji evaluates yield curve strategies for Canadian government bond portfolios under various interest rate scenarios. Hirji's supervisor, Éliane Prégent, forecasts that Canadian long-term rates will rise and short-term rates will fall over the next 12 months.

In contrast, Northco's chief economist forecasts that Canadian interest rates will increase or decrease by 100 basis points over the next 12 months. Based on the chief economist's forecast, Hirji suggests increasing the convexity of the French institutional client's portfolio by selling 10-year bonds and investing the proceeds in a duration-matched barbell position of Canadian government 3-year and long-term bonds. She notes that the duration of the 10-year bonds, along with the durations of the other portfolio bonds, aligns the portfolio's effective duration with that of the benchmark. Selected data on Canadian government bonds are presented in Exhibit 1.

Exhibit 1 Canadian Government Bonds As of 1 January

Security	Effective Duration	Effective Convexity
1-year	0.99	0.007
3-year	2.88	0.118
10-year	9.51	0.701
Long-term	21.30	2.912

* There is no single convention for how convexity numbers are presented; for example, Bloomberg has historically followed a convention of dividing the "raw" convexity number by 100 (as presented here). However, it is important to use the raw convexity number when estimating returns.

Hirji then considers a strategy to sell some long-term bonds from the French institutional client's portfolio and purchase short maturity at-the-money options on long-term bond futures. The portfolio's duration would remain unchanged. Prégent asks:

> "How would portfolio performance be affected by this strategy if the yield curve were to remain stable?"

Hirji also proposes the following duration-neutral trades for the French institutional client:

- Long/short trade on 1-year and 3-year Canadian government bonds
- Short/long trade on 10-year and long-term Canadian government bonds

Six months later, Hirji reviews Canadian government bonds for a Malaysian institutional client. Prégent and Hirji expect changes in the curvature of the yield curve but are not sure whether curvature will increase or decrease. Hirji first analyzes positions that would profit from an increase in the curvature of the yield curve. The positions must be duration neutral, and the maximum position that the Malaysian client can take in long-term bonds is C$150 million. Hirji notes that interest rates have increased by 100 basis points over the past six months. Selected data for on-the-run Canadian government bonds are shown in Exhibit 2.

Exhibit 2 On-the-Run Canadian Government Bonds As of 1 July

Maturity	YTM (%)	Duration	PVBP (C$ millions)
2-year	1.73	1.97	197
5-year	2.01	4.78	478
10-year	2.55	8.89	889
Long-term	3.16	19.60	1,960

Hirji then considers the scenario where the yield curve will lose curvature for the Malaysian institutional client. She notes that a 7-year Canadian government bond is also available in the market. Hirji proposes a duration-neutral portfolio comprised of 47% in 5-year bonds and 53% in 7-year bonds.

Finally, Hirji uses the components of expected returns to compare the performance of a bullet portfolio and a barbell portfolio for a British institutional client. Characteristics of these portfolios are shown in Exhibit 3.

Exhibit 3 Characteristics of Bullet and Barbell Portfolios

	Bullet Portfolio	Barbell Portfolio
Investment horizon (years)	1.0	1.0
Average annual coupon rate for portfolio	1.86%	1.84%
Average beginning bond price for portfolio	C$100.00	C$100.00
Average ending bond price for portfolio (assuming rolldown and stable yield curve)	C$100.38	C$100.46
Current modified duration for portfolio	4.96	4.92
Expected effective duration for portfolio (at the horizon)	4.12	4.12
Expected convexity for portfolio (at the horizon)	14.68	24.98
Expected change in government yield curve	–0.55%	–0.55%

7 Based on Prégent's interest rate forecast over the next 12 months, the yield curve strategy that would *most likely* realize the highest profit is:

A a carry trade.

B a bullet structure.

C duration management by buying long-term Canadian bonds.

8 Based on Exhibit 1, the gain in convexity from Hirji's suggestion is *closest* to:

A 0.423.

B 1.124.

C 1.205.

9 The answer to Prégent's question is that the portfolio would *most likely* experience:

A a loss.

B no change.

C a gain.

10 Which yield curve forecast will *most likely* result in the highest profit for Hirji's proposed duration-neutral trades?

A Increase in curvature

B Decrease in curvature

C Parallel downward shift

11 Based on Exhibit 2, the amount that Hirji should allocate to the 2-year bond position is *closest* to:

A C$331 million.

B C$615 million.

C C$1,492 million.

12 Relative to the Canadian government bond index, the portfolio that Hirji proposes for the Malaysian client will *most likely*:

A underperform.

B remain stable.

C outperform.

13 Based on Exhibit 3, the difference in the rolling yield between Hirji's bullet portfolio and barbell portfolio is:

A –8 basis points.

B –6 basis points.

C 2 basis points.

14 Based on Exhibit 3, the total expected return of Hirji's barbell portfolio is *closest* to:

A –2.30%.

B 0.07%.

C 4.60%.

The following information relates to questions 15–22

Silvia Abram and Walter Edgarton are analysts with Cefrino Investments, which sponsors the Cefrino Sovereign Bond Fund (the Fund). Abram and Edgarton recently attended an investment committee meeting where interest rate expectations for the next 12 months were discussed. The Fund's mandate allows its duration to fluctuate ±0.30 per year from the benchmark duration. The Fund's duration is currently equal to its benchmark. Although the Fund is presently invested entirely in annual coupon sovereign bonds, its investment policy also allows investments in mortgage-backed securities (MBS) and call options on government bond futures. The Fund's current holdings of on-the-run bonds are presented in Exhibit 1.

Exhibit 1 Cefrino Sovereign Bond Fund Current Fund Holdings of On-the-Run Bonds

Maturity	Coupon/YTM	Market Value	Modified Duration
1-year	0.78%	$10,000,000	0.99
3-year	1.40%	$10,000,000	2.92
5-year	1.80%	$10,000,000	4.74
10-year	2.34%	$10,000,000	8.82
30-year	2.95%	$10,000,000	19.69
Portfolio	1.85%	$50,000,000	7.43

Over the next 12 months, Abram expects a stable yield curve; however, Edgarton expects a steepening yield curve, with short-term yields rising by 1.00% and long-term yields rising by more than 1.00%.

Based on her yield curve forecast, Abram recommends to her supervisor changes to the Fund's holdings using the following three strategies:

Strategy 1: Sell the 3-year bonds, and use the proceeds to buy 10-year bonds.

Strategy 2: Sell the 5-year bonds, and use the proceeds to buy 30-year MBS with an effective duration of 4.75.

Strategy 3: Sell the 10-year bonds, and buy call options on 10-year government bond futures.

Abram's supervisor disagrees with Abram's yield curve outlook. The supervisor develops two alternative portfolio scenarios based on her own yield curve outlook:

Scenario 1 Sell all bonds in the Fund except the 2-year and 30-year bonds, and increase positions in these two bonds while keeping duration neutral to the benchmark.

Scenario 2 Construct a condor to benefit from less curvature in the 5-year to 10-year area of the yield curve. The condor will utilize the same 1-year, 5-year, 10-year, and 30-year bonds held in the Fund. The maximum allowable position in the 30-year bond in the condor is $17 million, and the bonds must have equal (absolute value) money duration.

Edgarton evaluates the Fund's positions from Exhibit 1 along with two of his pro forma portfolios, which are summarized in Exhibit 2:

Exhibit 2 Selected Partial Durations

Maturity	Beginning Yield Curve	Curve Shift	Current Portfolio Partial PVBP	Pro Forma Portfolio 1 Partial PVBP	Pro Forma Portfolio 2 Partial PVBP
1-year	0.78%	1.00%	0.0020	0.0018	0.0021
3-year	1.40%	1.00%	0.0058	0.0044	0.0061
5-year	1.80%	1.25%	0.0095	0.0114	0.0095
10-year	2.34%	1.60%	0.0177	0.0212	0.0159
30-year	2.95%	1.75%	0.0394	0.0374	0.0394

Lastly, Edgarton reviews a separate account for Cefrino's US clients that invest in Australian government bonds. He expects a stable Australian yield curve over the next 12 months. He evaluates the return from buying and holding a 1-year Australian government bond versus buying the 2-year Australian government bond and selling it in one year.

Exhibit 3 Cefrino Australian Government Bond Portfolio Assumptions for Stable Yield Curve

	Portfolio Strategies	
	Buy-and-Hold Portfolio	Ride-the-Yield Curve Portfolio
Investment horizon (years)	1.0	1.0
Bonds maturity at purchase (years)	1.0	2.0
Coupon rate	1.40%	1.75%
Yield to maturity	1.65%	1.80%
Current average portfolio bond price	A$99.75	A$99.90
Expected average bond price in one year for portfolio	A$100.00	A$100.10
Expected currency gains or losses	–0.57%	–0.57%

15 Based on Exhibit 1 and Abram's expectation for the yield curve over the next 12 months, the strategy *most likely* to improve the Fund's return relative to the benchmark is to:

A buy and hold.

B increase convexity.

C ride the yield curve.

16 Based on Edgarton's expectation for the yield curve over the next 12 months, the Fund's return relative to the benchmark would *most likely* increase by:

A riding the yield curve.

B implementing a barbell structure.

C shortening the portfolio duration relative to the benchmark.

17 Based on Exhibit 1 and Abram's interest rate expectations, which of the following strategies is expected to perform *best* over the next 12 months?

A Strategy 1

B Strategy 2

C Strategy 3

18 The yield curve expectation that Abram's supervisor targets with Scenario 1 is *most likely* a:

A flattening yield curve.

B reduction in yield curve curvature.

C 100 bps parallel shift downward of the yield curve.

19 Based on Exhibit 1, which short position is *most likely* to be included in the condor outlined in Scenario 2?

A 1-year \$338 million

B 5-year \$71 million

C 10-year $38 million

20 Based on Exhibits 1 and 2, which of the following portfolios is *most likely* to have the *best* performance given Edgarton's yield curve expectations?

A Current Portfolio

B Pro Forma Portfolio 1

C Pro Forma Portfolio 2

21 Based on Exhibit 3, the 1-year expected return of the Buy-and-Hold portfolio for the Cefrino Australian government bond portfolio is *closest* to:

A 0.83%.

B 1.08%.

C 2.22%.

22 Based on Exhibit 3, the implied Australian dollar (A$) 1-year rate, 1-year forward is *closest* to:

A 0.15%.

B 1.95%.

C 2.10%.

The following information relates to question 23–32

Susan Winslow manages bond funds denominated in US Dollars, Euros, and British Pounds. Each fund invests in sovereign bonds and related derivatives. Each fund can invest a portion of its assets outside its base currency market with or without hedging the currency exposure, but to date Winslow has not utilized this capacity. She believes she can also hedge bonds into currencies other than a portfolio's base currency when she expects doing so will add value. However, the legal department has not yet confirmed this interpretation. If the lawyers disagree, Winslow will be limited to either unhedged positions or hedging into each portfolio's base currency.

Given the historically low rates available in the US, Euro, and UK markets, Winslow has decided to look for inter-market opportunities. With that in mind, she gathered observations about such trades from various sources. Winslow's notes with respect to carry trades include these statements:

I. Carry trades may or may not involve a maturity mismatch.

II. Carry trades require two yield curves with substantially different slopes.

III. Inter-market carry trades just break even if both yield curves move to the forward rates.

Regarding inter-market trades in general her notes indicate:

IV. Inter-market trades should be assessed based on currency-hedged returns.

V. Anticipated changes in yield spreads are the primary driver of inter-market trades.

VI. Whether a bond offers a relatively attractive return depends on both the portfolio's base currency and the currency in which the bond is denominated.

Winslow thinks the Mexican and Greek markets may offer attractive opportunities to enhance returns. Yields in these markets are given in Exhibit 1, along with those for the base currencies of her portfolios. The Greek rates are for euro-denominated government bonds priced at par. In the other markets, the yields apply to par sovereign bonds as well as to the fixed side of swaps versus six-month Libor (i.e., swap spreads are zero in each market). The six-month Libor rates also represent the rates at which investors can borrow or lend in each currency. Winslow observes that the five-year Treasury-note and the five-year German government note are the cheapest to deliver against their respective futures contracts expiring in six months.

Exhibit 1 Sovereign Yields in Five Markets

	Floating	Fixed Rate with Semi-annual Payments				
	6 Mo Libor	1 Yr	2 Yr	3 Yr	4 Yr	5 Yr
Mexico	7.10%	7.15%	7.20%	7.25%	7.25%	7.25%
Greece	—	3.30%	5.20%	5.65%	5.70%	5.70%
Euro	0.15%	0.25%	0.30%	0.40%	0.50%	0.60%
UK	0.50%	0.70%	0.80%	0.95%	1.00%	1.10%
US	1.40%	1.55%	1.70%	1.80%	1.90%	1.95%

Winslow expects yields in the US, Euro, UK, and Greek markets to remain stable over the next six months. She expects Mexican yields to decline to 7.0% at all maturities. Meanwhile, she projects that the Mexican Peso will depreciate by 2% against the Euro, the US Dollar will depreciate by 1% against the Euro, and the British Pound will remain stable versus the Euro. Winslow believes bonds of the same maturity may be viewed as having the same duration for purposes of identifying the most attractive positions.

Based on these views, Winslow is considering three types of trades. First, she is looking at carry trades, with or without taking currency exposure, among her three base currency markets. Each such trade will involve extending duration (e.g., lend long/borrow short) in no more than one market. Second, assuming the legal department confirms her interpretation of permissible currency hedging, she wants to identify the most attractive five-year bond and currency exposure for each of her three portfolios from among the five markets shown in Exhibit 1. Third, she wants to identify the most attractive five-year bond and hedging decision for each portfolio if she is only allowed to hedge into the portfolio's base currency.

Winslow's firm has recently installed a test version of a new risk system which decomposes empirical yield curve movements into uncorrelated components and calculates the exposure of individual bonds as well as portfolios to each type of movement. The system's current estimates for the three most important component movements are given in Exhibit 2. Unfortunately, the system did not indicate the relative importance among these three movements.

Exhibit 2 Key Curve Components: +1 Standard Deviation Yield Changes (bps/week)

	Maturity							
	6 Mo	2 Yr	3 Yr	5 Yr	7 Yr	10 Yr	20 Yr	30 Yr
Comp A	6.0	5.1	4.3	1.7	–0.6	–2.4	–4.1	–4.3
Comp B	–5.3	0.9	1.6	2.0	1.2	0.0	–1.9	–2.4
Comp C	3.6	8.1	10.1	12.2	12.8	12.2	10.9	10.3

After loading the holdings of her US portfolio into the system, Winslow runs a report showing the impact of each risk component on the portfolio. The report is shown in Exhibit 3.

Exhibit 3 Portfolio Value Changes Due to +1 Standard Deviation Move in Each Risk Component

Component A	Component B	Component C
0.020 %	–0.053 %	–0.794 %

23 Which of Winslow's statements about carry trades is correct?

A Statement I

B Statement II

C Statement III

24 Which of Winslow's statements about inter-market trades is *incorrect*?

A Statement IV

B Statement V

C Statement VI

25 Among the carry trades available in the US, Euro, and UK markets, the highest expected return for the USD-denominated portfolio over the next 6 months is *closest to*:

A 0.275%.

B 0.85%.

C 0.90%.

26 Considering only the US, UK, and Euro markets, the most attractive duration-neutral, currency-neutral carry trade could be implemented as:

A Buy 3-year UK Gilts, Sell 3-year German notes, and enter a 6-month FX forward contract to pay EUR/receive GBP.

B Receive fixed/pay floating on a 3-year GBP interest rate swap and receive floating/pay fixed on a 3-year EUR interest rate swap.

C Buy the T-note futures contract and sell the German note futures contract for delivery in six months.

27 If Winslow is limited to unhedged positions or hedging into each portfolio's base currency, she can obtain the highest expected returns by

A buying the Mexican 5-year in each of the portfolios and hedging it into the base currency of the portfolio.

B buying the Greek 5-year in each of the portfolios, hedging the currency in the GBP-based portfolio, and leaving the currency unhedged in the dollar-based portfolio.

C buying the Greek 5-year in the Euro-denominated portfolio, buying the Mexican 5-year in the GBP and USD-denominated portfolios, and leaving the currency unhedged in each case.

28 If Winslow is allowed to hedge into any of the currencies, she can obtain the highest expected returns by

A buying the Greek 5-year in each portfolio and hedging it into Pesos.

B buying the Greek 5-year in each portfolio and hedging it into USD.

C buying the Mexican 5-year in each portfolio and not hedging the currency.

29 The *most likely* ranking of the yield curve components shown in Exhibit 2 from highest to lowest percentage of overall curve movements explained is:

A Component A, then Component B, then Component C.

B Component B, then Component C, then Component A.

C Component C, then Component A, then Component B.

30 Which of these scenarios would come *closest* to generating a parallel change in the yield curve (where sd indicates standard deviation)?

A Component A +1 sd; Component B +1 sd; Component C +1 sd

B Component A +1 sd; Component B –1 sd; Component C +1 sd

C Component A –1 sd; Component B +1 sd; Component C +1 sd

31 Among the scenarios in the previous question, Winslow's portfolio is *most* sensitive to:

A Scenario (A).

B Scenario (B).

C Scenario (C).

32 The weekly volatility of Winslow's portfolio is *closest to*:

A 0.56%.

B 0.80%.

C 0.63%.

The following information relates to questions 33–36

Katsuko Zhao and Johan Flander are portfolio managers with Cowiler Investments, a US-based company. They are assessing the effect of their yield curve forecasts on their bond portfolios. The yield curve is currently upward sloping.

Zhao's portfolio is currently invested in US Treasury securities. Zhao forecasts an instantaneous parallel downward shift in the yield curve. Zhao considers two alternatives to reposition her current portfolio given her yield curve forecast and assesses the tradeoff between convexity and yield. Exhibit 1 presents allocations for the current and two alternative portfolios. The durations of the current and alternative portfolios are closely matched.

Exhibit 1 Allocations for Current and Alternative Portfolios

Remaining Term	Current	Alternative 1	Alternative 2
2 years	33.33%	0.00%	50.00%
10 years	33.33%	100.00%	0.00%
20 years	33.33%	0.00%	50.00%

33 **Determine** which alternative portfolio in Exhibit 1 would be *most appropriate* for Zhao given her yield curve forecast. **Justify** your selection.

Template for Question 33

Determine which alternative portfolio in Exhibit 1 would be *most appropriate* for Zhao, given her yield curve forecast. (circle one)

Alternative 1	Alternative 2

Justify your selection.

Based on Zhao's forecast of an instantaneous parallel downward shift in the yield curve, she also considers selling a portion of the US Treasury securities in her portfolio and buying one of the following two investments:

Investment 1 A mortgage-backed security (MBS)

Investment 2 A near-the-money call option on 20-year Treasury bond futures

The effective duration of the resulting portfolio will be closely matched to Zhao's current portfolio.

34 **Determine** which investment would be *most appropriate* for Zhao given her yield curve forecast. **Justify** your response.

Template for Question 34

Determine which investment would be *most appropriate* for Zhao given her yield curve forecast. (circle one)

Investment 1	Investment 2

Justify your response.

Flander forecasts that the yield curve will steepen over the next 12 months, with long rates remaining the same and short and intermediate rates falling. Flander evaluates the effect of these interest rate changes on his three bond portfolios. The partial or key rate price value of a basis point (PVBP) data for Flander's three portfolios is presented in Exhibit 2.

Exhibit 2 Partial or Key Rate PVBPs for Short, Intermediate, and Long-Term Maturities

	Total	Short	Intermediate	Long
Portfolio A	0.0374	0.0056	0.0127	0.0191
Portfolio B	0.0374	0.0102	0.0079	0.0193
Portfolio C	0.0374	0.0103	0.0169	0.0102

35 **Determine** which portfolio in Exhibit 2 will *most likely* have the *best* performance over the next 12 months given Flander's yield curve forecast. **Justify** your response.

Template for Question 35

Determine which portfolio in Exhibit 2 will *most likely* have the *best* performance over the next 12 months given Flander's yield curve forecast. (circle one)		
Portfolio A	Portfolio B	Portfolio C

Justify your response.

Flander evaluates a new bullet portfolio and a new barbell portfolio, each with a 12-month time horizon, using zero-coupon notes issued by the Australian government. Flander projects that over the next 12 months, the Australian zero-coupon yield curve will experience a downward parallel shift of 60 bps. The Australian dollar is projected to remain stable relative to the US dollar. Exhibit 3 presents the data for the two portfolios.

Exhibit 3 Selected Data for Australian Bullet and Barbell Portfolio

	Bullet	Barbell
Investment horizon (years)	1.0	1.0
Average bond price for portfolio currently	98.00	98.00
Average bond price for portfolio in one year (assuming stable yield curve)	99.75	100.00
Expected effective duration for portfolio (at the horizon)	3.95	3.95
Expected convexity for portfolio (at the horizon)	19.50	34.00
Expected change in government bond yield curve	–0.60%	–0.60%

36 **Calculate** the total expected return for the bullet and barbell portfolios presented in Exhibit 3. **Show** your calculations. **Identify** the component factor that contributes most of the outperformance of the higher-performing portfolio.

Template for Question 36

Calculate the total expected return for the bullet and barbell portfolios presented in Exhibit 3. Show your calculations.

Identify the component factor that contributes most of the outperformance of the higher-performing portfolio.

SOLUTIONS

1 C is correct. Last year, McLaughlin expected the yield curve to be stable over the year. Riding the yield curve is a strategy based on the premise that, as a bond ages, it will decline in yield if the yield curve is upward sloping. This is known as "roll down"; that is, the bond rolls down the (static) curve. Riding the yield curve differs from buy and hold in that the manager is expecting to add to returns by selling the security at a lower yield at the horizon. This strategy may be particularly effective if the portfolio manager targets portions of the yield curve that are relatively steep and where price appreciation resulting from the bond's migration to maturity can be significant. McLaughlin elected to position her portfolio solely in 20-year Treasury bonds, which reflect the steepest part of the yield curve, with the expectation of selling the bonds in one year.

2 A is correct. The expected return on the strategy (riding the curve) is calculated as follows.

$E(R)$	≈	Yield income	(equal to Annual coupon rate/Current bond price)
	+	Rolldown return	[equal to (End bond price – Begin bond price)/Begin bond price]
	+	E(Change in price based on investor's views of yields and yield spreads)	
	–	E(Credit losses)	
	+	E(Currency gains or losses)	

Return Component	Formula*	Portfolio Performance
Yield income	Annual coupon payment/Current bond price	4/101.7593 = 3.93%
+ Rolldown return	$\dfrac{\left(\text{Bond price}_{\text{End-of-horizon}} - \text{Bond price}_{\text{Beginning-of-horizon}}\right)}{\text{Bond price}_{\text{Beginning-of-horizon}}}$	(109.0629 – 101.7593)/101.7593) = 7.18%
+ E(Change in price based on investor's views of yields and yield spreads)		0%
= Rolling yield	Yield income + Rolldown return	3.93% + 7.18% = 11.11%
– E(Credit losses)	N/A	–0%
+ E(Currency gains or losses)	Given	–1.50%
= Total expected return		= 9.61%

In this case, the E(Change in price based on investor's views of yields and yield spreads) term is equal to zero because McLaughlin expects the yield curve to remain stable.

3 B is correct. McLaughlin expects the yield curve to experience an increase in the butterfly spread, with the 30-year yield remaining unchanged, which implies that the yield curve will increase its curvature, pinned at the 30-year yield, as shown in Exhibit 1. The barbell portfolio, consisting of 2-year and 30-year bonds, would be expected to perform best. Although the two-year rate is expected to increase, the effective duration of two-year bonds is quite small, resulting in minimal price impact. Similarly, the 30-year yield is expected to remain constant, resulting in minimal price impact as well. Relative to the

barbell portfolio, the laddered portfolio has greater exposure to the expected increases in the 5-year and 10-year yields, and the bullet portfolio has greater exposure to the expected increase in the 10-year yield. Therefore, the barbell portfolio would be expected to perform best given McLaughlin's interest rate expectations.

4 C is correct. McLaughlin expects interest rate volatility to be high and the yield curve to experience an increase in the butterfly spread, with the 30-year yield remaining unchanged. Given these expectations, a long barbell (2s and 30s, short bullet [10s] butterfly trade would be most appropriate. The two-year yield is expected to slightly increase by 0.04%, resulting in minimal price impact given the relatively low duration of two-year bonds. Similarly, the 30-year yield is expected to remain constant, resulting in minimal price impact as well. The 10-year yield (+0.50%) is expected to increase by more than the 5-year yield (+0.40%), and with its higher effective duration, the 10-year would be appropriate for the short bullet part of the butterfly trade.

5 B is correct. McLaughlin expects interest rate volatility to be high and the yield curve to experience an increase in the butterfly spread, with the 30-year yield remaining unchanged. To increase the portfolio's expected return, Donaldson and McLaughlin should buy call options on long-maturity government bond futures to increase convexity.

6 B is correct. Statement 2 is correct: If yields rise, a portfolio of a given duration with higher convexity will experience less of a price decrease than a similar-duration, lower-convexity portfolio. Statement 1 is incorrect, as portfolios with larger convexities often have lower yields. Investors will be willing to pay for increased convexity when they expect yields to change by more than enough to cover the sacrifice in yield.

7 B is correct. A bullet performs well when the yield curve is expected to steepen. Since Prégent's forecast is for long rates to rise and short rates to fall, this strategy will add value to the French client's portfolio by insulating the portfolio against adverse moves at the long end of the curve. If short rates fall, the bullet portfolio gives up very little in profits given the small magnitude of price changes at the short end of the curve.

8 A is correct. To maintain the effective duration match, the duration of the 10-year bond sale must equal the total weighted duration of the 3-year and long-term bond purchases.

$$\begin{aligned} 9.51 &= (\text{Duration of 3-year bond} \times \text{Weight of 3-year bond}) + (\text{Duration of} \\ &\quad \text{long-term bond} \times \text{Weight of long-term bond}) \\ x &= \text{weight of 3-year bond} \\ (1 - x) &= \text{weight of long-term bond} \\ 9.51 &= 2.88x + 21.30(1 - x) \\ x &= 0.64 \text{ or } 64\% \end{aligned}$$

The proceeds from the sale of the 10-year Canadian government bond should be allocated 64% to the 3-year bond and 36% to the long-term bond:

$$9.51 = (64\% \times 2.88) + (36\% \times 21.30)$$

$$\begin{aligned} \text{Gain in convexity} &= (\text{Weight of the 3-year}) \times (\text{Convexity of the} \\ &\quad \text{3-year}) + (\text{Weight of the long-term bond}) \times (\text{Convexity} \\ &\quad \text{of the long-term bond}) - (\text{Weight of the 10-year}) \times \\ &\quad (\text{Convexity of the 10-year}) \\ \text{Gain in convexity} &= (64\% \times 0.118) + (36\% \times 2.912) - (100\% \times 0.701) = \\ &\quad 0.42284 \text{ or } 0.423 \end{aligned}$$

9 A is correct. Short maturity at- or near-the-money options on long-term bond futures contain a great deal of convexity. Thus, options increase the convexity of the French client's portfolio. Options are added in anticipation of a significant change in rates. If the yield curve remains stable, the portfolio will experience a loss from both the initial purchase price of the options and the foregone interest income on the liquidated bonds.

10 A is correct. The trades are also called a condor and employ four positions, much like a butterfly with an elongated body. Each pair of duration-neutral trades would result in a profit if the yield curve adds curvature. The trades at the short end of the curve (going long the 1-year bond and short the 3-year bond) would profit if that end of the curve gets steeper. In addition, the trades at the long end of the curve (going short the 10-year bond and long the long-term bond) would profit if that end of the curve becomes flatter.

11 C is correct. In order to take duration-neutral positions that will profit from an increase in the curvature of the yield curve, Hirji should structure a condor. This condor structure has the following positions: long the 2-year bonds, short the 5-year bonds, short the 10-year bonds, and long the long-term bonds. Hirji's allocation to the 2-year bond position is calculated as follows:

The C\$150 million long-term bonds have a money duration of C\$150 × 1,960 = C\$294,000

Allocation to 2-year bond = Money duration of long-term bonds/PVBP of 2-year bond

2-year bond position = C\$294,000/197 = 1,492.39 or C\$1,492 million

12 C is correct. Hirji proposes an extreme bullet portfolio focusing on the middle of the yield curve. If the forecast is correct and the yield curve loses curvature, the rates at either end of the curve will rise or the intermediate yields will drop. As a result, bonds at the ends of the yield curve will lose value or the intermediate bonds will increase in value. In either case, the bullet portfolio will outperform relative to a more diverse maturity index portfolio like the benchmark.

13 B is correct. The rolling yield of the two portfolios is calculated as follows:

Return Component	Formula	Bullet Portfolio	Barbell Portfolio
Yield income	Annual coupon payment/Current bond price	1.86/100.00 = 1.86%	1.84/100.00 = 1.84%
+ Rolldown return	(Bond price$_{eh}$ – Bond price$_{bh}$)/Bond price$_{bh}$	(100.38 – 100.00)/100.00 = 0.38%	(100.46 – 100.00)/100.00 = 0.46%
= Rolling yield	Yield income + Rolldown return	= 2.24%	= 2.30%

Difference in Rolling yield = Rolling yield of the bullet portfolio – Rolling yield of the barbell portfolio

2.24% – 2.30% = –0.06% or –6 basis points

14 C is correct. The total expected return is calculated as follows:

Return Component	Formula	Barbell Return (C)	Distractor A	Distractor B
Yield income	Annual coupon payment/ Current bond price	1.84/100.00 = 1.84%	1.84/100.00 = 1.84%	1.84/100.00 = 1.84%
+ Rolldown return	(Bond price$_{eh}$ – Bond price$_{bh}$)/ Bond price$_{bh}$	(100.46 – 100.00)/100.00 = 0.46%	(100.46 – 100.00)/100.00 = 0.46%	(100.46 – 100.00)/100.00 = 0.46%

Return Component	Formula	Barbell Return (C)	Distractor A	Distractor B
= Rolling yield	Yield income + Rolldown return	= 2.30%	= 2.30%	= 2.30%
+ E(change in price based on yield view)	$(-MD_{eh} \times \Delta yield) + [½ \times Convexity \times (\Delta yield)^2]$	$[-4.12 \times -0.55\%] + [½ \times 24.98 \times (-0.55\%)^2]$ = 2.30%	$[-4.12 \times -0.55\%] + [½ \times 24.98 \times (-0.55\%)]$ = −4.60%	$[4.12 \times -0.55\%] + [½ \times 24.98 \times (-0.55\%)^2]$ = −2.23%
= Total expected return		**= 4.60%**	= −2.30%	= 0.07%

15 C is correct. Since Abram expects the curve to remain stable, the yield curve is upward sloping and the Fund's duration is neutral to its benchmark. Her best strategy is to ride the yield curve and enhance return by capturing price appreciation as the bonds shorten in maturity.

16 C is correct. If interest rates rise and the yield curve steepens as Edgarton expects, then shortening the Fund's duration from a neutral position to one that is shorter than the benchmark will improve the portfolio's return relative to the benchmark. This duration management strategy will avoid losses from long-term interest rate increases.

17 B is correct. In a stable yield curve environment, holding bonds with higher convexity negatively affects portfolio performance. These bonds have lower yields than bonds with lower convexity, all else being equal. The 5-year US Treasury has higher convexity than the negative convexity 30-year MBS bond. So, by selling the 5-year Treasury and purchasing the 30-year MBS, Abram will reduce the portfolio's convexity and enhance its yield without violating the duration mandate versus the benchmark.

18 A is correct. Scenario 1 is an extreme barbell and is typically used when the yield curve flattens. In this case, the 30-year bond has larger price gains because of its longer duration and higher convexity relative to other maturities. If the yield curve flattens through rising short-term interest rates, portfolio losses are limited by the lower price sensitivity to the change in yields at the short end of the curve while the benchmark's middle securities will perform poorly.

19 A is correct. To profit from a decrease in yield curve curvature, the correct condor structure will be: short 1s, long 5s, long 10s, and short 30s. The positions of the condor will be: short \$338 million 1-year bond, long \$71 million 5-year bond, long \$38 million 10-year bond, and short \$17 million 30-year bond.

This condor is structured so that it benefits from a decline in curvature, where the middle of the yield curve decreases in yield relative to the short and long ends of the yield curve.

To determine the positions, we take the maximum allowance of 30-year bonds of \$17 million and determine money duration. Money duration is equal to market value x modified duration divided by 100. 30-year bond money duration = \$17 million × 19.69/100 = \$3,347,300. The market values of the other positions are:

1-year bond: \$3,347,300 × 100/0.99 = \$338.11 million or \$338 million

5-year bond: \$3,347,300 × 100/4.74 = \$70.62 million or \$71 million

10-year bond: \$3,347,300 × 100/8.82 = \$37.95 million or \$38 million

20 C is correct. Given Edgarton's expectation for a steepening yield curve, the best strategy is to shorten the portfolio duration by more heavily weighting shorter maturities. Pro Forma Portfolio 2 shows greater partial duration in the 1- and

3-year maturities relative to the current portfolio and the least combined exposure in the 10- and 30-year maturities of the three portfolios. The predicted change is calculated as follows:

Predicted change = Portfolio par amount × partial PVBP × (curve shift in bps)/100

21 B is correct. The total expected return is calculated as:

Total expected return = Yield income + Rolldown return = Rolling yield + E (currency gains or losses).

Return Component	Formula	Buy-and-Hold Portfolio Performance
Yield income	Annual coupon payment/Current bond price	1.40/99.75 = 1.40%
+ Rolldown return	(Bond price$_{\text{end of horizon}}$ – Bond price$_{\text{beginning of horizon}}$) ÷ Bond price$_{\text{beginning of horizon}}$	(100 – 99.75)/99.75 = 0.25%
= Rolling yield	Yield income + Rolldown return	1.40 + 0.25 = 1.65%
+ E (currency gains or losses)	Given	–0.57%
= Total expected return		1.08%

22 B is correct. The implied forward rate can be calculated using the yield to maturity (YTM) of the 2-year Ride-the-Yield Curve and 1-year Buy-and-Hold portfolios.

$F_{1,1} = [(1.018)^2/1.0165] - 1 = 1.95\%$

23 A is correct. Carry trades may or may not involve maturity mis-matches. Intra-market carry trades typically do involve different maturities, but inter-market carry trades frequently do not, especially if the currency is not hedged.

B is incorrect. Carry trades may involve only one yield curve, as is the case for intra-market trades. In addition, if two curves are involved they need not have different slopes provided there is a difference in the level of yields between markets.

C is incorrect. Inter-market carry trades do not, in general, break even if each yield curve goes to its forward rates. *Intra*-market trades *will* break even if the curve goes to the forward rates because, by construction of the forward rates, all points on the curve will earn the "first-period" rate (that is, the rate for the holding period being considered). *Inter*-market trades need not break even unless the "first-period" rate is the same in the two markets. If the currency exposure is not hedged, then breaking even also requires that there be no change in the currency exchange rate.

24 C is correct. Winslow's Statement VI is *incorrect*. Due to covered interest arbitrage, the relative attractiveness of bonds does not depend on the currency into which they are hedged for comparison. Hence, the ranking of bonds does not depend on the base currency of the portfolio.

A is incorrect because Winslow's Statement IV is *correct*. Inter-market trades should be assessed on the basis of returns hedged into a common currency. Doing so ensures that they are comparable. Neither local currency returns nor unhedged returns are comparable across markets because they involve different currency exposures/risks.

B is incorrect because Winslow's Statement V is *correct*. The primary driver of inter-market trades is anticipated changes in yield differentials. Over horizons most relevant for active bond management, the capital gains/losses arising from yield movements generally dominate the income component of return (i.e., carry) and rolling down the curve. Hence, expectations with respect to yield movements are the primary driver of inter-market trade decisions.

25 B is correct. The highest potential return, 0.85%, reflects borrowing USD for 6 months and buying the UK 5-year bond. The carry component of the expected return is actually a *loss* of 0.15% [= (1.10% – 1.40%)/2], but this is more than offset by the 1% expected appreciation of GBP versus USD. A much higher carry component +0.90% = (1.95% – 0.15%)/2 could be obtained by borrowing for 6 months in EUR to buy the US 5-year note, but that advantage would be more than offset by the expected 1% loss from depreciation of the USD (long) against the Euro (short).

A is incorrect because a higher expected return of 0.85% can be obtained. This answer, +0.275% [= (1.95% – 1.40%)/2], is the highest carry available over the next 6 months within the US market itself (an intra-market carry trade).

C is incorrect. This answer (+0.90%) is the highest potential carry component of return but ignores the impact of currency exposure (being long the depreciating USD and short the appreciating Euro).

26 B is correct. In order to be duration-neutral and currency-neutral, the trade must lend long/borrow short in one market and do the opposite (lend short/borrow long), with the same maturities, in another market. The best carry is obtained by lending long/borrowing short on the steepest curve and lending short/borrowing long on the flattest curve. The GBP curve is the steepest and the EUR curve is the flattest. The largest yield spread between these markets is 0.55% at the 3-year maturity, and the narrowest spread is 0.35% at the 6-month maturity. Hence, the best trade is to go long the GBP 3-year/short the EUR 3-year and long the EUR 6-month/short the GBP 6-month. This can be implemented in the swaps market by receiving 3-year fixed/paying 6-month floating in GBP and doing the opposite in EUR (receiving 6-month floating/paying 3-year fixed). The net carry is +0.10% = [(0.95% – 0.50%) + (0.15% – 0.40%)]/2 for six months.

A is incorrect. The FX forward position as stated (pay EUR/receive GBP) corresponds to implicitly borrowing EUR for six months and lending GBP for six months. Correct execution of the trade would require the opposite, receiving EUR and delivering GBP 6 months forward.

C is incorrect. This combination of futures positions does create a duration-neutral, currency neutral carry trade, but it is not the highest available carry. Since the T-note futures price reflects the pricing of the 5-year note as cheapest to deliver, the long position in this contract is equivalent to buying the 5-year Treasury and financing it for 6 months. This generates net carry of 0.275% = (1.95% – 1.40%)/2. Similarly, the short position in the German note futures is equivalent to being short the 5-year German note and lending the proceeds for 6 months, generating net carry of –0.225% = (0.15% – 0.60%)/2. The combined carry is 0.05%, half of what is available on the position in B.

27 B is correct. Winston should buy the Greek 5-year bond for each portfolio. In the US dollar portfolio, she should leave the currency unhedged, accepting the exposure to the Euro, which is projected to appreciate by 1% against the USD. In the UK portfolio, she should hedge the bond's EUR exposure into GBP. In the Euro-based portfolio there is no hedging decision to be made because the Greek bond is denominated in EUR.

Because yields are projected to remain unchanged in the US, UK, Euro, and Greek markets, the 5-year bonds will still be priced at par in six months when they have 4.5 years to maturity. Hence, the local market return for each of these bonds will equal half of the coupon: 0.975%, 0.55%, 0.30%, and 2.85%, respectively. The Mexican 5-year will be priced to yield 7.0% at the end of the period. Its price will be

$$\sum_{t=1}^{9} \frac{7.25/2}{\left(1 + \frac{0.07}{2}\right)^t} + \frac{100}{\left(1 + \frac{0.07}{2}\right)^9} = 100.9501$$

Its local market return is therefore 4.576% = (100.9501 + 7.25/2)/100. By covered interest parity, the cost of hedging a bond into a particular currency is the short-term (six months here) rate for the currency into which the bond is hedged minus the short-term rate for the currency in which the bond is denominated. For hedging US, UK, and Mexican bonds into Euros for six months the calculation is:

USD into EUR: (0.15% – 1.40%)/2 = –0.625%

GBP into EUR: (0.15% –0.50%)/2 = –0.175%

MXN into EUR: (0.15% – 7.10%)/2 = –3.475%

(Note that a negative number is a cost while a positive number would be a benefit.)

Combining these hedging costs with each bond's local market return, the returns hedged into EUR, which can now be validly compared, are:

US: 0.975% + (–0.625%) = 0.350%

UK: 0.550% + (–0.175%) = 0.375%

MX: 4.576% + (–3.475%) = 1.101%

GR: 2.850% + 0 = 2.850%

EU: 0.300% + 0 = 0.300%

The Greek bond is by far the most attractive investment. This would still be true if returns were hedged into USD or GBP. So, the Greek 5-year should be purchased for each portfolio. Whether or not to actually hedge the currency exposure depends on if the cost/benefit of hedging is greater than the projected change in the spot exchange rate. For the dollar-denominated portfolio, hedging the Greek bond into USD would "pick up" 0.625% (the opposite of hedging USD into EUR). But EUR is expected to appreciate by 1.0% against the dollar, so it is better to leave the bond unhedged in the USD-denominated portfolio. Hedging EUR into GBP picks up 0.175% of return. Since EUR is projected to remain unchanged against GBP, it is better (from an expected return perspective) to hedge the Greek bond into GBP.

A is incorrect because it can be seen from the explanation for B above that the Greek 5-year bond is by far the most attractive investment, returning 2.85% compared to the Mexican 5-year bond's return of 1.101%. If the returns for these bonds were hedged into USD or GBP (instead of EUR), in each case the return on the Mexican 5-year bond would still be inferior to that of the Greek 5-year bond.

C is incorrect because it can be seen from the explanation for B above that the Greek 5-year bond is by far the most attractive investment, returning 2.85% compared to the Mexican 5-year bond's return of 1.101%. If the returns for these bonds were hedged into USD or GBP (instead of EUR), in each case the return on the Mexican 5-year bond would still be inferior to that of the Greek

5-year bond. Moreover, over the 6-month investment horizon the Mexican Peso is expected to depreciate against both the GBP and USD, further impairing the unhedged returns on the Mexican 5-year bond in GBP and USD terms.

28 A is correct. As shown in the previous question, the Greek bond is the most attractive. Although the Peso is expected to depreciate by 2% against the EUR and the GBP and by 1% against the USD, this is less than the benefit of hedging EUR into MXN (+3.475%). The net currency component of the expected return is +1.475% = (3.475% – 2.0%) for the EUR and GBP portfolios and +2.475% = (3.475% – 1.0%) for the USD-denominated portfolio. Hedging into GBP would add only 0.175% for any of the portfolios. Hedging into USD would reduce expected return for any of the portfolios because the pick up on the hedge (+0.625%) is less than the expected depreciation (–1.0%) of the USD against the Euro and GBP.

B is incorrect. Hedging the Euro-denominated Greek bond into USD would reduce expected return for any of the portfolios because the pick on the hedge (+0.625%) is less than the expected depreciation of the USD against the Euro and GBP.

C is incorrect. As shown above, the Greek bond is more attractive than the Mexican bond.

29 C is correct. Component (C) is a "shift" in which all yields move in the same direction by similar, though not exactly equal, amounts. The shift is by far the dominant component of yield curve movements. Duration, which assumes shifts are actually parallel, derives its importance as risk measure from this fact. Component (A) is a "twist" in which the ends of the yield curve move in opposite directions while the middle of curve stays roughly unchanged. The twist is the second most important type of yield curve movement. Bond managers focus on barbells versus bullets during twist-induced changes in the slope of the yield curve. Component (B) is a "butterfly" movement in which the ends of the yield curve move in the same direction and the middle of the curve moves in the opposite direction. While meaningful butterflies are less important than twists and much less important than shifts in terms of explaining overall movements of the yield curve. Butterflies are driven in part by changes in yield volatility.

A is incorrect. Component (C) is a "shift," which is by far the most important component of yield curve movements. Component (A) is a "twist," which is more important than Component (B), which is a "butterfly" movement.

B is incorrect. Component (C) is a "shift," which is by far the most important component of yield curve movements. Component (A) is a "twist," which is more important than Component (B), which is a "butterfly" movement.

30 B is correct. A roughly parallel shift in all yields will be generated by a combination of: +1 standard deviation "shift" (component C), +1 standard deviation "twist" (component A), and –1 standard deviation "butterfly" movement (component B). Note that reversing each of these movements would still be an approximately parallel move but in the opposite direction. Taking a positive (+1 sd) move in component C as given, the mostly likely correct combination can be determined by inspection. An upward move in component C increases all yields, but intermediate yields rise the most followed by long maturity yields, and the very short end rises the least. Adding a positive "twist" (+1 sd of component A) will help equalize the movements at the ends of the curve (as short yields rise while long yields fall) but will exacerbate somewhat the larger increase in the middle of the curve. A negative "butterfly" movement (–1 sd of component B) will reduce the intermediate yields and raise the yields at the ends of the curve bringing movements along the whole curve into rough alignment.

A is incorrect. This scenario results in a pronounced "hump" shaped movement because the positive "butterfly" movement (+1 sd of component B) increases intermediate yields and lowers yields at the ends of the yield curve.

C is incorrect. This scenario results in a roughly parallel increase from the intermediate maturities out to 30 years. However, due to the negative "twist" (–1 sd of component A), a curve steepening, there is a much smaller increase at 2 years and sharp decline in yields at the shortest maturity (6 months).

31 C is correct. The impact of each scenario on Winslow's portfolio is simply an equally weighted combination of the impacts given in Exhibit 3.

Scenario A: 0.02 + (–0.053) + (–0.794) = –0.827

Scenario B: 0.02 – (–0.053) + (–0.794) = –0.721

Scenario C: –0.02 + (–0.053) + (–0.794) = –0.867

A is incorrect. Winslow's portfolio is more sensitive to scenario C.

B is incorrect. Winslow's portfolio is more sensitive to each of the other scenarios.

32 B is correct. As mentioned previously, the three yield curve movements are uncorrelated, so the effect of each composite scenario is the sum of the contributions of the individual components. The following tables summarize the effects of all eight composite scenarios.

Shift	Twist	Butterfly
Component C	**Component A**	**Component B**
–0.794%	0.020%	–0.053%

	+ Shift				– Shift			
	+ Twist + Bfly	+ Twist – Bfly	– Twist + Bfly	– Twist – Bfly	+ Twist + Bfly	+ Twist – Bfly	– Twist + Bfly	– Twist – Bfly
Winslow's Portfolio	–0.8270%	–0.7210%	–0.8670%	–0.7610%	0.7610%	0.8670%	0.7210%	0.8270%

The mean for Winslow's portfolio is zero because the returns for the eight composite scenarios sum to zero. To compute the weekly volatility (standard deviation), square and sum the returns, divide by 8, and take the square root. Note that the eight returns are actually four pairs of plus/minus the same number. So, the weekly volatility for Winslow's portfolio is:

$$\sqrt{\frac{\left(2 \times 0.8270^2\right) + \left(2 \times 0.7210^2\right) + \left(2 \times 0.8670^2\right) + \left(2 \times 0.7610^2\right)}{8}} = 0.80\%$$

A is incorrect. This answer results from squaring and summing four of the returns, dividing by 8, then taking the square root. This incorrectly accounts for the effects of only four of the eight composite scenarios.

$$\sqrt{\frac{0.8270^2 + 0.7210^2 + 0.8670^2 + 0.7610^2}{8}} = 0.56\%$$

C is incorrect. This answer results from squaring and summing the returns, dividing by 8, but then failing to take the square root.

$$\frac{\left(2 \times 0.8270^2\right) + \left(2 \times 0.7210^2\right) + \left(2 \times 0.8670^2\right) + \left(2 \times 0.7610^2\right)}{8} = 0.63\%$$

33

Template for Question 33

Determine which alternative portfolio in Exhibit 1 would be *most appropriate* for Zhao, given her yield curve forecast. (circle one)

Alternative 1	Alternative 2

Justification:

- Alternative 2 would be most appropriate.
- A barbell portfolio (Alternative 2) has higher convexity than a bullet portfolio (Alternative 1).
- The higher-convexity barbell portfolio (Alternative 2) will likely outperform the bullet portfolio (Alternative 1) if there is an instantaneous downward parallel shift in the yield curve because of the barbell portfolio's greater sensitivity to the expected decline in yields.

Alternative 2 is a barbell structure, and Alternative 1 is a bullet structure. A barbell portfolio has higher convexity than a bullet portfolio. In an instantaneous downward parallel shift, the higher-convexity barbell portfolio will outperform the bullet portfolio because of the barbell portfolio's greater sensitivity to declining yields. Portfolios with higher convexity are most often characterized by lower yields. Investors will be willing to pay for increased convexity when they expect yields to change by more than enough to cover the give-up in yield.

34

Template for Question 34

Determine which investment would be *most appropriate* for Zhao given her yield curve forecast. (circle one)

Investment 1	Investment 2

Justification:

- Investment 2 is the most appropriate investment choice given Zhao's yield curve forecast.
- Purchasing a near-the-money call option on Treasury bond futures would add convexity and better position the portfolio for the forecasted downward parallel shift in the yield curve.
- Buying an MBS would decrease convexity, which would not be ideal given Zhao's expectation of a downward parallel shift in the yield curve.

In the case of an instantaneous downward parallel shift in the yield curve, a portfolio with added convexity resulting from the purchase of a near-the-money option on Treasury bond futures would increase in value more than a portfolio without the call option. Purchasing an MBS would decrease convexity, which would not be ideal given Zhao's expectation of an instantaneous downward parallel shift in the yield curve.

There would be no significant effect on the portfolio resulting from duration because the durations are closely matched.

35

Template for Question 35

Determine which portfolio in Exhibit 2 will *most likely* have the *best* performance over the next 12 months given Flander's yield curve forecast. (circle one)

Portfolio A	Portfolio B	Portfolio C

Justification:

- Portfolio C will most likely have the best performance given Flander's yield curve forecast.
- Portfolio C should outperform both Portfolio A and Portfolio B if the yield curve steepens, because of Portfolio C's higher partial PVBPs for short- and intermediate-term bonds.

Portfolio C is expected to outperform Portfolio A and Portfolio B if the yield curve steepens, because of Portfolio C's higher partial PVBPs for short- and intermediate-term bonds.

In Flander's forecast for a yield curve steepening, long yields will remain the same, and short and intermediate rates will decline. The long-term bonds will not change in value, because the long-term yield is not expected to change. A decrease in both the short-term and intermediate-term rates, however, will cause price increases in short-term and intermediate-term bonds. Because Portfolio C has the highest partial PVBPs in both short-term and intermediate-term bonds, Portfolio C would have the best performance in this yield curve scenario.

Portfolios A and B would be expected to underperform Portfolio C if the yield curve steepens. Portfolios A and B have lower partial PVBPs for both short-term and intermediate-term bonds than Portfolio C.

36

Template for Question 36

Calculate the total expected return for the bullet and barbell portfolios presented in Exhibit 3. Show your calculations.

		Portfolio Performance	
Return Component	**Formula**	**Bullet**	**Barbell**
Yield income	Annual Coupon Payment ÷ Current Bond Price The bullet and barbell portfolios contain only zero-coupon bonds, so there is no yield income.	0	0
+ Rolldown return		(99.75 – 98.00)/98.00 = 1.7857%	(100.00 – 98.00)/98.00 = 2.0408%
= Rolling yield	Yield Income + Rolldown Return	0 + 1.7857% = 1.7857%	0 + 2.0408% = 2.0408%
+ E(Change in price based on yield view)		[–3.95 × (–0.60%)] + [½ × 19.5 × $(–0.60\%)^2$] = 2.4051%	[–3.95 ×(–0.60%)] + [½ × 34 × $(–0.60\%)^2$] = 2.4312%
= Total expected return		4.1908%	4.4720%

Identify the component factor that contributes most to the overperformance of the higher performing portfolio.

- The barbell portfolio outperforms the bullet portfolio by approximately 28 bps.
- Rolldown return contributes the majority of barbell outperformance (approximately 25.5 bps of outperformance), likely resulting from strong price appreciation of longer-maturity zeros.
- The greater convexity of the barbell portfolio contributed a small amount (approximately 2.6 bps) of outperformance.

Rolldown return is the component factor that contributes most of the approximately 28-bp outperformance of the barbell portfolio compared with the bullet portfolio. The bullet and barbell portfolios contain only zero-coupon bonds, so the yield income is zero. Rolldown return (and rolling yield) contributed approximately 25.5 bps of outperformance (i.e., 2.0408% – 1.7857%), and the greater convexity of the barbell portfolio contributed just over 2.6 bps of outperformance (i.e., 2.4312% – 2.4051%).

The strong rolldown contribution is likely driven by the stronger price appreciation (under the stable yield curve assumption) of longer-maturity zeros in the barbell portfolio relative to the price appreciation of the intermediate zeros in the bullet portfolio as the bonds ride the curve over the one-year horizon to a shorter maturity. In this particular case, rolling yield and rolldown return are equal, because yield income is zero.

READING

21

Fixed-Income Active Management: Credit Strategies

by Campe Goodman, CFA, and Oleg Melentyev, CFA

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

LEARNING OUTCOMES

Mastery	The candidate should be able to:
☐	**a.** describe risk considerations in investment-grade and high-yield corporate bond portfolios;
☐	**b.** compare the use of credit spread measures in portfolio construction;
☐	**c.** discuss bottom-up approaches to credit strategies;
☐	**d.** discuss top-down approaches to credit strategies;
☐	**e.** discuss liquidity risk in credit markets and how liquidity risk can be managed in a credit portfolio;
☐	**f.** describe how to assess and manage tail risk in credit portfolios;
☐	**g.** discuss considerations in constructing and managing portfolios across international credit markets;
☐	**h.** describe the use of structured financial instruments as an alternative to corporate bonds in credit portfolios.

1 INTRODUCTION

This reading covers strategies used in the construction and management of credit portfolios. A credit portfolio consists primarily of securities for which credit risk is an important consideration. The credit market is the component of the fixed-income market that includes both publicly traded debt securities (such as corporate bonds, sovereign and non-sovereign government bonds, supranational bonds, and commercial paper) and non-publicly traded instruments (such as loans and privately placed securities). The credit market also includes structured financial instruments—such as mortgage-backed securities, asset-backed securities, and collateralized debt obligations—that may be traded publicly or non-publicly.

Corporate bonds are the largest portion of the credit market. Section 2 compares investment-grade and high-yield corporate bonds and highlights implications of differences in these bonds for portfolio construction and management. Section 3 describes basic measures used to evaluate credit securities, including credit spread measures and excess returns from credit securities. Section 4 discusses two main approaches to credit strategy—bottom-up and top-down—used in constructing and managing credit portfolios. Section 5 discusses examines how to manage two important non-credit risks—liquidity risk and tail risk—in credit portfolios.

When managing international credit portfolios, portfolio managers need to consider various global implications. Section 6 discusses issues and risks that are particularly relevant for international credit portfolios. In addition to corporate bonds, credit investors may consider structured financial instruments such as mortgage-backed securities, asset-backed securities, collateralized debt obligations, and covered bonds. Section 7 covers the use of structured financial instruments in credit portfolios. The final section summarizes the reading.

2 INVESTMENT-GRADE AND HIGH-YIELD CORPORATE BOND PORTFOLIOS

More than half of the global credit market, represented by the Bloomberg Barclays Global Aggregate Index, consists of corporate bonds. As of 31 December 2015, the amount of corporate debt outstanding was almost US$7.4 trillion, or about 54% of the global credit universe.[1]

Corporate bond investors draw an important distinction between investment grade and high yield. *Investment-grade corporate bonds* have higher credit ratings than high-yield corporate bonds, and they typically have lower credit and default risk as well as lower yields. *High-yield corporate bonds* have lower, speculative-grade credit ratings, higher credit and default risk, and higher yields compared with investment-grade corporate bonds.[2]

In this reading, we reference credit ratings to distinguish between investment-grade and high-yield bonds. In practice, credit portfolio managers and analysts do not rely exclusively on ratings issued by the credit rating agencies when evaluating the creditworthiness of bond issuers. Rather, they typically conduct their own analysis and make independent assessments of the creditworthiness of issuers. Portfolio managers and analysts may consider the "four Cs" of credit analysis—capacity, collateral, covenants, and character—or the extended "five Cs," which includes capital, and use credit models to evaluate credit worthiness. In doing so, portfolio managers and analysts may use a ratings methodology similar to that of the rating agencies.

When assessing the suitability of bonds for their portfolios, credit portfolio managers must sometimes invest within certain ratings categories. For example, a portfolio manager's investment guidelines may prohibit investing in debt rated below investment grade by one or more of the credit rating agencies.

1 The global corporate debt universe is represented here by the Bloomberg Barclays Global Corporate Index, and the global credit universe is represented by the Bloomberg Barclays Global Aggregate Index.

2 In this reading, "investment-grade bonds" and "high-yield bonds" both refer to corporate bonds unless indicated otherwise. "High yield" is the term most commonly used by investors in this asset class. Credit rating agencies often refer to high yield as "speculative grade," and this reading occasionally uses this term. Moody's Investors Service defines bonds rated from Aaa to Baa3 as investment grade and bonds rated below Baa3 as speculative grade. Both Standard & Poor's and Fitch Ratings define bonds rated from AAA to BBB– as investment grade and bonds rated below BBB1 as speculative grade. The financial press often uses the term "junk bonds."

2.1 Credit Risk

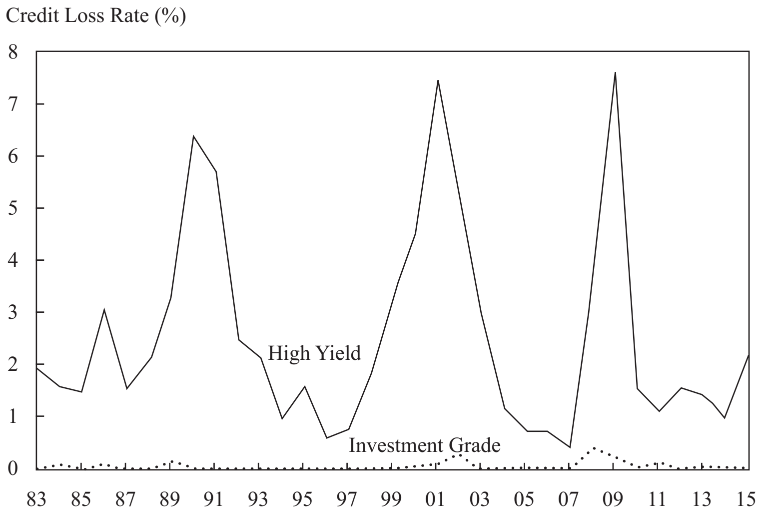
Credit risk is the risk of loss caused by a counterparty's or debtor's failure to make a promised payment. Credit risk has two components: (1) **default risk**, which is the probability that a borrower defaults or fails to meet its obligation to make full and timely payments of principal and interest, according to the terms of the debt security; and (2) **loss severity** (also called **loss given default**), which is the amount of loss if a default occurs.

Although investment-grade and high-yield bonds are defined primarily by their credit risk, in practice they differ in other ways, including their sensitivity to interest rate changes. Differences in credit and default risk, in interest rate sensitivity, and in liquidity have implications for credit portfolio construction.

Credit and default risk and credit loss rates are historically much lower for investment-grade bonds than for high-yield bonds. A *credit loss rate* represents the percentage of par value lost to default for a group of bonds. The credit loss rate is equal to the bonds' default rate multiplied by the loss severity. Because loss severity can be no more than 100%, the credit loss rate is less than or equal to the default rate.

Exhibit 1 shows annual credit loss rates from 1983 through 2015 for all corporate bonds rated by Moody's Investors Service. During this period, the largest credit loss rate for investment-grade bonds is 0.42%, and the average loss rate is only 0.06%. For high-yield bonds, the average credit loss rate is 2.55%, and there are multiple years, usually around economic recessions, in which default losses exceed 5%.

Exhibit 1 Annual Credit Loss Rates for Corporate Bonds, 1983–2015*



	Investment Grade	High Yield
Average	0.06%	2.55%
Standard deviation	0.10%	1.96%
Maximum	0.42%	7.61%
Minimum	0.00%	0.42%

* Based on issuer-weighted average default rates and issuer-weighted senior unsecured bond recovery rates.
Source: Moody's Investors Service.

As Exhibit 1 makes clear, the credit loss rate on high-yield bonds is substantially higher—on average more than 40 times larger—*and* more variable than on investment-grade bonds.

The higher credit loss rate means that credit risk is usually the most important consideration for high-yield portfolio managers. In contrast, for investment-grade portfolio managers, other risks inherent in corporate bonds—credit migration (or credit downgrade) risk, spread risk, and in particular, interest rate risk—are typically the most relevant considerations.

2.2 Credit Migration Risk and Spread Risk

Although credit losses on investment-grade bonds are small compared with high-yield bonds, credit risk is still an important driver of investment-grade bond returns. Investment-grade bonds can experience deterioration in their credit quality—called *credit migration risk*—and as they become riskier, their credit spreads typically widen (or increase). In addition, if a company's bonds are downgraded to below investment grade by one or more of the credit rating agencies, portfolio managers owning these bonds may be forced to sell them if their portfolios are not permitted to hold high-yield bonds. Forced sales can result in losses to a portfolio.

Because credit spread volatility—as opposed to outright credit default loss—is more relevant for investment-grade bonds, the risk in a portfolio of investment-grade bonds is typically measured in terms of **spread duration**.

Spread duration is a useful measure for determining a portfolio's sensitivity to changes in credit spreads. Duration indicates the percentage price effect of an interest rate change on a bond, and spread duration measures the effect of a change in *spread* on a bond's price. Spread duration provides the approximate percentage *increase* in bond price expected for a 1% *decrease* in credit spread (or vice versa).

For example, about two weeks after it was issued in May 2016, a bond issued by the Australian bank Westpac with a coupon of 2.10% and a maturity date of 13 May 2021 had both a modified duration and spread duration of approximately 4.70 years. The bond trades at a price of 99.60, which equates to a credit spread of 0.80%, or 80 bps. If this bond's credit spread decreases (narrows) by 20 bps, to 60 bps, and interest rates are unchanged, then its price will increase to approximately $100.54 = 99.60 \times \{1 + [-4.70 \times (0.0060 - 0.0080)]\}$.

For non-callable, fixed-rate corporate bonds, spread duration is generally very close to modified duration. In other words, interest rate changes and spread changes have almost identical effects on non-callable, fixed-rate corporate bonds. For floating-rate bonds (also called floaters) and some other types of bonds, however, the spread duration can differ substantially from the modified duration.

For example, Westpac also has a floater maturing on the same date as the fixed-rate bond, 13 May 2021. This bond also has a spread duration of 4.70 years, but its modified duration is only 0.21. The floater trades at a price of 100.55 with a credit spread of 88 bps. If its credit spread narrows by 20 bps, as in the above example, then its price increases to approximately $101.50 = 100.55 \times [1 + (-4.70 \times -0.0020)]$. The price increases by a percentage similar to the percentage price increase on the fixed-rate bond.

If, however, *interest rates* decrease by 20 bps (and spreads remain unchanged), then the floater's price increases to only $100.59 = 100.55 \times [1 + (-0.21 \times -0.0020)]$. The floater experiences almost no price change as a result of the change in interest rates because of the bond's short modified duration. In contrast, because its modified duration is equal to its spread duration, the Westpac 2.10% fixed-rate bond experiences an identical price change if interest rates decrease by 20 bps or if the credit spread narrows by 20 bps.

This example illustrates that the spread risk in an investment-grade portfolio consisting of floating-rate bonds should be measured by spread duration, not modified duration.

The much higher credit loss rate experienced on high-yield bonds compared with investment-grade bonds results in an emphasis on credit risk and market value of the position to evaluate high-yield risk. The reason for the emphasis on a position's market value is that all bonds with the same seniority ranking in an issuer's capital structure will typically be treated equally in the event of default—and therefore all experience the same loss severity—regardless of their maturity or spread duration. Consequently, in the event of default, an investor likely cares only about the *size* of her position rather than its spread duration. Given identical seniority and the same issuer, a €1,000,000 position with low spread duration will experience the same loss as a €1,000,000 position with much longer spread duration.

It is prudent for investment-grade and high-yield credit portfolio managers to be aware of both spread risk and default risk, as well as to understand both market value–based and spread duration–based risk measures. Investment-grade bonds do occasionally experience defaults, so large concentrated positions in these bonds can be imprudent. As an extreme example, consider a portfolio that holds only one investment-grade bond. Such a portfolio has binary exposure to default risk: Either it will experience no default loss or, if its single holding does default, it will experience a loss much larger than most investors would expect from a typical investment-grade bond portfolio. Also note that high-yield bonds, as with investment-grade bonds, do experience meaningful spread changes even in the absence of default. Therefore, high-yield portfolio managers should still be aware of their portfolios' spread durations.

2.3 Interest Rate Risk

High-yield portfolios usually have greater exposure to credit risk than investment-grade portfolios do, but investment-grade portfolios have more exposure to interest rate risk than high-yield portfolios. To understand why exposure to interest rate risk is greater in investment-grade portfolios, we revisit the concept of duration.

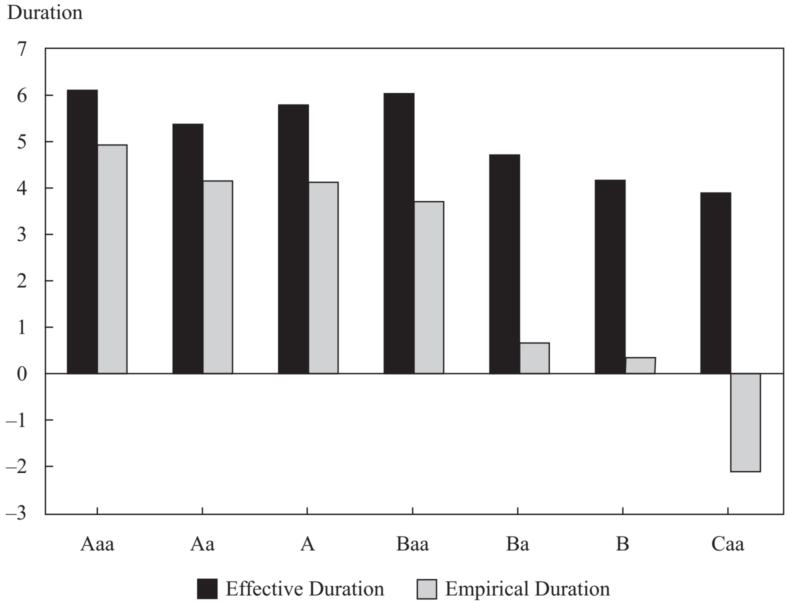
In theory, a change in interest rates has the same effect on a risk-free bond (a bond assumed to have no default risk) as it does on a risky bond. A bond's yield can be viewed as a default risk-free interest rate plus a spread. The spread is equal (or close) to zero for a riskless security and typically positive for a security with credit risk. A change in the risk-free rate has no theoretical effect on spread, so all else being equal, changes in risk-free rates should have exactly the same effects on the yields of both risk-free and risky bonds.

In practice, however, credit spreads tend to be negatively correlated with risk-free interest rates. One important reason for this phenomenon is that key macro factors, such as economic growth, default rates, and monetary policy, usually have opposite effects on risk-free rates and spreads. For example, a better economic environment generally leads to *higher* risk-free rates and *narrower* credit spreads, whereas a weaker economic environment generally results in *lower* risk-free rates and *wider* credit spreads. As a result of the typically negative correlation between risk-free rates and credit spreads, changes in risk-free rates tend to generate smaller changes in corporate bond yields than theoretical measures of duration suggest. This reduced effect is even more pronounced for securities with high credit risk and large credit spreads—that is, bonds with comparatively large credit spreads have less sensitivity to interest rate changes than bonds with smaller credit spreads. As a result, the price behavior of bonds with high credit risk often more closely resembles that of equities rather than fixed income.

Empirical duration is a measure of interest rate sensitivity that is determined from market data. A common way to calculate a bond's empirical duration is to run a regression of its price returns on changes in a benchmark interest rate. For example, the price returns of a 10-year euro-denominated corporate bond could be regressed on changes in the 10-year German bund or the 10-year Euribor swap rate.

Exhibit 2 shows two measures of interest rate sensitivity, effective duration and empirical duration, for US corporate bonds across the Moody's credit rating spectrum.[3] The investment-grade bonds are those rated Baa and above.[4] For all credit ratings, empirical duration is smaller than the theoretically based effective duration. The difference between effective and empirical duration is largest for the high-yield categories (bonds rated Ba, B, and Caa). Notably, Ba rated and B rated bonds have almost no empirical sensitivity to interest rate changes, and Caa rated bonds actually have *negative* empirical durations. This finding indicates that when risk-free interest rates fall (or rise), credit spreads on Caa rated bonds rise (or fall) by *more* than the magnitude of the change in interest rates.

Exhibit 2 Effective Duration and Empirical Duration by Rating Category



Source: Barclays Capital and Wellington Management.

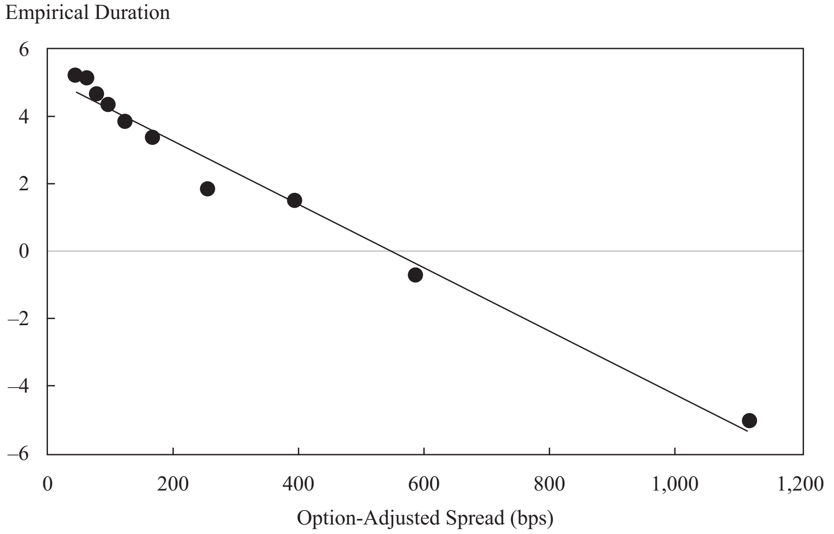
Because investment-grade corporate bonds have meaningful interest rate sensitivity, investment-grade portfolio managers usually manage their portfolio durations and yield curve exposures closely. In contrast, high-yield portfolio managers are less likely to focus on interest rate and yield curve dynamics but rather focus on credit risk. It is important for high-yield investors to keep in mind, however, that when default losses are low and credit spreads are relatively tight, high-yield bonds tend to behave more like investment-grade bonds—that is, with greater interest rate sensitivity.

3 Effective duration for each rating category represents the average of Bloomberg Barclays' month-end values of "modified adjusted duration" from August 1997 through February 2016. Empirical duration for each rating category represents the regression of Bloomberg Barclays' monthly returns on changes in the US 10-year Treasury yield based on month-end data for the same period.

4 Technically, Baa3 is Moody's lowest investment-grade rating. Because of data availability, this exhibit uses broad rating categories.

Exhibit 3 shows the relationship between option-adjusted spread (OAS) levels and empirical duration derived from regression results of 20 years of US corporate bond data. A widely used measure of credit spread, OAS is discussed in more detail later in this reading. The exhibit demonstrates that corporate bonds with low credit spreads tend to have greater empirical duration. This relationship between credit spreads and empirical duration is consistent with the relationship between credit ratings and empirical duration previously seen in Exhibit 2. Highly rated bonds, which typically have lower credit spreads, have greater empirical duration.

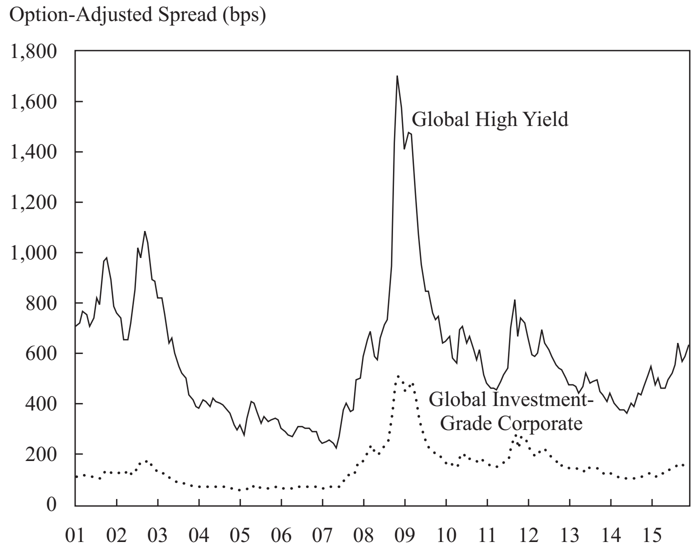
Exhibit 3 Empirical Duration versus OAS



Source: Barclays Capital and Wellington Management.

Exhibit 4 shows the OAS of global investment-grade and high-yield bonds from 2001 through 2015, using the Bloomberg Barclays Global Aggregate–Corporate and Bloomberg Barclays Global High Yield indexes as representatives of these sectors.

Exhibit 4 History of OAS for Global Corporate Bonds, 2001–2015



Source: Barclays Capital.

As Exhibit 4 shows, since 2001 the average credit spread on investment-grade bonds has typically been below 200 bps and exceeded 400 bps only during the 2008–2009 global financial crisis. Individual investment-grade bonds may trade at spreads significantly wider than the average, but investment-grade bond spreads overall are almost always well below 400 bps.

Exhibit 4 also illustrates the earlier point that high-yield bonds, on average, have much wider spreads and greater volatility than investment-grade bonds. It is interesting to note that the average credit spread on the high-yield index was at or below 400 bps for the four years before the 2008–2009 global financial crisis. The low average credit spread of the four years reflected a strong economic environment that resulted in lower perceived risk among bond investors. During periods when spreads in the high-yield market approach those in the investment-grade market, high-yield investors ignore interest rate risk at their peril.

All investors in credit markets should remember that the observed relationships between interest rates and credit spreads are, by definition, *empirically* derived and not theoretical truths. During some periods, credit spreads have been positively correlated with interest rates. For example, on 22 May 2013, the Federal Reserve announced that it would begin to reduce its mortgage and Treasury bond purchase programs. This announcement began a period (often called the "Taper Tantrum") lasting about one month in which interest rates rose and credit spreads widened substantially. During this period, many credit securities exhibited empirical durations that were in *excess* of their theoretical durations.

2.4 Liquidity and Trading

Liquidity is defined as the ability to purchase or sell an asset quickly and easily at a price close to fair market value. The bid–ask (or bid–offer) spread is a frequently referenced measure of liquidity in the bond market. A smaller bid–ask spread indicates greater liquidity. An individual bond's liquidity tends to be positively correlated with both the bond's issue size and the size of the market in which the bond is traded. The investment-grade market is larger than the high-yield market, and the average investment-grade issue size is larger than the average high-yield issue size. These two characteristics are important factors that help to explain why investment-grade issues are, on average, more liquid than high-yield issues.

Bond dealers are another factor in bond market liquidity. Liquidity tends to be positively correlated with inventory size: Bonds that are held in larger size in dealers' inventories are usually more liquid. For both regulatory and risk management reasons, dealers tend to hold larger inventories of bonds that are less volatile and that have higher credit ratings. As a result, dealers generally hold smaller inventories of high-yield bonds than of investment-grade bonds. This situation contributes to the relative illiquidity of high-yield bonds compared with investment-grade bonds.

The differences in liquidity between high yield and investment grade have implications for portfolio management. Bid–offer spreads are larger for high-yield bonds than for investment-grade bonds of similar maturity, and consequently turnover in high-yield bond portfolios is more costly than in investment-grade portfolios. Credit securities are traded mainly in over-the-counter markets, and it is typically challenging to buy and sell many outstanding bonds, even if they are constituents of major bond indexes. These transaction difficulties are particularly pronounced in the high-yield market: Many high-yield bonds do not trade frequently at all and can be very difficult to buy or sell. A high-yield portfolio manager who funds a new high-yield portfolio may not be able to buy the same bonds that are held in other portfolios and may need to locate substitutes. This lack of bond availability also arises at times in the investment-grade market, particularly in longer-term bonds.

How bonds are quoted differs between the investment-grade and high-yield markets. Investment-grade bonds are usually quoted as spreads over benchmark government bonds. This quoting convention essentially shows investment-grade bonds as risk-free bonds with credit spreads. High-yield bonds, which tend to behave more like equities than investment-grade bonds, are usually quoted in price terms. These different quoting practices reflect the relative sensitivity of investment-grade bonds to spread changes, as well as the relative importance of default losses for high-yield bonds.

EXAMPLE 1

Investment-Grade and High-Yield Bond Portfolios

Compared with an investment-grade bond portfolio manager, a high-yield bond portfolio manager will *most likely* put greater emphasis on:

A credit risk.

B spread risk.

C interest rate risk.

Solution:

A is correct. Credit risk is usually the most important consideration for high-yield portfolio managers because of the higher credit risk and credit loss rate in high-yield portfolios compared with investment-grade portfolios. For investment-grade portfolio managers, interest rate, spread, and credit migration (downgrade) risks are typically the most relevant considerations.

3 CREDIT SPREADS

In constructing credit portfolios, portfolio managers are often interested in separating their analysis of interest rate risk from their analysis of other risks such as credit spread risk, credit migration risk, default risk, and liquidity risk. These other risks are referred to as credit-related risks. In particular, portfolio managers find it useful to compare the portion of return and risk associated with assuming credit-related risks. This section focuses on credit spreads, including a discussion of some key measures of credit spread and a discussion of excess returns, which are the returns resulting from assuming credit-related risks.

3.1 Credit Spread Measures

Credit spread is perhaps the single most important measure that investors use in credit security selection. Credit spread measures provide a quick way to judge the return compensation that an investor will receive for assuming credit-related risks. As a key input in the selection and pricing of securities, a bond's credit spread is a function of several factors, including its likelihood of default, its probable loss given default, its credit migration risk, and its market liquidity risk. Credit spread measures also play an important role in the construction of credit portfolios and in investors' expectations of portfolio risk and return.

3.1.1 *Benchmark Spread and G-Spread*

A simple way to calculate a credit spread is to subtract the yield on a security with little or no credit risk (benchmark bond) from the yield on a credit security with a similar duration. This measure is called the **benchmark spread**. Typically, the benchmark bond is an on-the-run government bond. An on-the-run bond is defined as the most recently issued benchmark-size security of a particular maturity.[5]

A problem with benchmark spread is the potential maturity mismatch between the credit security and the benchmark bond. Unless the benchmark yield curve is perfectly flat, using different benchmark bonds will produce different measures of credit spread.

The G-spread is often used when the benchmark bond is a government bond. **G-spread** is the spread over an actual or interpolated government bond. When no government bond exists that has the same maturity as the credit security, a linear interpolation of the yields on two on-the-run government bonds is used as the benchmark rate. The yields of the two government bonds are usually weighted so that their weighted average maturity matches the credit security's maturity. Simplicity is a key advantage of the G-spread: It is easy to calculate and understand, and different investors usually calculate it the same way.

From a portfolio construction perspective, the G-spread is useful because the calculation indicates a way to hedge the credit securities' interest rate risk. An investor can hedge the interest rate risk of a credit security by selling the duration-weighted amounts of the two benchmark government bonds out of his portfolio (or by selling them short if they are not owned).

The G-spread is also useful for estimating yield and price changes for fixed-rate credit securities that do not have optionality. This feature is helpful because, as mentioned previously, many credit securities trade infrequently and lack regularly posted prices. For small changes in interest rates, the G-spread provides a good estimate of the likely yield change in a credit security. A change in the yield(s) of the benchmark

5 The issue size that an investor deems "benchmark size" varies by market and changes over time, and it may even differ among investors.

government bonds changes the interpolated yield. The change in the interpolated yield is assumed to represent the change in the yield on the credit security. The assumed change in the yield based on changes in the interpolated yield and the duration of the credit security can be used to estimate the credit security's new price.

EXAMPLE 2

Using G-Spread to Calculate Interest Rate Hedges and Price Changes

On 31 March 2016, a portfolio manager gathers information for the following bonds:

1 Citigroup 3.75% due 16 June 2024
2 US Treasury 1.5% due 31 March 2023 (on-the-run 7-year Treasury note)
3 US Treasury 1.625% due 15 February 2026 (on-the-run 10-year Treasury note)

Price, yield, and effective duration measures for the three bonds are as follows:

	Price	Yield	Maturity	Effective Duration
Citigroup 3.75% due 16 June 2024	103.64	3.24%	7.96	7.0
US Treasury 1.5% due 31 March 2023	99.80	1.53%	7.00	6.7
US Treasury 1.625% due 15 February 2026	98.70	1.77%	9.88	9.1

Later, the portfolio manager observes that the 7-year Treasury note's yield has fallen from 1.53% to 1.43% while the 10-year Treasury note yield remains unchanged.

1 What is the new yield on the Citigroup bond, assuming its spread remains unchanged?
2 Based on the interest rate changes, what is the new price of the Citigroup bond?

Solution to 1:

Assuming yield spreads are unchanged, the yield of the Citigroup bond is now 3.17%. First, calculate the G-spread on the Citigroup bond.

A weighting of 66.7% of the 7-year Treasury note and 33.3% of the 10-year Treasury note matches the 7.96-year maturity of the Citigroup bond:

$(9.88 - 7.96) \div (9.88 - 7.00) = 66.7\%$

$(55.7\% \times 7.00) + (33.3\% \times 9.88) = 7.96$

Therefore, the linearly interpolated yield on the 7.96-year benchmark maturity is 1.61%:

$(66.7\% \times 1.53) + (33.3\% \times 1.77) = 1.61\%$

and the G-spread on the Citigroup bond is 163 bps (the difference between its yield and the interpolated yield): 3.24% – 1.61% = 1.63%.

Next, find the new yield on the interpolated Treasury after the interest rate change:

$(66.7\% \times 1.43) + (33.3\% \times 1.77) = 1.54\%$

The interpolated Treasury yield has fallen by 7 bps from 1.61% to 1.54%. Add the G-spread of 163 bps to the interpolated Treasury yield to arrive at a new yield for the Citigroup bond of 3.17%. 1.54% + 1.63% = 3.17%

Solution to 2:

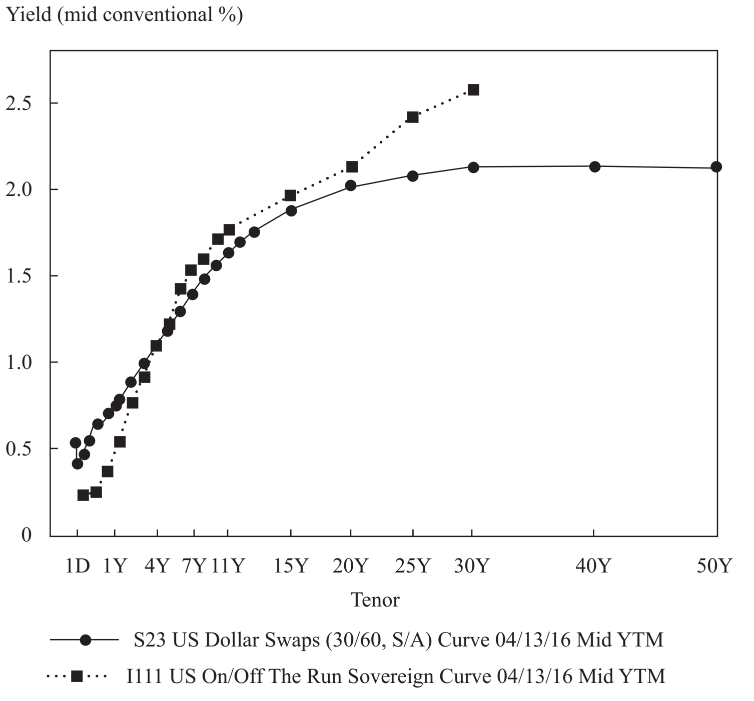
The new price on the Citigroup bond can be estimated based on its yield change and its duration. The price has risen from 103.64 to 104.15 = 103.64 × [1 + (7 × 0.07%)], representing an absolute increase of 0.51 or a percentage increase of 0.49%.

3.1.2 *I-Spread*

The **I-spread**, or interpolated spread, is a measure that is conceptually very similar to the G-spread. Instead of using yields on government bonds as benchmark rates, the I-spread normally uses swap rates that are denominated in the same currency as the credit security.

For a credit investor, a key advantage of using swap rates over yields on government bonds is that swap curves may be "smoother" (less disjointed) than government bond yield curves. Government bond yield curves are sometimes affected by supply and demand for specific government bonds, especially on-the-run issues. Exhibit 5 shows the relative smoothness in the US dollar swap curve (solid line), which is based on Libor, compared with the US Treasury yield curve (dotted line) on 13 April 2016.

Exhibit 5 US Treasury and Swap Yield Curves on 13 April 2016



Source: Bloomberg

Credit investors should keep two points in mind when evaluating the G-spread and the I-spread. First, a benchmark rate is usually most helpful when it represents a credit risk-free rate. If the market perceives credit risk in either a country's government bonds or its banks, then yields on government bonds or interbank rates do not necessarily provide a good representation of the risk-free rate.

Second, credit investors sometimes hedge interest rate exposure using benchmark bonds. If an investor calculates a bond's I-spread but uses government bonds to hedge his exposure, then his realized spread will likely differ from his calculated spread. For an investor who is hedging interest rate exposure, the choice of hedging instrument should correspond to the choice of spread measure used.

3.1.3 *Z-Spread and Option-Adjusted Spread*

Benchmark spread, the G-spread, and the I-spread are particularly useful for pricing and hedging credit securities, but investors generally use two other measures—Z-spread and option-adjusted spread—when they want to compare relative value across credit securities.

The **Z-spread**, or zero-volatility spread, is the yield spread that must be added to each point of the implied spot yield curve to make the present value of a bond's cash flows equal its current market price. For bonds without embedded options, such as non-callable fixed-rate bonds, the Z-spread is a good measure of the bond's credit spread.

The **option-adjusted spread** (OAS) is a more generalized version of the Z-spread. The OAS is the constant spread that, when added to all the one-period forward rates on the interest rate tree, makes the arbitrage-free value of the bond equal to its market price. For credit portfolio managers, OAS provides the spread measure that is most useful for comparing bonds with different features, such as embedded options.

The main shortcoming of OAS is that it depends on assumptions regarding future interest rate volatility. Also, a bond with an embedded option is unlikely to realize the spread implied by the bond's OAS; the realized spread will either be more or less than the OAS, depending on whether the option is actually exercised. For these reasons, OAS is a rather theoretical measure of credit spread. Despite these shortcomings, OAS is the most widely accepted measure of credit spread for comparing bonds with optionality and other features that generate uncertainty in the bonds' cash flows.

EXAMPLE 3

Using Credit Spread Measures

The Charter Communications 5.75% bond issue due 15 January 2024 has the following call schedule:

Callable on or after	At a Price of
15 July 2018	102.875
15 July 2019	101.917
15 July 2020	100.958
15 July 2021	100

On 11 April 2016, the bond issue is trading at a price of 104. Spread measures are as follows:

G-Spread	367
I-Spread	369
Z-Spread	371
OAS	297

Based on the information given, explain why the OAS differs from the other spreads, what the difference in spread implies, and why OAS is the best measure of relative value for the Charter Communications bond.

Solution:

Because the bond is trading significantly above the price at which it can be called, the probability of the bond being called on the next call date is reasonably high. A call option on a bond is effectively "sold" by the investor to the issuer. The issuer is likely to exercise the option only when the exercise is favorable for the issuer.

The bond's OAS of 297 bps is lower than its G-spread, I-spread, or Z-spread because of the call option on the bond. The difference between the OAS and the other spread measures implies that the value of the call option is about 70 bps.

The option-adjusted spread is the best measure of the value of the Charter Communications bond compared with the other spread measures because it reflects the value of the embedded option.

3.1.4 *Credit Spread Measures in a Portfolio Context*

Credit spread measures can also be considered in a portfolio context. Most diversified portfolios include bullet bonds (entire payment of principal occurs at maturity) and bonds with embedded options. It is challenging to apply the G-spread, I-spread, or Z-spread to a diversified portfolio of credit securities because none of these spread measures reflects optionality in relevant bonds. The most appropriate measure for a portfolio-level spread is the OAS. To calculate a portfolio OAS, each bond's OAS is weighted by its market value.

EXAMPLE 4

OAS of a Portfolio

A portfolio consists of investments in two bond issues, Bond A and Bond B. The following table shows relevant information on the bonds in this portfolio. Calculate the portfolio's OAS.

	Face Value (US$)	Price[a]	Accrued Interest[a]	OAS (bps)
Bond A	1 billion	95	1.5	125
Bond B	2 billion	97	2.0	150

[a] Price and accrued interest are per 100 of par value.

Solution:

$$\begin{aligned}
\text{Market value of investment in Bond A} &= \$1 \text{ billion} \times (0.95 + 0.015) \\
&= \$965 \text{ million} \\
\text{Market value of investment in Bond B} &= \$2 \text{ billion} \times (0.97 + 0.02) \\
&= \$1.980 \text{ billion} \\
\text{Portfolio market value} &= \$965 \text{ million} + \$1.98 \text{ billion} \\
&= \$2.945 \text{ billion} \\
\text{Portfolio weight for Bond A} &= \$965 \text{ million}/\$2.945 \text{ billion} \\
&= 32.8\% \\
\text{Portfolio weight for Bond B} &= \$1.980 \text{ billion}/\$2.945 \text{ billion} \\
&= 67.2\%
\end{aligned}$$

$$\text{OAS of portfolio} = (0.328 \times 125 \text{ bps}) + (0.672 \times 150 \text{ bps}) \approx 142 \text{ bps}$$

3.2 Excess Return

Credit investors often choose to evaluate and manage interest rate risk and credit-related risks separately. In addition to the credit spread measures discussed earlier, a useful tool for evaluating and managing credit-related risks is excess return. In the context of credit securities, excess return is the return of a bond after interest rate risk has been hedged.

Excess return can be thought of as the compensation that a bond investor receives for assuming credit-related risks. That is, excess return is the additional return that an investor receives for purchasing a credit security instead of a security with similar interest-rate sensitivity but with no credit risk.

When credit portfolio managers use excess return as a tool for security selection and portfolio construction, they typically manage the interest rate risk of their portfolios separately from their credit-related risks. This separation occurs because excess return does not, by definition, account for the return or risk from interest rate changes.

A bond's credit spread is related to its expected excess return. Credit spread is equal to excess return if there is no change in the security's yield or in interest rates, and if the security does not default during the holding period. Changes in credit spreads, however, usually cause a bond's excess returns to deviate from its spread.

Equation 1 approximates the excess return on a credit security:

$$\text{XR} \approx (s \times t) - (\Delta s \times \text{SD}) \quad (1)$$

where XR is the holding-period excess return, s is the spread at the beginning of the holding period, t is the holding period expressed in fractions of a year, Δs is the change in the credit spread during the holding period, and SD is the spread duration of the bond.

Equation 1 assumes no default losses. Default is a binary event—either it occurs or it does not—and this aspect means that it is difficult to represent *realized* excess return in Equation 1. The possibility of future default losses, however, can be incorporated into *expected* excess return (EXR), according to Equation 2:

$$\text{EXR} \approx (s \times t) - (\Delta s \times \text{SD}) - (t \times p \times L) \quad (2)$$

where p is the annualized expected probability of default and L is the expected loss severity. Note that the term $(p \times L)$ is the *expected annual credit loss*.

EXAMPLE 5

Calculating Excess Return

A corporate bond has a spread duration of five years and a credit spread of 2.75% (275 bps).

1. What is the approximate excess return if the bond is held for six months and the credit spread narrows 50 bps to 2.25%? Assume the spread duration remains at five years and that the bond does not experience default losses.
2. What is the instantaneous (holding period of zero) excess return if the spread rises to 3.25%?
3. Assume the bond has a 1% annualized expected probability of default and expected loss severity of 60% in the event of default. What is the expected excess return if the bond is held for six months and the credit spread is expected to fall to 2.25%?

Solution to 1:

Using Equation 1, the excess return on the bond is approximately 3.875% = (2.75% × 0.5) – [(2.25% – 2.75%) × 5].

Solution to 2:

Using Equation 1, the instantaneous excess return on the bond is approximately –2.5% = (2.75% × 0) – [(3.25% – 2.75%) × 5].

Solution to 3:

Using Equation 2, the expected excess return on the bond is approximately 3.575% = (2.75% × 0.5) – [(2.25% – 2.75%) × 5] – (0.5 × 1% × 60%).

4 CREDIT STRATEGY APPROACHES

Credit strategies normally establish return and risk parameters. A credit strategy is typically designed to achieve a constrained objective, such as "construct and manage a portfolio that maximizes return within a set of risk limits," or "construct and manage a portfolio that outperforms a given benchmark by x% using only investment-grade bonds." In most of the following discussion, assume that the investor's objective is to outperform a given benchmark, such as the Bloomberg Barclays US Credit Index, the Bloomberg Barclays Euro Corporate Index, or the BofA Merrill Lynch US High Yield Master II Index.

This section discusses two important credit strategy approaches. Each is an active management approach. Section 4.1 discusses the **bottom-up approach**, which involves selecting the individual bonds or issuers that the investor views as having the best relative value from among a set of bonds or issuers with similar features (usually the same industry and often the same country of domicile). Section 4.2 discusses the **top-down approach**, which involves the investor formulating a view on major macroeconomic trends, such as economic growth and corporate default rates, and then selecting the bonds that the investor expects to perform best in the expected environment.

4.1 The Bottom-Up Approach

The bottom-up approach to credit strategy is sometimes called a "security selection" strategy. The key feature of the bottom-up approach is the assessment of the relative value of individual issuers or bonds. This approach is most appropriate for analyzing companies that have comparable credit risk, as opposed to those companies whose credit risk varies considerably (for example, investment-grade and high-yield companies).

4.1.1 *Dividing the Credit Universe*

An investor's initial step in a bottom-up approach is establishing her universe of eligible bonds and then dividing the universe of eligible bonds into industry sectors, such as telecommunications and capital goods. The investor may divide each sector even further: For example, telecommunications companies may be segmented into wireless and wireline communications, or into Asian, European, and US companies. Within each sector, she can use relative value analysis to determine the bonds that are the most attractively valued.

An investor's typical starting point for identifying industry sectors is the sector classifications provided by the vendor of the benchmark. An astute investor, however, can add value by perceiving where these classifications are overly broad or incorrect. For example, oil and gas pipeline companies, now called the "midstream" sector in Bloomberg Barclays bond indexes, were largely classified by Bloomberg Barclays as utilities until mid-2014. When oil and gas prices fell, the pipeline companies underperformed traditional utility companies substantially.

There is no clear rule about whether a benchmark classification is too broad or too fine, but the investor typically wants each sector to contain a set of companies for which she expects company-level risks, rather than industry or macro risks, to be the dominant factors. For example, the "global banking" sector may be too broad. Banks often have heterogeneous business models; they are subject to different regulatory regimes; and their credit quality is frequently tied to the prevailing economic environment in which they do business.

In a portfolio that is not managed against a benchmark, the investor will divide the universe into sectors without reference to benchmark classifications. The investor still must decide whether she will compare relative value across relatively broad or narrow sectors.

EXAMPLE 6

Dividing the Credit Universe

An investor is conducting a relative value analysis on bond issuers in the retail sector. He is trying to decide whether the global clothing retail sector is a sufficiently granular (narrowly defined) sector for his analysis. Through his research, he has determined the following:

- Large clothing retailers are diversified across Europe, Asia, and the Americas.
- Small clothing retailers tend to sell into only one of these three regions.
- Clothing retailing is a cyclical business, and the three regions differ substantially in their economic growth cycles.

Describe considerations that the investor may use in determining how to divide the retail sector.

Solution:

The investor typically wants each sector to contain a set of companies for which he expects company-level risks, rather than industry or macro risks, to be the dominant factors. Based on the investor's analysis, smaller clothing retailers differ meaningfully from larger retailers. Smaller retailers sell in only one region, whereas larger retailers sell in many regions globally.

The investor may want to divide the global retail clothing sector into larger and smaller companies. Larger clothing retailers may be reasonably viewed as a single sector, because they are diversified across the world. He may want to consider European, Asian, and American small retailers as three separate sectors, however, because their macroeconomic trends differ.

4.1.2 *Bottom-Up Relative Value Analysis*

Once the credit universe has been divided into sectors, the investor identifies the bonds with the "best" relative value within each sector. The key to relative value decisions in credit portfolio management is weighing the *compensation* for credit-related risks (that is, the expected excess return) against the expected *magnitude* of the credit-related risks. As a reminder, credit-related risks include credit spread risk, credit migration risk, default risk, and liquidity risk.

If the investor decides that two issuers have *similar* credit-related risks, then she will typically compare credit spread measures and buy bonds of the issuer with the higher spread because those bonds likely have a higher potential for excess returns. For issuers with *different* credit-related risk, the investor must decide whether the additional spread is sufficient compensation for the additional credit risk taken. Useful considerations in comparing issuers with different credit-related risks include the following:

- Historical default rate information based on credit rating categories can help the investor decide how much compensation is needed for additional default risk.
- Information on the average spread level for each sector and credit rating is also useful. For example, if the investor identifies a BBB rated pharmaceutical company whose bonds trade at wider credit spreads than the average spread on bonds of other BBB rated pharmaceutical companies, the investor may want to investigate further why the market is demanding additional compensation for the company's bonds. In a similar manner, an investor may want to analyze the spread difference between a BBB rated pharmaceutical company and an A rated pharmaceutical company.

Recall Equations 1 and 2, the equations for excess returns and expected excess returns, respectively. These two equations are useful in analyzing a bond's credit-related risk. Note that in Equation 1, credit spread, holding period, and spread duration can be determined by the investor; however, the change in credit spread is unknown in advance and the investor must form expectations for this variable. If credit spreads do not change during the holding period, the second term in Equation 1 is zero. This possibility is important to consider if the investor is deciding between bonds of similar maturity and plans to hold a bond to maturity. If an investor plans to hold a bond to maturity, the change in credit spread throughout the holding period is effectively zero. If the investor's holding period is shorter than the bond's maturity, or if the investor is comparing bonds with different maturities, then the expected change in the credit spread is an additional factor to consider.

In the case of unchanged spreads, credit relative value analysis is essentially about weighing the unknown prospect of default losses and/or credit ratings migration against the known compensation provided by credit spreads. If an investor examines two bonds and assigns a similar default loss expectation to each one, then he will generally prefer to buy the bond with the greater spread. When facing a choice between two bonds of similar spread, the investor will assess which bond he expects to have lower default losses. Bonds with larger risk of default loss will generally have greater credit spreads, because the spread provides compensation for the default risk.

Although a credit investor may select the securities on which her excess return expectations are the highest, the investor sometimes favors bonds for which her excess return expectations are lower. Liquidity, portfolio diversification, and risk are all important considerations in security selection decisions. For example, if two bonds differ significantly in their riskiness or liquidity, then the investor may prefer the lower-risk bond, even if she anticipates a lower excess return.

Another instance can arise if an investor is not hedging interest rate risk, or if he is not separating the management of interest rate and credit risk. In this case, the investor may choose to buy a bond based on his expectations of total return, rather than excess return, when comparing securities.

EXAMPLE 7

Using Expected Excess Return in Relative Value Analysis

An investor has gathered the following information on four bonds she is considering for purchase:

Bond	Spread Duration	Yield	Z-Spread (bps)	Credit Rating
W	2	3.5%	200	Baa2
X	5	4.0%	100	A2
Y	5	5.5%	225	Ba2
Z	5	6.5%	350	B2

She uses the following historical information on annual default rates to estimate the probability of default. She assumes a 40% recovery rate on any defaults (that is, a 60% expected loss severity).

Credit Rating	Average Annual Default Rates
A1	0.24%
A2	0.27%
A3	0.31%
Baa1	0.36%
Baa2	0.43%
Baa3	0.61%
Ba1	1.20%
Ba2	1.28%
Ba3	2.37%
B1	2.93%
B2	3.19%
B3	3.65%

The investor has a six-month holding period.

1 Based on expected excess return, determine which bond the investor is most likely to buy if she expects that spreads will remain unchanged.

2 If the investor expects that spreads will narrow by 50 bps during the holding period, determine which bond the investor is most likely to buy. If the choice of bond has changed from Question 1, explain why.

3 Explain why an investor considers factors other than expected excess return in relative value decisions.

Solution to 1:

The expected annual default probability for each of the four bonds based on their respective rating category is as follows:

Bond	Credit Rating	Annual Expected Probability of Default
W	Baa2	0.43%
X	A2	0.27%
Y	Ba2	1.28%
Z	B2	3.19%

Equation 2 is used to calculate the expected excess return for each bond. For Bond W, the expected excess return is 0.87% = (2% × 0.5) – (0 × 2) – (0.5 × 0.43% × 60%). The following table summarizes the relevant information for all four bonds:

Bond	Credit Rating	Annualized Expected Probability of Default (p)	Spread Duration (SD)	Z-Spread in bps (s)	Expected Loss Severity (L)	Expected Excess Return (EXR)
W	Baa2	0.43%	2	200	60%	**0.87%**
X	A2	0.27%	5	100	60%	**0.42%**
Y	Ba2	1.28%	5	225	60%	**0.74%**
Z	B2	3.19%	5	350	60%	**0.79%**

Based on the expected excess returns, the investor will most likely purchase Bond W. Despite having the lowest yield among the four bonds, Bond W has the highest expected excess return.

Solution to 2:

The expected excess return calculation now incorporates a change in the bonds' spreads. For Bond W, the expected excess return is 1.87% = (2% × 0.5) – (–0.5% × 2) – (0.5 × 0.43% × 60%). The following table summarizes the relevant information for all four bonds:

Bond	Credit Rating	Annualized Expected Probability of Default (p)	Spread Duration (SD)	Z-Spread in bps (s)	Expected Spread Change, in bps (Δs)	Expected Loss Severity (L)	Expected Excess Return (EXR)
W	Baa2	0.43%	2	200	–50	60%	1.87%
X	A2	0.27%	5	100	–50	60%	2.92%
Y	Ba2	1.28%	5	225	–50	60%	3.24%
Z	B2	3.19%	5	350	–50	60%	3.29%

Based on the expected excess returns, the investor will most likely purchase Bond Z. The choice of bond differs from the previous question because, as a result of Bond W's shorter spread duration, the spread narrowing had a smaller effect on it compared with the other bonds.

Solution to 3:

A credit investor may select the securities on which her excess return expectations are the highest, but other considerations, such as liquidity, portfolio diversification, and risk, also play a role. Bonds are chosen and managed in the context of an overall portfolio. Because bonds vary in their riskiness, liquidity, and correlation with other portfolio assets, an investor may prefer a bond with lower risk or greater liquidity, or a bond that provides better portfolio diversification, even if she anticipates a lower average return.

In Question 2, Bond Z was selected based on its superior expected excess return compared with the other three bonds. Bond Z, however, has a lower credit rating than the other bonds, implying higher credit risk and possibly lower liquidity than the other bonds. As a result, the investor may prefer Bond Y, which has a higher credit rating than Bond Z, even if she anticipates a slightly lower average return for Bond Y. She may even prefer Bond X, which has the highest credit rating, even though according to her analysis it has lower expected excess return than Bond Y or Bond Z.

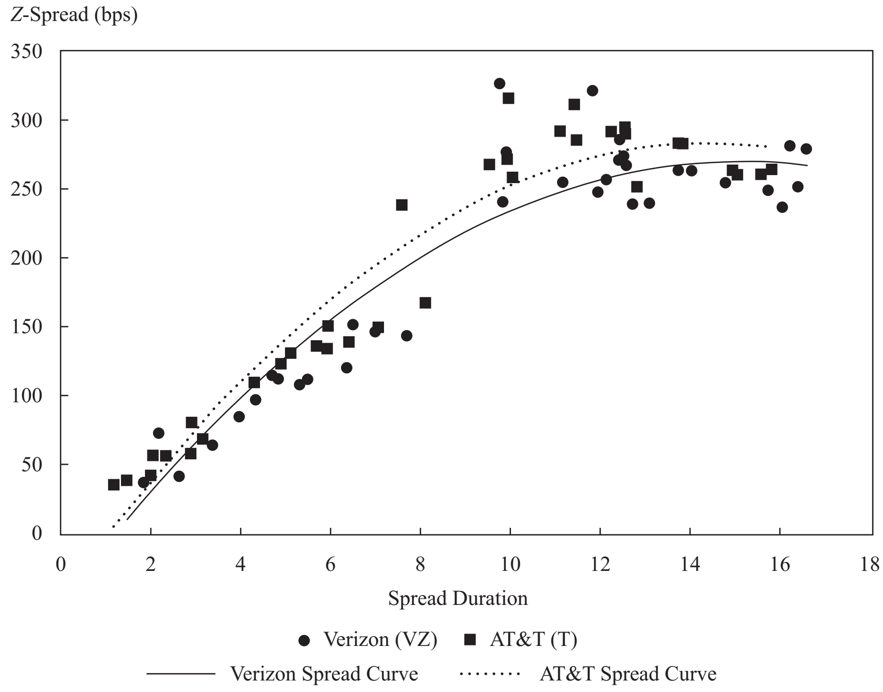
4.1.3 *Spread Curves*

The key decision in relative value analysis within a specific sector is to identify the issuers that have the best relative value. The equation for expected excess return is useful because it provides a way to summarize and understand the tradeoff among spread, default loss, and spread changes.

Many issuers have several bond issues, each of which typically has a different maturity and duration. To reflect the various maturities, a **spread curve** can be developed for each issuer and may be useful in conducting relative value analysis. A spread curve is the fitted curve of credit spreads for each bond of an issuer plotted against either the maturity or duration of each of those bonds.

Exhibit 6 plots the Z-spread versus the spread duration for bonds of two telecommunications companies, Verizon (VZ) and AT&T (T), on 4 December 2015.

Exhibit 6 Spread Curves, Verizon and AT&T



Source: Wellington Management

For a given duration, the spreads of the two issuers across the spread curves are very close: For most maturities, AT&T bonds have slightly wider spread than Verizon bonds. If an investor believes that both issuers' bonds have similar market liquidity, then he may believe that the market perceives AT&T's credit risk to be slightly higher than that of Verizon.

If the investor also believes that AT&T is actually more creditworthy than Verizon, he can take a variety of actions based on his relative value view. The actions depend on his portfolio's objective and constraints. If his objective is to outperform a benchmark, and he cannot use derivatives or take short positions, then he can maintain an *overweight* position in AT&T bonds and an *underweight* or *zero weight* in Verizon bonds relative to the benchmark. If his objective is to generate positive absolute returns, underweighting or avoiding Verizon bonds is not appropriate because these actions are meaningful only in the context of a benchmark. If permitted, he can express his relatively negative view on Verizon by purchasing default protection through credit default swaps (CDS), by buying put options, or by shorting Verizon bonds.

A few bonds of both AT&T and Verizon have spreads that are significantly above or below the fitted spread curves. An investor may view these bonds as potentially attractive, but he should investigate the bonds further before taking action. These bonds may have substantially different risk or liquidity characteristics compared with the other bonds because of differences in the bonds' features. Risk or liquidity differences may cause the spreads to vary considerably from their respective spread curves. For example, bonds could be issued by different subsidiaries or have different levels of seniority. It is important to understand each bond's structural features before concluding that the bond is attractive or unattractive based on spread alone.

4.1.4 *Other Considerations in Bottom-Up Relative Value Analysis*

In addition to analyzing excess returns and spread curves, other considerations in bottom-up relative-value analysis include the following:

- *Bond structure*. In performing relative value analysis, an investor must be careful to consider the features of the bonds and their priority in the capital structure. For example, subordinated debt normally offers more credit spread than senior debt. As another example, callable debt often has a larger option-adjusted spread than otherwise comparable non-callable debt.
- *Issuance date*. Bonds that have been recently issued by entities with frequent bond issues tend to have narrower bid–offer spreads and greater daily transaction volume. If an investor expects to have a short holding period, then she may prefer to transact in these more liquid "benchmark bonds." Benchmark bonds have some shortcomings, however. A benchmark issue often trades at a narrower credit spread and provides less compensation to an investor than "off-the-run" (existing older) issues of the same issuer. A benchmark issue may not remain highly liquid for its entire term; eventually the issuer may borrow again, and the newer bond may become the issuer's benchmark bond. Even if the issuer does not borrow again, the newly issued bond will age and may lose some liquidity. The investor should consider his holding period and need for liquidity in his choice to buy or avoid benchmark bonds.
- *Supply*. When an issuer announces a new corporate bond issue, the issuer's existing bonds often decline in value, and their spreads widen. This price decline and spread widening is often explained by market participants as an effect of increased supply. A related explanation for spread widening among existing bonds is that because demand is not perfectly elastic, new issues are often given a price concession to entice borrowers to buy the new bonds. This price concession may result in all existing bonds of an issuer to reprice based on the relatively wider spread in the new issue. A third explanation is that more debt issuance may signal an increase in an issuer's credit risk.
- *Issue size*. Issue size and its effects on credit valuation can vary. Bonds with larger issue sizes may be more frequently traded and held by a greater number of market participants. These factors may increase the bonds' liquidity and value and reduce their spread compared with bonds having smaller issue size. The popularity of different fixed-income benchmarks may also interact with issue size to produce differing effects on bond valuations. Most traditional bond indexes are weighted by the amount of debt outstanding. This weighting methodology helps to create demand for large debt issuers, because some credit portfolio managers do not deviate too far from benchmark weights. However, larger issue sizes do not always lead to tighter spreads. In some cases, very large corporate issuers may find that their debt actually trades at a *wider* spread compared with the debt of comparably rated issuers. Investors should be aware that the relationship between issue size and spread is not always clear.

EXAMPLE 8

Using Spread Curves in Relative Value Analysis

At the end of 2016, an analyst is about to conduct a relative value analysis of the following bonds issued by a single company. All of these bonds are available in the market at the time he is conducting his analysis:

Bond	Coupon	Maturity	Time to Maturity (years)	Credit Ratings	Issue Size	Duration	Price	Yield	Credit Spread (bps)
A	2.40%	12/31/2018	2	A2/A	2,000,000,000	2.0	100	2.40%	40
B	3.50%	12/31/2021	5	A2/A	1,500,000,000	4.6	100	3.50%	50
C	8.00%	9/30/2022	5.7	Ba1/BB+	50,000,000	4.7	109.5	6.02%	299
D	5.00%	12/31/2046	30	A2/A	1,000,000,000	15.8	100	5.00%	100

1 Evaluate whether the analyst should include Bond C in the relative value analysis.

The company is issuing a new 10-year bond with the following features:

Bond	Coupon	Maturity	Time to Maturity (years)	Credit Ratings	Issue Size	Duration	Price	Yield	Credit Spread (bps)
E	4.00%	12/31/2026	10	A2/A	3,000,000,000	8.2	100	4.00%	80

2 Explain how the analyst may compare the relative value of the company's new issue with that of the outstanding bonds.

Solution to 1:

Bond C has a much higher spread than the company's other bonds. The analyst should try to identify the cause(s) of this difference before including Bond C in the relative value analysis. Bond C's higher coupon and lower credit rating suggest that it is riskier than the other bonds. Bond C may be subordinated in the company's capital structure. Bond C also has a much smaller issue size, indicating that the bond may be less liquid than the company's other bonds. Relatively illiquid bonds often carry greater spreads to compensate investors for this disadvantage. Finally, Bond C's higher price means that the loss in the event of default is likely to be larger. To summarize, it is most likely unsuitable to include Bond C in the relative value analysis.

Solution to 2:

The company has no outstanding bonds maturing around 2026. The spread for a bond maturing in 2026 can be roughly interpolated, however, using issues already in the market. The spread should be somewhere between the spreads of Bonds B and D. Using the bonds' durations to interpolate, we find the interpolated spread to be approximately $66 = 50 + \{[(8.2 - 4.6)/(15.8 - 4.6)] \times (100 - 50)\}$. The new issue, with a spread of 80 bps, appears to be attractively valued in the context of the company's outstanding issues.

4.1.5 *Bottom-Up Portfolio Construction*

In bottom-up portfolio construction, the investor may identify a model portfolio with ideal position sizes according to both sector and individual bonds. The investor then buys the bonds that most closely represent the appropriate risk exposures in the model portfolio.

Because the investor divided the universe into sectors as part of a bottom-up approach, the weightings of these sectors provide a reasonable guide to position sizing. The simplest metric to use for sizing positions is *market value*. Therefore, within each sector allocation, the investor may choose to buy positions of equal market value. Alternatively, she may aim for larger positions in the bonds that she views as most attractively valued.

Another metric commonly used in sizing positions is *spread duration*, which we discussed in Section 2.

As an example of using spread duration, suppose a portfolio manager is considering two investment-grade bonds that he expects to have similar credit spread volatility. Bond A has 5 years of spread duration, and Bond B has 10 years of spread duration. He may consider a 2% portfolio-weighted position in Bond A to have nearly the same risk as a 1% portfolio-weighted holding in Bond B. That is, if he holds a 2% position in Bond A and a 1% position in Bond B, then a 1% (100-bp) increase in the credit spread of either bond will contribute about –0.10% to the portfolio's returns: $1\% \times 2\% \times -5 = 1\% \times 1\% \times -10 = -0.10\%$.

Bottom-Up Portfolio Construction

Suppose that one sector in an investor's benchmark consists of European retail companies. If the European retail sector constitutes 8% of the investor's benchmark based on market value, then she may target an 8% weighting in those European retailers that she has determined to be most attractively valued. If the portfolio has a market value of £50,000,000, then an 8% weighting will imply purchasing £4,000,000 worth of European retailers.

Now suppose that the portfolio's benchmark has a weighted-average spread duration of 4.0, and the European retailers in the benchmark have a weighted-average spread duration of 5.0. Then, measured by spread duration, the European retailers constitute 10% [$(5.0 \times 8\%)/4.0$] of the benchmark. Using this spread duration metric, the investor would target a 10% weighting in European retailers.

When deciding whether to use market value or spread duration as the portfolio sizing metric, a key factor is the relative importance of default loss risk versus credit spread risk. If default losses are a significant concern, then market value is a better measure of risk. If defaults are unlikely and spread change is the more relevant risk, then spread duration is usually a better measure. This distinction tends to relate back to the difference between investment-grade and high-yield bond portfolios: Spread duration is more commonly used for investment grade, and market value is more commonly used for high yield.

In determining the position sizes in a portfolio, a portfolio manager may strictly adhere to the sector weightings in the benchmark and the portfolio. Bottom-up portfolio managers often find in their relative value analysis, however, that some sectors seemingly have many attractively valued bonds whereas other sectors have fewer. Bottom-up portfolio managers sometimes buy more bonds or larger position sizes in the bonds of those sectors where opportunities are more abundant. Portfolio managers can therefore implement sector weightings that differ from the benchmark weights.

Because obtaining desired bonds can be challenging, investors typically use several alternatives to deal with this difficulty:

- *Substitution.* The second (or third, and so on) most attractively valued security in a sector may be a reasonable substitute for an investor's most preferred bond.

- *Indexing*. Constructing a portfolio to mirror the performance of a specified index is called **indexing**. Benchmark bonds, total return swaps on the benchmark index, credit default swap index derivatives, and exchange-traded funds are some relatively liquid instruments that investors use to obtain market exposure until desired bonds become available.
- *Cash*. If the investor expects that his desired bonds will soon be available, then holding cash as a substitute may be a useful option. Cash can negatively affect returns during longer periods, however, particularly among portfolios that focus on long-maturity bonds or high-yield debt.

4.2 The Top-Down Approach

The bottom-up approach to credit strategy focuses on individual bonds and issuers. By contrast, the top-down approach to credit strategy focuses on macro factors; that is, factors that affect most sectors and individual issuers and bonds. Macro factors that are important to credit investing primarily include the following: economic growth; overall corporate profitability; default rates; risk appetite; changes in expected market volatility; changes in credit spreads; interest rates; industry trends; and currency movements.

A portfolio manager using a top-down approach typically determines which sectors of the credit market have attractive relative value based on her view on macro factors. The portfolio manager then overweights those sectors by purchasing bonds in those sectors. In contrast, the manager underweights (or perhaps takes short positions in) bonds belonging to those sectors with a relatively unfavorable macro outlook.

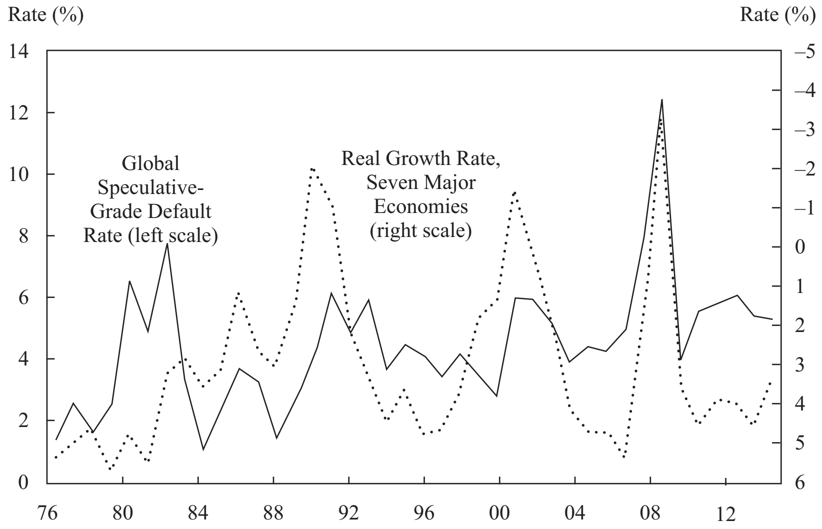
An important distinction between the top-down and bottom-up approaches is that sector divisions used by a top-down investor are often broader than those used by a bottom-up investor. For example, a top-down investor who expects credit spreads to narrow may view high-yield bonds as having better relative value than investment-grade bonds. Grouping all investment-grade bonds together or all high-yield bonds together is not consistent with a bottom-up approach, but it is not unusual for a top-down approach.

4.2.1 *Credit Quality*

An important decision for many top-down credit investors is determining the desired credit quality of their portfolios. This decision is similar to an equity investor's choice of portfolio beta. An equity portfolio with a beta greater than one tends to outperform the market when stock prices rise and underperform when stock prices fall. Similarly, a credit portfolio that holds more low-quality bonds than a credit market benchmark will usually outperform the benchmark when credit spreads narrow and when default rates are lower or declining. Likewise, a higher-quality credit portfolio usually outperforms a market benchmark when credit spreads widen and when default rates are higher or rising.

Two key components of an investor's credit quality decision are expectations for the *credit cycle* and expectations for *credit spread changes*. Expectations for the credit cycle are reflected in variations of the default rate over time. Credit spread changes and the credit cycle are both heavily influenced by macro factors. Exhibit 7 shows global speculative-grade default rates (left axis) and the real GDP growth rate (right axis) in seven major economies—Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States—from 1976 through 2015. Real GDP growth is plotted on an inverted scale to better visualize the correlation between the two data series. The graph shows that sharp declines in growth often result in sizable increases in the default rate. By extension, the business cycle and the credit cycle seem to be correlated during certain periods, although not perfectly so.

Exhibit 7 Global Speculative-Grade Default Rate and Real GDP Growth Rate, 1976–2015

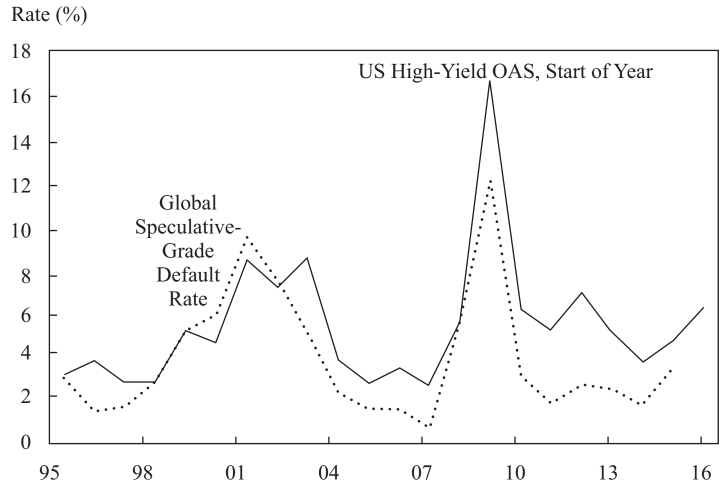


Sources: Moody's, OECD, and Haver Analytics.

A portfolio manager or analyst may decide to use the relationship between default rates and real GDP growth in his investment decision-making process; for example, he may have an above-consensus view on real GDP growth and conclude that defaults are likely to be lower than market expectations.

As Exhibit 7 demonstrates, default rates and real GDP growth are reasonably correlated. The correlation between default rates and credit spreads is even higher, as shown in Exhibit 8. The exhibit graphs the global speculative-grade default rate and US high-yield spreads (measured by the OAS of the Bloomberg Barclays US High Yield Index) from 1995 through 2015. Exhibit 8 indicates that changes in credit spreads are usually a good predictor of changes in default rates one year ahead.

Exhibit 8 Global Speculative-Grade Default Rate and US High-Yield Spread, 1995–2015



Sources: Moody's and Bloomberg Barclays.

Exhibit 8 suggests that an investor seeking to outperform the market will likely need a forecast horizon longer than one year. If the investor has an above-consensus forecast of GDP growth extending beyond one year, he may conclude that credit spreads will narrow and may position his portfolio accordingly.

4.2.1.1 Measuring Credit Quality in a Top-Down Approach After determining the desired credit quality of their portfolio, portfolio managers find it useful to assess the credit quality of their portfolio. Portfolio managers commonly use one or more of the following approaches to assess the portfolio credit quality:

Average credit rating. Under this approach, a numerical weighting of each credit rating category is assigned, as in Exhibit 9. The choice of weighting methodology is an important decision. An issue with the use of arithmetic weighting is that many bond risks (notably default risk) do not change in a linear manner across credit rating categories. Default risk, for example, typically increases more quickly as an issuer's credit rating declines. The use of non-arithmetic weightings is a way to handle the non-linear relationship of bond risks.

Exhibit 9 Numerical Weighting Approach to Credit Ratings

Moody's	S&P	Fitch	Arithmetic Factor	Moody's Rating Factor
Aaa	AAA	AAA	1	1
Aa1	AA+	AA+	2	10
Aa2	AA	AA	3	20
Aa3	AA–	AA–	4	40
A1	A+	A+	5	70
A2	A	A	6	120
A3	A–	A–	7	180
Baa1	BBB+	BBB+	8	260
Baa2	BBB	BBB	9	360

Exhibit 9 (Continued)

Moody's	S&P	Fitch	Arithmetic Factor	Moody's Rating Factor
Baa3	BBB–	BBB–	10	610
Ba1	BB+	BB+	11	940
Ba2	BB	BB	12	1,350
Ba3	BB–	BB–	13	1,766
B1	B+	B+	14	2,220
B2	B	B	15	2,720
B3	B–	B–	16	3,490
Caa1	CCC+	CCC+	17	4,770
Caa2	CCC	CCC	18	6,500
Caa3	CCC–	CCC–	19	8,070
Ca	CC	CC	20	10,000

Source: Wellington Management and Moody's.

An example comparing the measurement of a portfolio's average credit quality using arithmetic versus non-arithmetic weightings can show the effects of weighting choice. Using arithmetic weighting (the "arithmetic factor" column in Exhibit 9), a portfolio in which 50% of the bonds are rated A1/A+ and the other 50% are rated Ba3/BB– has an average credit quality score of 9 = (50% × 5) + (50% × 13). Referring to Exhibit 9, this score of 9 corresponds to an average credit rating of Baa2/BBB. Using a non-arithmetic weighting (the "Moody's Rating Factor" column in Exhibit 9), the portfolio's average credit quality score is 918 = (50% × 70) + (50% × 1,766). The score of 918 corresponds most closely to an average credit rating of Ba1/BB+. The average credit rating using non-arithmetic weightings is two levels (notches) below the rating using arithmetic weighting.

In summary, using arithmetic weighting to assess a portfolio's average credit quality is likely to overestimate its credit quality and underestimate its credit risk when the bonds in the portfolio span a broad range of the credit spectrum. Using non-arithmetic weighting, a portfolio consisting of bonds in the same rating category will have *less* credit risk than a portfolio with the same rating category on an arithmetically weighted basis. For example, a portfolio consisting of only Baa2/BBB bonds has a Moody's rating factor of 360, whereas a portfolio consisting equally of Baa1/BBB+ bonds and Baa3/BBB– bonds has a factor of 435 = (50% × 260) + (50% × 610).

Average OAS. A portfolio's credit quality can also be estimated using OAS. To calculate a portfolio's average OAS, each bond's individual OAS is weighted by its market value.

Average Spread Duration. Average OAS is a reasonable representation of portfolio credit quality, but it does not fully account for the risk of credit spread volatility. For example, a portfolio composed of 30-year corporate bonds with an average OAS of 100 will be more sensitive to changes in credit spreads compared with a portfolio of two-year bonds having the same average OAS. A weighted-average spread duration can account for the risk of credit spread volatility.

Duration Times Spread. Duration times spread (DTS) is a measure of credit quality that attempts to account for both average OAS and average spread duration. A bond's DTS is simply its duration multiplied by its OAS. By extension, a portfolio's DTS is a weighted average of the DTS of its individual bonds. DTS is more comprehensive than average OAS or average spread duration, but it is also somewhat less intuitive than either of those measures.

4.2.1.2 Excess Returns in a Top-Down Approach A portfolio manager using a top-down approach can apply her expectations for default losses and credit spread changes to compute the portfolio's expected excess return. To compute the approximate expected excess return, we refer back to Equation 2, repeated here:

$$\text{EXR} \approx (s \times t) - (\Delta s \times \text{SD}) - (t \times p \times L)$$

EXAMPLE 9

Top-Down Excess Returns

An investor has gathered information and formed expectations for four bond indexes. Each index contains bonds within a single, unique rating category.

Index Rating Category	Current OAS in bps (s)	Expected OAS in One Year, in bps	Expected Credit Loss Rate ($p \times L$)	Spread Duration (SD)
A	244	118	0.00%	5.6
Baa	334	206	0.04%	6.1
Ba	571	370	0.08%	4.4
B	736	510	0.31%	3.9

The investor has a one-year holding period. He intends to purchase bonds of a single rating category and is choosing among the categories represented by the four indexes. Based on expected excess return, determine which rating category the investor is most likely to choose. (Assume that the spread duration does not change during the one-year holding period.)

Solution:

The following table summarizes the approximate expected excess returns (EXR) for each of the four rating categories:

Rating	Excess Return (approximate)
A	(0.0244 × 1) – [(0.0118 – 0.0244) × 5.6] – (1 × 0) = 0.0950 ≈ **9.5%**
Baa	(0.0334 × 1) – [(0.0206 – 0.0334) × 6.1] – (1 × 0.0004) = 0.1111 ≈ **11.1%**
Ba	(0.0571 × 1) – [(0.0370 – 0.0571) × 4.4] – (1 × 0.0008) = 0.1447 ≈ **14.5%**
B	(0.0736 × 1) – [(0.0510 – 0.0736) × 3.9] – (1 × 0.0031) = 0.1586 ≈ **15.9%**

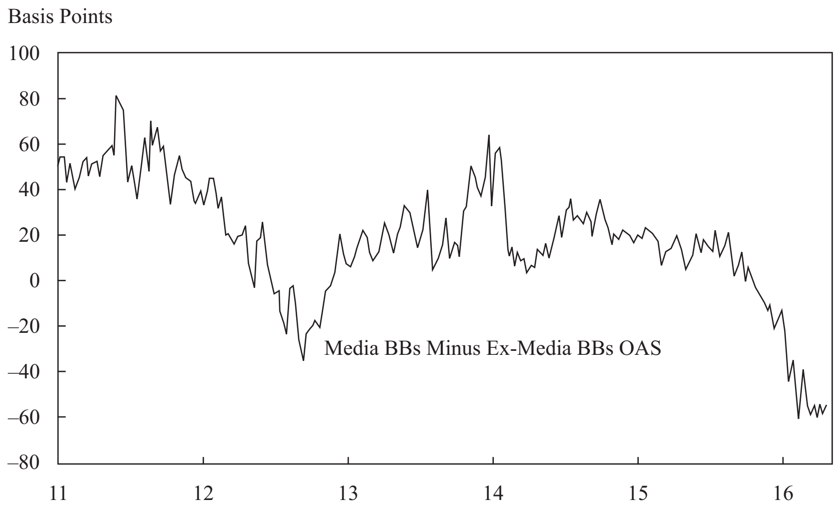
Based on the investor's expectations for default losses and credit spread changes, the Ba rated and B rated bonds are expected to outperform the more highly rated A and Baa bonds. Based only on expected excess return, the investor is most likely to choose B rated bonds. The investor must weigh these return expectations against the more volatile, less liquid nature of lower-quality bonds and construct a portfolio accordingly.

4.2.2 *Industry Sector Allocation*

Industry sector allocations (or weightings) are an important part of a top-down approach to credit strategy. A top-down approach to sector allocation is largely based on a portfolio manager's macro views. For example, an economic slowdown in emerging markets caused a substantial decline in the price of oil and major industrial metals from 2013 through 2015, negatively affecting the bond valuations of producers of those commodities. As another example, default rates on US high-yield energy bonds increased substantially from 2% in 2014 to 20% in early 2016, resulting in spreads on these bonds as a group widening to more than 1,000 bps. A portfolio manager's decision to underweight oil or energy bonds in the early stage of these respective periods may have resulted in material outperformance versus a passive benchmark.

A portfolio manager may use quantitative tools, such as regression analysis, in making industry allocation decisions. For example, the average spread of the high-yield bonds in a particular industry sector could be regressed against the average spread of the investment-grade bonds in the same industry sector. As another example, the average spread of bonds within an individual industry sector and rating category could be compared with the average spread of the bonds that are in that same rating category but exclude the chosen industry sector. Exhibit 10 compares spreads of BB rated, US-dollar denominated media bonds in developed markets against the spreads of BB rated bonds (excluding the bonds in the media industry sector) for the period from 2011 through April 2016. The exhibit shows that in April 2016, the average spread of BB rated media bonds was approximately 60 bps tighter than the average spread of the BB rated bond universe (excluding media bonds). This level was the tightest in the five-year period shown.

Exhibit 10 Regression of Sector Spreads, 2011–2016



Source: Deutsche Bank.

A portfolio manager may use information on spreads in an industry sector and other considerations, such as her view on credit fundamentals, in deciding whether to take an overweight, underweight, or equal-weight position in an industry sector relative to its weighting in a benchmark. For example, the portfolio manager may interpret that tight relative spreads on media bonds reflect a market view that the credit quality of BB rated bonds in the media industry sector is superior to the credit quality of the average BB rated bond. However, if the portfolio manager believes that the credit quality of media bonds is no better than that of other BB rated bonds, then she may choose to take an underweight or short position in media bonds compared with the weighting in a benchmark.

A portfolio manager may also use financial ratio analysis in industry sector allocation. For example, a manager could compare sector spreads and sector leverage, whereby leverage may be defined as total or net debt as a multiple of EBITDA (earnings before interest, taxes, depreciation, and amortization) for the sector as a whole. Generally speaking, higher leverage should imply higher credit risk and thus wider spreads. A portfolio manager could compare sectors on a spread-versus-leverage basis to identify relative value opportunities.

4.2.3 *Interest Rate Measurement and Management in a Top-Down Strategy*

Interest rate changes are an important factor in returns for investment-grade and, to a lesser extent, high-yield bonds. A portfolio manager who uses a bottom-up approach generally tries to mitigate the portfolio's exposure to interest rate movements. A portfolio manager who uses a top-down approach, however, may actively manage the portfolio based on expectations of future changes in interest rates and future interest rate volatility.

4.2.3.1 Measuring Interest Rate Exposure Interest rate exposure in a credit portfolio is typically monitored and managed using effective duration, which accounts for optionality in a portfolio's credit securities. If, for example, a portfolio manager expects that yields will decline by more than what the market is pricing, then he may position his portfolio so that its effective duration is greater than the benchmark duration (or greater than zero, for an absolute return portfolio). Conversely, he may position his portfolio so that its effective duration is less than the benchmark duration (or less than zero, for an absolute return portfolio) if he expects that yields will rise by more than what the market is pricing.

Effective duration provides a useful measure of a portfolio's exposure to parallel shifts in the yield curve, but it does not fully measure the risk of non-parallel yield curve shifts. To measure a portfolio's exposures to non-parallel yield curve changes, a portfolio manager uses *key rate durations* (that is, durations at key points along the yield curve). If, for example, a portfolio manager wishes to express a view that the yield curve will flatten—although not in a parallel manner— beyond what is priced into markets, she is likely to structure her portfolio to be more sensitive to changes in long-term interest rates and less sensitive to changes in short-term interest rates. The portfolio's key rate durations will likely exceed the benchmark's key rate durations in longer maturities (typically those greater than 5 to 10 years) and will be below the benchmark's key rate durations in shorter maturities.

A credit portfolio manager may also want to monitor the portfolio's exposure to interest rate volatility, particularly if the portfolio contains bonds with embedded options, such as callable corporate bonds or agency mortgage-backed securities. *Effective convexity*, which measures how much a bond or portfolio's duration changes as interest rates change, is commonly used by credit portfolio managers to manage exposure to interest rate volatility.

If a portfolio manager expects that interest rate volatility will be *high*, then the manager may structure the portfolio to have *greater* convexity than that of the benchmark. In this manner, the portfolio will benefit from interest rate shifts: The portfolio's duration will lengthen as rates fall and will shorten as rates rise. If the portfolio manager expects that interest rate volatility will be *low*, the manager may structure the portfolio to have *lower* convexity than the benchmark. The portfolio with lower convexity than the benchmark will respond adversely to interest rate changes, although additional spread income from holding bonds with low (or negative) convexity may more than compensate for the assumed interest rate risk.

4.2.3.2 Managing Interest Rate Exposure Portfolio managers manage interest rate exposure in a portfolio using a variety of approaches.

Maturity management. The portfolio manager may select appropriate credit securities in order to obtain his targeted effective duration and key rate durations. The main advantage of this approach is that it can be accomplished without the use of derivatives. This approach has several disadvantages, however, including the following:

- Credit curve management and credit security selection decisions cannot be disentangled from duration and yield curve management. For example, it is impossible to buy long corporate bonds for their typically higher spreads without having exposure to long interest rates as well.
- Because desired corporate bonds are not available in all maturities, it may be difficult to match key rate durations closely. For example, a portfolio manager forming a new portfolio may find it expensive or nearly impossible to buy bonds other than those that are recently issued.
- A manager of an absolute return portfolio may want the portfolio to have low or zero interest rate exposure. This target is almost impossible to achieve without using derivatives, unless the portfolio consists exclusively of bonds with very short maturities or floating-rate notes.

Derivatives. A portfolio manager may buy the corporate bonds she finds most attractive on a spread basis and then use derivatives such as futures or interest rate swaps to manage the portfolio's effective duration and key rate durations.

The main advantages of this approach are that key rate durations can be controlled independently of credit spread curve exposures, and the liquidity of the interest rate derivatives markets allows exposures to be easily changed. The main disadvantage of this approach is that not all investors are willing or able to use derivatives. Using derivatives is particularly impractical for smaller portfolios.

Volatility Management. A portfolio's exposure to interest rate volatility can be managed with credit securities or with derivatives. To manage interest rate volatility with credit securities, a manager may use callable bonds or agency pass-through mortgages. To manage interest rate volatility with derivatives, options are often used.

4.2.4 *Country and Currency Exposure*

Credit portfolio managers may invest beyond their own country or in credit instruments denominated in other than their own currency. In doing so, portfolio managers can benefit from higher return potential but may also be subject to additional risk. Currency and/or country views are often implemented using a top-down approach, through the use of credit securities or derivatives.

If an investor believes that the interest rate differential between two countries will change, then he can buy credit securities in the currency in which he expects yields to fall and sell credit securities in the currency in which he expects yields to rise. Unless he can hedge currency risk, his portfolio will be exposed to currency fluctuations as well as changes in interest rates. An investor can also express a currency view and assume currency risk in his portfolio by purchasing bonds in a currency other than the benchmark currency (or by taking an overweight or underweight position in bonds issued in a particular currency if the portfolio benchmark contains multiple currencies).

It is more common for investors to use forwards and futures, rather than credit securities, to express country or currency views, or to manage currency exposures. These instruments are generally highly liquid and enable investors to manage currency risk separately from other portfolio exposures. For example, suppose that an investor believes that European corporate bonds will outperform Japanese corporate bonds on a currency-hedged basis, and she does not want to express a currency view. In a portfolio managed against a global bond benchmark, she may choose to overweight European corporate bonds and underweight Japanese corporate bonds. Because

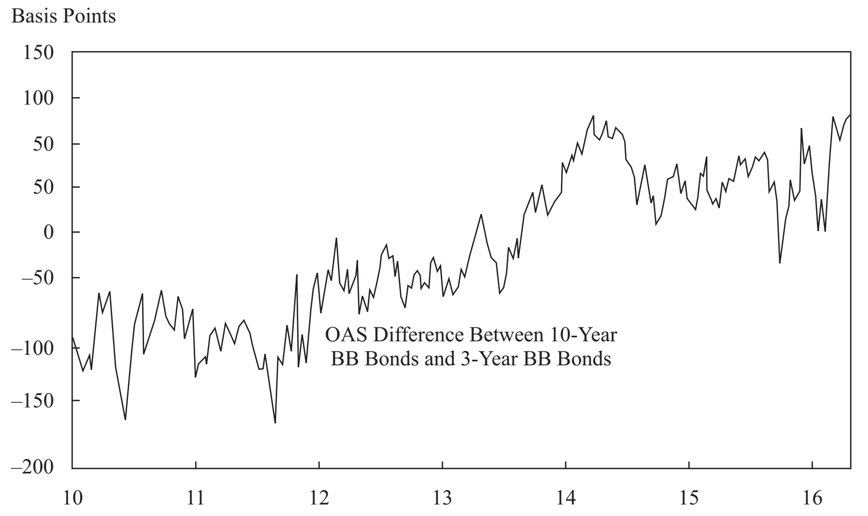
European corporate bonds are primarily issued in euros and Japanese corporate bonds are issued in yen, she may sell euros forward and buy yen forward to hedge her portfolio's unwanted currency exposure.

4.2.5 *Spread Curves in Top-Down Approach*

Spread curves can be constructed for a larger credit segment, such as an industry, currency, or index, in a top-down approach. There are a number of different possible views on spread curves that an investor using a top-down approach may wish to express in his portfolio. These include views that a particular credit spread curve will flatten or steepen, or that two spread curves will converge or diverge.

For example, in April 2016, an investor examines the relative value between (1) spreads of BB rated bonds with 10 years to maturity and (2) BB rated bonds with 3 years to maturity. Exhibit 11 shows the spread differences between these two BB rated segments from 2010 through April 2016. It should be noted that Exhibit 11 excludes the energy sector from both spread curves from 2014 through April 2016 as a way of reducing the effect of distressed valuation levels in the energy sector during this period. In April 2016, average spreads of 10-year BB rated bonds were around 100 bps wider than three-year BB rated bonds—approximately the widest level during the period shown. A portfolio manager may decide to use this information to overweight 10-year BB rated bonds or underweight 3-year BB rated bonds in his portfolio. It should be noted that the portfolio manager would need to consider the sector composition of the spread curves being evaluated, such as the case in Exhibit 11 whereby the energy sector was excluded for a component of the spread curve.

Exhibit 11 Spread Curve between 10-Year and 3-Year BB Bonds



Source: Deutsche Bank.

4.3 Comparing the Bottom-Up and Top-Down Approaches

Investors can construct a portfolio using a top-down approach, a bottom-up approach, or a combination of the two. Each approach has different advantages and disadvantages.

The main advantage of the bottom-up approach is that investors may find it easier to gain an informational advantage in individual companies or bonds rather than the overall market. In this regard, an investor can closely examine a small set of companies and seek to identify risks that the market may have overlooked. Because a sizable portion of credit returns can be attributed to macro factors, however, it can be difficult to earn substantial returns from bottom-up security selection without exposing the portfolio (intentionally or unintentionally) to macro factors, using leverage or taking short positions. If an investor views the most attractive bonds among issuers in a single industry or country, she may experience disappointing returns if that country's or industry's macro factors perform poorly relative to other countries or industries. Many investors are constrained from using leveraged credit strategies, and leverage itself obviously carries financial risk.

The main advantage of a top-down approach is that a sizable portion of credit returns can be attributed to macro factors. However, a top-down approach may be difficult to implement because expectations for interest rates, economic cycles, and other macro influences are closely examined by market participants and, in many cases, reasonably reflected in credit market prices. As a result, it can be difficult for an investor to gain an informational advantage in a top-down approach.

In practice, investors often combine top-down and bottom-up approaches. For example, an investor may begin with top-down portfolio decisions that focus on a particular industry and region, such as European financial sector bonds. Then he can restrict his bottom-up relative value analysis to bonds issued by European financial companies. Alternatively, an investor with a bottom-up focus may choose to monitor and manage the portfolio's exposure to major top-down factors, so that individual security selection will be the major driver of portfolio returns. For example, an investor who wants to focus on bottom-up analysis may strive to minimize her portfolio's exposure to changes in the credit cycle by keeping important portfolio risk statistics, such as credit quality, duration, and credit spread, equal to those of the investor's benchmark.

EXAMPLE 10

Choosing a Credit Strategy

A credit investor has conducted extensive research on the European chemicals and consumer staples industries. He is constructing a portfolio of bonds issued by companies in these industries. The investor seeks to outperform a benchmark consisting of bonds issued by European chemicals and consumer staples companies.

Evaluate whether a top-down or bottom-up approach is most appropriate for this investor.

Solution:

A bottom-up approach is more appropriate than a top-down approach for this investor. The key aspect of the bottom-up approach to credit strategy is assessing the relative value of individual bonds or issuers. The investor has conducted extensive research on companies within the industries. By contrast, a top-down approach first determines which sectors have attractive relative value and then selects bonds within those sectors. More broadly, a top-down approach involves taking views on macro factors.

4.4 ESG Considerations in Credit Portfolio Management

Some fixed-income mandates include a requirement that the portfolio consider environmental, social, and governance (ESG) factors in the investment process. ESG factors are particularly relevant to the credit component of fixed-income portfolio mandates. Credit portfolio management may incorporate ESG considerations in one or more of the following ways.

Relative value considerations. Companies and industries with poor ESG practices may have more credit risk for several reasons. Some examples are as follows:

- Major polluters risk environmental lawsuits and fines.
- Companies with poor labor practices may be vulnerable to frequent strikes or work stoppages, boycotts, or lawsuits. They may lose profitability if they are forced to adhere to strict labor regulations.
- Companies with weak board oversight (poor governance) may have a high risk of aggressive or outright fraudulent accounting.

Guideline constraints. Some portfolios' investment policy statements include prohibitions on purchasing bonds issued by entities that engage in certain activities. Examples include the following:

- Companies that derive a significant percentage of revenues (typically at least 5%–10%) from controversial products or activities, such as tobacco.
- Governments with weak human rights protections or other poor social records. Credit portfolios are a means for investors to express views on a government's ESG policies.

Portfolio-level risk measures. A credit portfolio manager may choose to incorporate ESG into the portfolio management process in several different ways:

- *Monitoring of exposures to ESG-related risk factors.* For example, a portfolio manager may limit or avoid exposure to the subprime lending industry because of business practices demonstrated by certain lenders. This exposure could include corporate debt issued by subprime lenders, asset-backed securities for which the collateral is subprime auto loans, and even counterparty exposure to banks that derive a significant percentage of revenue from subprime lending.
- *Targeting an average ESG portfolio score.* A portfolio manager may derive an issuer's ESG ratings (or scores) either internally or by using an external vendor that provides ESG ratings or scores. In this manner, a portfolio manager may consider constructing a portfolio with an average ESG rating that meets or exceeds a certain target. She may buy some bonds with lower ESG ratings if the bonds' other relative value characteristics are sufficiently attractive, and she may compensate by buying other bonds with high ESG ratings. The portfolio manager may also choose to avoid bonds issued by companies that do not meet a certain ESG rating.

Positive impact investing opportunities. ESG mandates are not restricted to just avoiding bonds with negative ESG-related factors. A portfolio manager can aim to invest a certain percentage of his portfolio in bonds of issuers that are generating a positive social or environmental impact. Green bonds are one of the most commonly cited examples of a positive impact bond. Green bonds fund projects that have positive benefits for the environment or climate. Bonds issued by not-for-profit hospitals and low-income housing projects are other types of bonds that may have a positive social impact.

LIQUIDITY RISK AND TAIL RISK IN CREDIT PORTFOLIOS

5

In this section, we discuss liquidity risk in credit markets and how investors can manage liquidity risk in practice. We also discuss tail risk in credit portfolios, including how such risk can be assessed and managed.

5.1 Liquidity Risk

Liquidity is an important consideration in credit investing. Compared with sovereign bonds in large developed markets (such as US Treasuries, German bunds, and Japanese government bonds), corporate bonds are relatively illiquid. Market data, including price data and data necessary to evaluate liquidity, are readily available for sovereign bonds in most major markets. By contrast, market data to evaluate corporate bond liquidity are more limited and less readily available. TRACE (Trade Reporting and Compliance Engine) is a commonly used system for US corporate bond investors but still has limitations in pricing consistency.

Concerns among credit investors about liquidity risk have increased subsequent to the 2008–2009 global financial crisis. The introduction of new regulatory constraints resulted in many broker/dealers substantially reducing their holdings (inventories) of corporate bonds. Because broker/dealer holdings of corporate bonds support trading in secondary markets, the reduction of holdings decreased liquidity in credit markets.

On the positive side, the growth of electronic trading platforms (ETPs) has potentially improved credit market liquidity. These platforms represent an attempt to shift the credit market from a dealer-dominated market to a more open, competitive market. The success of ETPs in shifting credit market dynamics remains to be seen, however.

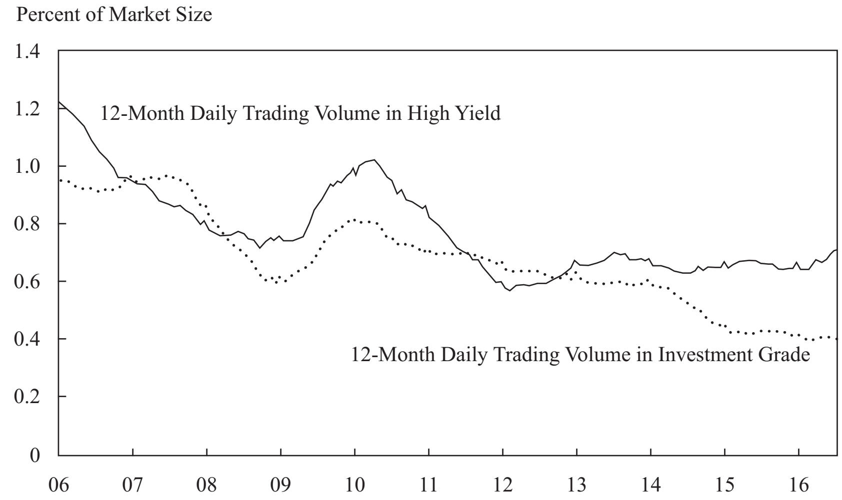
5.1.1 *Measures of Secondary Market Liquidity in Credit*

Liquidity in secondary credit markets can be evaluated using a variety of measures, including trading volume, spread sensitivity to fund outflows, and bid–ask spreads.

In this section, US data, which are readily available, are used to evaluate liquidity. Data may be less available in other markets, which can affect liquidity risk for credit portfolios within those markets and for credit portfolios managed across international markets.

Trading Volume As broker/dealers have reduced their corporate bond holdings, trading volume in credit markets has declined subsequent to the 2008–2009 global financial crisis. Exhibit 12 shows trading volumes in the US high-yield and investment-grade corporate bond markets from 2006 through June 2016, expressed as a percentage of each market's size (total market value). The graph shows the average daily trading (on a 12-month trailing basis) for investment-grade and high-yield corporate bonds as a percentage of each market's total size. On average for 2015 in the US high-yield market, daily trading volume was 0.7% of the total size of the US high-yield market and the comparable proportion for the US investment-grade market was slightly more than 0.4%. In 2006, two years before the global financial crisis, the proportions were 1.2% in the US high-yield market and just under 1.0% in the US investment-grade market.

Exhibit 12 US High-Yield and Investment-Grade Trading Volume as a Percentage of Market Size, 2006–June 2016

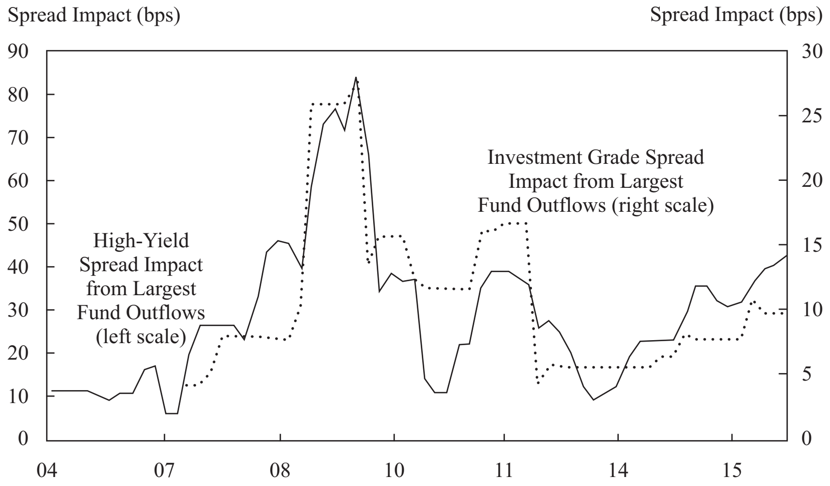


Source: Deutsche Bank and TRACE.

US credit markets and US Treasury markets are often correlated, and trading volumes have also decreased in US Treasuries. Average daily trading volume relative to market size for US Treasuries was around 4% in 2015, down from around 13% in 2006. It is important for investors to properly understand the liquidity environment in credit markets, as well as its implications. Although many investors perceive high-yield liquidity as poor, as shown in Exhibit 12, the change in liquidity in US high yield has been relatively small compared with the higher-quality US investment-grade market.

Spread Sensitivity to Fund Outflows Another measure used to evaluate liquidity is spread sensitivity to large withdrawals by investors from credit funds. A large withdrawal is likely to require a fund to sell assets. In Exhibit 13, the graph shows the effect on US high-yield and investment-grade credit spreads following large withdrawals from US credit funds from 2004 through 2016. Spread sensitivity in this graph is measured as *spread widening*, in bps, divided by the *percentage outflow* from US high-yield and investment-grade funds. Percentage outflow, in turn, is defined as total US dollars withdrawn from high-yield or investment-grade funds, divided by the funds' assets under management (AUM). The high-yield scale is on the left-hand side of Exhibit 13, and the investment-grade scale is on the right. The magnitude of the scales indicates that for a given percentage outflow, there is typically a greater effect on high-yield prices and spreads than on investment-grade prices and spreads. In other words, the high-yield market appears less liquid than the investment-grade market based on this measure.

Exhibit 13 Spread Sensitivity to Fund Outflows

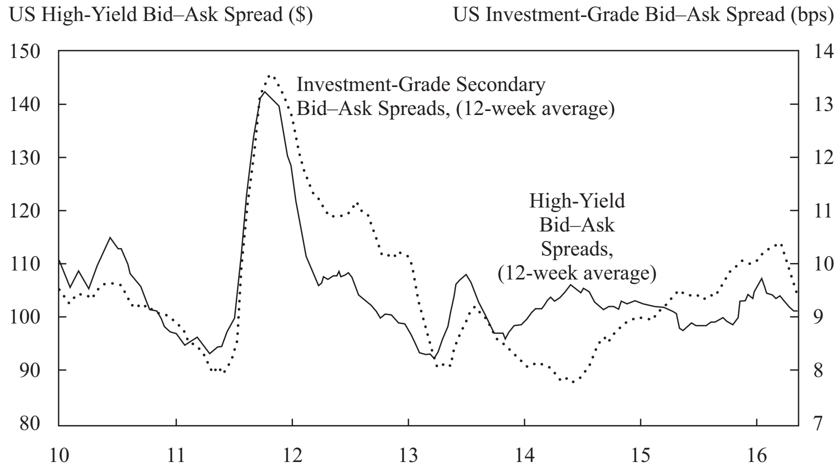


Source: Deutsche Bank and EPFR.

A key takeaway from Exhibit 13 is that spread sensitivity is not constant: It is affected by economic conditions. In both the high-yield and the investment-grade markets, the increase in spread relative to percentage outflow was greatest during the global financial crisis and in its immediate aftermath. Other financial “shocks” have also been shown to affect credit spreads.

Bid–Ask Spreads Bid–ask spreads can also be used to assess liquidity in credit markets. Exhibit 14 shows bid–ask spreads (12-week averages) for US high-yield and investment-grade markets from 2010 through 2016, measured in dollar price for high yield (left-hand side) and basis points of spread in investment grade (right-hand side). As we discussed in Section 2, quoting conventions differ between the investment-grade and high-yield markets: High-yield bonds are usually quoted in price terms, whereas investment-grade bonds are usually quoted as a spread over a benchmark government bond.

Exhibit 14 Secondary Market Bid–Ask Spreads in US High Yield and Investment Grade, 2010–2016



Source: Deutsche Bank and Thomson Reuters.

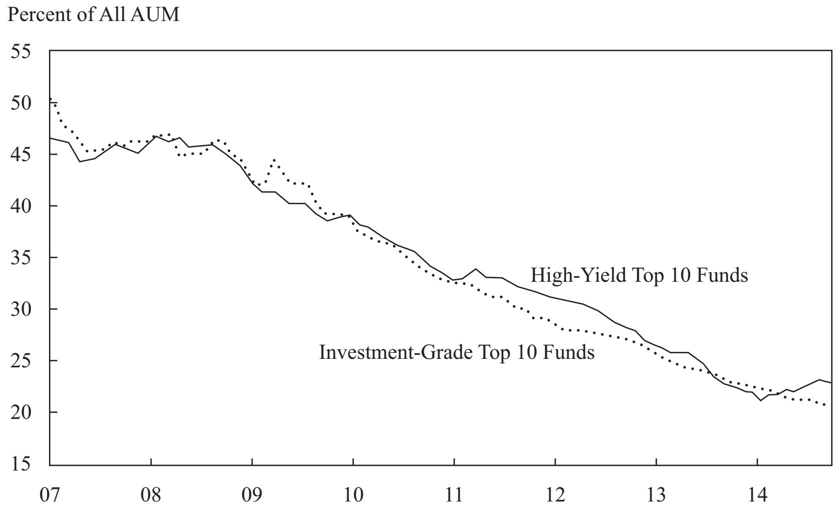
Generally speaking, bid–ask data should be analyzed cautiously because such information is stable only when markets, in turn, are stable. More-volatile market conditions often have a negative effect on bid–ask spreads. This effect is often temporary and suggests that bid–ask levels tend to stabilize after a brief period of volatility.

5.1.2 *Structural Industry Changes and Liquidity Risk*

The credit market experienced substantial structural changes following the 2008–2009 global financial crisis. Participants in the credit market depend on the dealer community to provide market liquidity in credit securities. Following the crisis, the cost of capital for dealers increased substantially, and the ability and willingness of dealers to maintain large bond positions on their balance sheets decreased significantly. These changes occurred for two reasons. First, new regulations (such as the Volcker Rule in the United States) restricted dealers' ability to take risk, hold inventories, and engage in some trading activities that may have helped to support credit market liquidity in the past. Second, dealers generally became more risk averse and opted to reduce risk and balance sheet size, even beyond what is required by regulators.

Not all structural changes in credit markets have reduced liquidity and therefore increased liquidity risk. Exhibit 15 shows the percentage of total US high-yield and investment-grade assets under management held in the 10 largest funds. Exhibit 15 shows that the concentration of US high-yield and investment-grade assets under management in the 10 largest funds decreased from 2007 through 2014. With AUM more widely dispersed among credit investors, the reduced concentration potentially increases liquidity in credit markets. That is, a larger number of independent market participants may result in differences in market views and varying interest in issuers and individual securities.

Exhibit 15 Top 10 Largest Funds, US High Yield and Investment Grade Credit, 2007–2014



Source: Deutsche Bank.

5.1.3 *Management of Liquidity Risk*

In an environment of decreased liquidity and increased liquidity risk, liquidity management has become increasingly important for credit portfolio managers. Ways to manage liquidity include holding cash; managing position sizes; holding liquid, non-benchmark bonds; and making use of credit default swap (CDS) index derivatives and exchange-traded funds (ETFs).

As the most liquid asset, cash is an important consideration in liquidity management among credit portfolio managers. In many cases, credit portfolio managers have increased the percentage of cash in their portfolios. Preceding the 2008–2009 global financial crisis, cash levels typically approximated 2% to 3% of credit portfolios. In many cases, cash levels increased following the crisis to as much as 5% to 7%.

Position sizes are selected in the context of liquidity. Typically, more-liquid credit securities are given greater portfolio weight, all else being equal. Holding greater weights of liquid credit securities and cash may decrease expected credit portfolio returns, but the liquid nature of these assets may be an increasingly important consideration among portfolio managers.

Liquid credit securities that are outside portfolio managers' benchmarks may also be used as cash surrogates. For example, a high-yield portfolio manager could use liquid investment-grade bonds as a cash surrogate, or an investment-grade investor could use Treasuries as a cash surrogate. Such positions typically provide some incremental yield over cash and can be liquidated relatively easily to raise cash for portfolio management needs.

Portfolio managers may manage liquidity risk using CDS index derivatives, such as CDX and iTraxx. The market for CDS derivatives is relatively more active than credit markets. For example, in 2015, the average daily trading volume in CDX indexes of US high-yield and US investment-grade bonds was US$7 billion and US$25 billion, respectively.[6] By comparison, in 2015, the average daily trading volume for US corporate bonds totalled US$8 billion in high yield and US$15 billion in investment

6 Source: The Depository Trust & Clearing Corporation (DTCC).

grade.[7] Put another way, the single CDX index for US high-yield bonds traded nearly as much as all US high-yield bonds in the "cash" bond market, and the CDX index for US investment-grade bonds traded significantly more than all US investment-grade bonds in the "cash" bond market.

Having grown substantially following the global financial crisis, ETFs offer another alternative for portfolio managers to manage liquidity risk. As of 31 March 2016, the total market value of high-yield and investment-grade credit ETFs was US$40 billion and US$90 billion, respectively, up from virtually zero prior to the financial crisis. Credit ETFs enable investors to more quickly obtain diversified exposure in the credit markets, although at the expense of reduced ability to actively select individual credit securities. One concern among some credit investors is that because ETFs are easy to trade, the funds may experience unusual market movements during periods of high credit volatility, and their prices may deviate from their net asset values.

5.2 Tail Risk

Tail risk is the risk that there are more actual events in the tail of a probability distribution than probability models would predict. As an example of tail risk, consider that during a 25-year period ending in August 2008, monthly total returns for the widely used Bloomberg Barclays US Corporate Index had a standard deviation of 2.1%. During the last four months of 2008, however, the monthly total returns of the Bloomberg Barclays Corporate Index were –7.8%, –6.4%, 4.1%, and 6.8%, sequentially. The absolute values of these monthly returns, respectively, were 3.7, 3.0, 2.0, and 3.2 standard deviations from the mean of the preceding 25-year period. With a normal distribution, it would have been almost impossible for a risk model based on historical returns to foresee the possibility of such a return pattern.

Tail risk events are difficult to model and virtually impossible to predict in advance. Such events do occur in credit markets, however, and often result in unexpectedly large negative and positive portfolio returns. It is important for credit investors to manage for the possibility of tail risk events.

5.2.1 *Assessing Tail Risk in Credit Portfolios*

Tail risk is, by definition, poorly measured by risk models that seek to extrapolate past behavior of securities prices to future returns. Tail risk assessment requires tools that allow for unusual patterns of returns.

5.2.1.1 Scenario Analysis A common tool for assessing tail risk in credit portfolios is **scenario analysis**, which is a risk assessment technique that examines portfolio performance under specific situations. The primary purpose of scenario analysis is to test the portfolio's performance under plausible but unusual circumstances. Scenario analysis in credit portfolios often involves projecting portfolio returns when there are large moves in corporate bond prices (because small price changes are not unusual) or large changes in spreads, and it may include scenarios based on actual historical or hypothetical events.

5.2.1.2 Historical and Hypothetical Scenario Analysis Past periods when securities prices demonstrated unusual behavior are good candidates for historical scenario analysis of tail risk. Examples include the prolonged default cycle in high-yield bonds from 2000 through 2002 and the 2008–2009 global financial crisis. Periods when defaults were concentrated in a sector, such as the telecommunication industry in the early 2000s or the housing sector in 2008, are also useful for historical scenario analysis.

7 Source: FINRA.

Because tail risk is ultimately the risk of extremely unusual events, one useful approach is envisioning events that have not occurred but might cause large moves in security prices. Hypothetical scenarios may include large moves in interest rates, exchange rates, credit spreads, or the price of oil or other commodities.

5.2.1.3 Correlations in Scenario Analysis Scenario analysis in credit often involves assessing potential changes in *correlations* between security prices. Such changes in correlations can be important because many portfolios depend on diversification as a source of risk management. During periods of financial crisis, correlations tend to move closer to 1.0.

When correlations increase significantly, a portfolio that had appeared well diversified may be subject to unexpected price movements. For example, during the 2008–2009 global financial crisis, defaults were widespread across the US residential real estate sector, and other sectors of the credit market also experienced significant losses. Returns for some sectors, such as commercial mortgage-backed securities, were 10 or more standard deviations from the mean monthly return that one could have estimated based on widely available historical data. As a result, many investors found that their portfolios were less diversified than their risk models had predicted.

As we have discussed, most credit securities are somewhat illiquid. During financial crises, securities that are somewhat illiquid can become even less liquid. Exposure to financial crises can therefore be assessed as a form of liquidity risk. Liquidity "tiers" or liquidity "scores" are tools credit investors use to measure portfolio exposure to this form of tail risk.

5.2.2 *Managing Tail Risk in Credit Portfolios*

Once an investor has identified potential tail risk events in his credit portfolio, she can attempt to manage these tail risks. Investors often use portfolio diversification and tail risk hedges to manage against tail risk events.

5.2.2.1 Portfolio Diversification A *portfolio diversification* strategy offers one way to protect against tail risk. For example, an investor's portfolio has a substantial overweight position in oil producers compared with its benchmark, and the investor is concerned that portfolio returns will suffer if oil prices fall substantially. A potential solution is to overweight positions in sectors that typically benefit from lower oil prices, such as airlines and consumer goods.

A key advantage of using a diversification strategy as a tail risk hedge is that the strategy may have only a modest incremental cost. If the investor in the preceding example believes that airlines and consumer goods are attractively valued sectors, adding overweight positions in these two sectors may improve his portfolio's risk characteristics and gain exposure to sectors in which he sees attractive value.

Portfolio diversification in tail risk management has potential limitations. An investor may find it difficult to identify attractively valued investment opportunities that can protect against every tail risk that the investor foresees. Also, the use of portfolio diversification as tail risk protection may not fully achieve an investor's objectives. Referring back to the oil price example, airlines and consumer goods companies may not have the same sensitivity to changes in oil prices that oil producers do. If oil prices fall, airlines and consumer goods may not provide the loss protection against declining oil prices that the investor expects.

5.2.2.2 Tail Risk Hedges A *tail risk hedge* strategy involves using securities or derivatives that act as "insurance" in tail event scenarios. The use of tail risk hedges gives an investor increased ability to manage the most concerning risks.

The most commonly used instruments in a tail risk hedge strategy are CDS and options. Consider again the example of a portfolio with an overweight allocation to oil producers. The investor may consider buying put options on oil futures contracts.

Alternatively, he may buy CDS or credit spread options on the bonds of the oil producers he finds least attractively valued. These choices allow the investor to specifically hedge against oil price movements or against default in oil producing issuers.

The primary drawback of tail risk hedging is that, like insurance, it typically has a cost and therefore lowers portfolio returns if the tail risk event does not occur. Not surprisingly, tail risk hedges tend to be most expensive when the tail risk event seems most likely to occur. Investors must therefore carefully consider the costs and benefits of tail risk protection. If the investor determines that the probability of an adverse event occurring is sufficiently high, he may be willing to pay for protection against that possibility—even if it does not improve the portfolio's expected return.

Investors who cannot use derivatives face an additional challenge in hedging tail risk. Derivatives are often the most inexpensive and capital-efficient tail risk hedges in the credit market, and those investors who cannot use derivatives may be unable to hedge certain tail risks.

6 INTERNATIONAL CREDIT PORTFOLIOS

Many credit portfolios include bonds issued in multiple countries and currencies, and as a result, credit portfolio managers often need to consider global implications in their portfolios. At the end of 2015, the Bloomberg Barclays Global Credit Index comprised more than 15,000 securities denominated in 14 currencies, with issuers domiciled in 114 countries.

Even portfolio managers who focus exclusively on bonds issued in a single country and denominated in that country's currency must be aware that international implications exist for those bonds. For many companies, particularly large ones, a sizable portion of their revenues come from outside their home countries. Also, many companies purchase or produce a significant portion of their products outside of their home countries. For example, US-based Apple Inc. generated more than 60% of its 2015 revenues outside the United States and had significant operations outside of the United States.

6.1 Relative Value in International Credit Portfolios

Credit portfolio managers can sometimes identify relative value opportunities when country or regional differences arise in credit cycles, credit quality and sector composition, or market factors.

Credit cycles typically affect the entire global credit universe, but to varying degrees across regions. For example, in 1997 and 1998, a high level of corporate defaults was largely confined to emerging markets; a few years later, in 2001 and 2002, corporate default levels were high in the United States and Europe but relatively low in emerging markets. Defaults during the 2008–2009 global financial crisis were concentrated in US credit markets, but a few years later, Europe experienced elevated default levels amid a sovereign debt crisis. In general, determining the timing and location of credit cycle weakening is an important top-down relative value consideration for global credit portfolio managers.

The credit quality of issuers typically differs by region. For example, European high-yield indexes have a higher concentration of BB rated bonds, whereas US high-yield indexes have a higher concentration of CCC rated bonds. Given this regional difference in ratings, investors may expect that in a bullish market environment, the US high-yield market will outperform the European high-yield market.

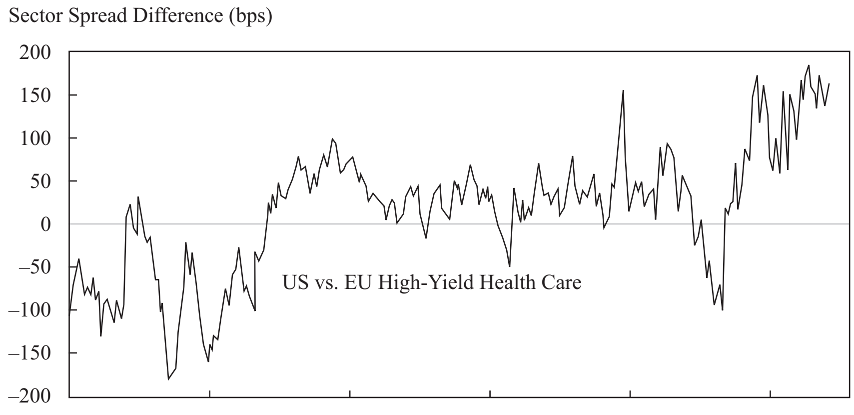
Sector composition also differs by region. For example, the energy industry has a higher representation in US credit market indexes than in European credit market indexes (both in investment grade and high yield). This difference in sector composition contributed to the outperformance of European credit markets relative to US markets during 2014 and 2015, when oil prices sharply declined.

Market factors, including both supply and demand factors, often vary globally with respect to corporate bonds. For example, in the United States, new issuance of investment-grade corporate bonds reached an all-time high in 2015. This high supply of corporate bonds in the US market partly contributed to the underperformance of the US investment-grade credit market compared with other global credit markets (where corporate bond issuance was not as strong) during 2015. Demand for corporate bonds may differ because of the composition of investor type. Some investors (such as pension funds) often prefer, or are mandated by law, to invest in their own country's assets or markets. Demand may also differ as a result of investor preferences. For example, the negative interest rate climate in Europe during 2015 and early 2016 resulted in many investors favoring European credit securities over sovereign bonds for better yield opportunities in the region. This increase in European credit investment resulted in significant valuation differences compared with US credit markets.

Exhibit 16 provides evidence of the valuation difference between the US and European (designated as "EU") high-yield credit markets from 2011 through 2016. The graphs in the exhibit show the average monthly spread difference (in basis points) between the US and European high-yield health care sectors and between the US and European high-yield automotive markets, based on Deutsche Bank indexes. The credit spread levels of these two industry sectors are reasonably aligned from 2013 through 2015 but sometimes demonstrate significant valuation differences (in both directions) when market dynamics vary widely in the US and European credit markets. These valuation differences could reflect varying macro trends, sector credit quality, and investor flows across regions.

Exhibit 16 Sector Spread Differences in US and European High Yield, 2010–2016

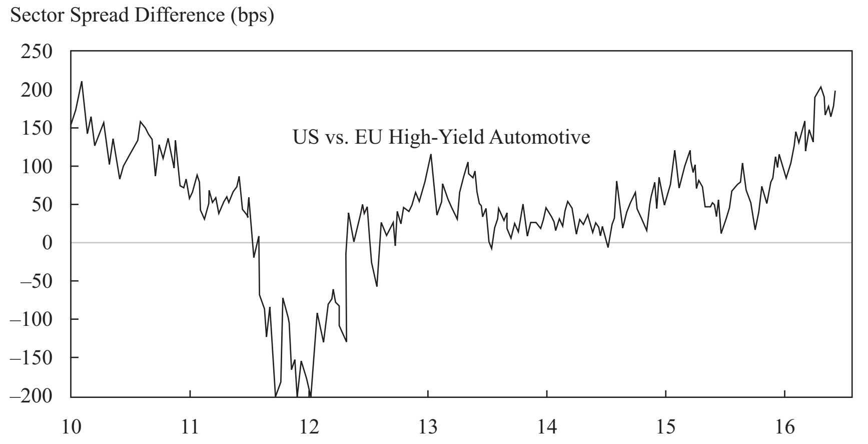
Panel A



(continued)

Exhibit 16 (Continued)

Panel B



Source: Deutsche Bank.

6.2 Emerging Markets Credit

The growth of the emerging market credit universe has created additional investment opportunities for credit investors. According to Deutsche Bank indexes, from 2005 to 2015, the size of the emerging market corporate bond universe increased from US$210 billion to US$1.25 trillion. As of 2015, the size of the emerging market corporate bond universe was approximately the size of the US high-yield credit market.

Several differences exist between credit markets in emerging market countries and credit markets in developed countries, including the following:

- *Concentration in commodities and banking.* Commodity producers and banks represent a much higher proportion of emerging market indexes than of developed market indexes. Because loan portfolios of emerging market banks are often highly exposed to the commodity sector, the effect of commodities, either directly or indirectly, on emerging markets can be even more pronounced.
- *Government ownership*. Many emerging market bond issuers are government owned or have a controlling or partial stake owned by their local government. When a government owns or controls a company, a primary advantage for credit investors is the potential for explicit or implicit support in the event of a perilous financial situation for the company. A primary disadvantage for credit investors is uncertainty in the contractual rights and interests of non-domestic bondholders as part of a debt restructuring. Historically, recovery rates for emerging market bonds in default, on average, are lower than in developed markets. Moody's estimates that between 1982 and 2013, the average recovery rate for senior unsecured bonds issued by Latin American companies was 34%, compared with 42% for senior unsecured bonds issued by US companies.
- *Credit quality*. Compared with that of developed markets, the emerging market credit universe has a high concentration in both the lower portion of the investment-grade rating spectrum and the upper portion of high yield. This concentration of credit ratings largely reflects the sovereign ratings of emerging markets. Rating agencies typically apply a "sovereign ceiling" to corporate issuers globally, implying that (with few exceptions) a company is normally rated no higher than the sovereign credit rating of its domicile.

6.3 Global Liquidity Considerations

Liquidity has important implications for global credit portfolios. All credit markets tend to have liquidity issues, but the level of illiquidity varies across countries and regions. The US credit market is one of the most liquid, reflecting its market value; number of issuers, dealers, and investors; and size and frequency of new bond issuance compared with the credit markets in most other countries and regions. In addition, trade reporting systems such as TRACE in the United States, which provides transparency of information, are virtually non-existent elsewhere in the world. In contrast to the United States, liquidity conditions in emerging markets tend to be particularly constrained. In emerging markets, a relatively small number of bonds trade regularly, which typically results in investors demanding higher premiums for holding emerging market credit securities. In general, credit portfolio managers need to recognize global illiquidity issues when seeking to expand their portfolios to global credit markets, including effects on valuation.

6.4 Currency Risk in Global Credit Portfolios

Non-domestic currency movements represent a major risk of investing in global credit markets. Currency risk can be particularly relevant when interest rates are very low. If investment-grade credit returns in the local currency are modest, a non-domestic credit investor's expected return can easily be erased by currency movements. A practical way of dealing with currency risk in credit portfolios is to hedge foreign exchange exposures. Global credit portfolio managers often use currency swaps to hedge foreign exchange exposures, if such swaps are available and cost-effective. Pegged currencies, such as the Chinese yuan and the Hong Kong dollar, can provide geographical diversification while limiting foreign exchange volatility and the need for hedging.

6.5 Legal Risk

Global differences in regulations and laws, such as bankruptcy laws, are an additional source of risk for international credit portfolio managers. Nearly all countries have complex bankruptcy laws, and investors who lack a full understanding of these laws could face a lower-than-expected recovery rate in the event of a corporate bond default. Credit investors face a single federal bankruptcy law in the United States, but the situation differs in regions such as the European Union, where each country has its own unique bankruptcy laws. In some less developed markets, creditors must sometimes face legal systems that are influenced by government officials and equity holders.

STRUCTURED FINANCIAL INSTRUMENTS

7

Structured financial instruments are securities that are supported (backed) by collateral, or pools of assets, and in turn repackage risks. Common types of structured financial instruments include mortgage-backed securities (MBS), asset-backed securities (ABS), collateralized debt obligations (CDOs), and covered bonds. The terminology regarding structured financial instruments varies by jurisdiction. Notably, MBS are a form of ABS that represent rights to receive cash flows from portfolios of mortgage loans. The distinction between MBS and other types of ABS is common in the United States.

Investors can benefit from using structured financial instruments in credit portfolios. One such benefit for investors is the potential for higher portfolio returns compared with traditional fixed-income securities. Many structured financial instruments are divided into multiple tranches with different risk and return profiles (and accompanying different credit ratings). Under this structure, a risk-averse investor may elect to purchase a senior tranche that provides lower potential risk and return, whereas a risk-tolerant investor may elect to purchase a mezzanine tranche with higher potential risk and return. Another benefit for investors who use structured financial instruments is the potential for relative value opportunities. Such opportunities may exist because corporate credit securities and structured financial instruments often differ in their features, valuation, and risk exposures. If an investor wants exposure to a specific market or macroeconomic factor such as real estate, interest rate volatility, or consumer credit, the structured finance market provides investment opportunities that may be more difficult to implement through corporate credit.

Another benefit of using structured financial instruments is improved portfolio diversification. As an example, during the 10-year period from 2006 through 2015, the Bloomberg Barclays Global Corporate Index had an annualized total return of 4.3% with an annualized standard deviation (volatility) of 7.0%. A portfolio that invested 75% of its assets in the Bloomberg Barclays Global Corporate Index and 25% in the Bloomberg Barclays Global Securitized Index would have had almost identical returns, but volatility would have been almost 1% (or 100 bps) lower per year. The types of collateral pools that can support structured finance securities are quite heterogeneous and may have very different fundamental drivers of value than corporate or government bonds.

Because the US structured finance market is the largest in the world, the discussion and examples in this section often refer to the United States. However, many non-US investors hold US structured financial instruments in their portfolios, notably MBS.

7.1 Mortgage-Backed Securities

MBS, in particular residential MBS (RMBS), constitute a significant portion of the structured finance sector. In addition to the potential for portfolio diversification, MBS may provide other advantages relative to corporate bonds:

1 *Liquidity*. Agency RMBS, which are securities backed by a US government agency (Ginnie Mae, or the Government National Mortgage Association) or by either of the US government-sponsored enterprises Fannie Mae (the Federal National Mortgage Association) or Freddie Mac (the Federal Home Loan Mortgage Corporation), are often an attractive alternative to corporate bonds. Agency RMBS may provide similar returns and better liquidity than high-quality corporate bonds. The US agency mortgage market is one of the most liquid credit markets in the world. According to a 2014 Federal Reserve study, average trading volumes in the most liquid US agency mortgages were between \$10 billion and \$80 billion per day in the preceding two years, similar to volumes in the US Treasury market and many times the average trading volume of the 100 most liquid US corporate bonds (\$15 million to \$40 million).[8]

2 *Exposure to real estate*. MBS can be used to more directly express investment views on real estate markets, in both residential properties (through RMBS) and commercial properties (through commercial MBS, or CMBS), compared with corporate bonds. Although corporate bonds issued by certain types of

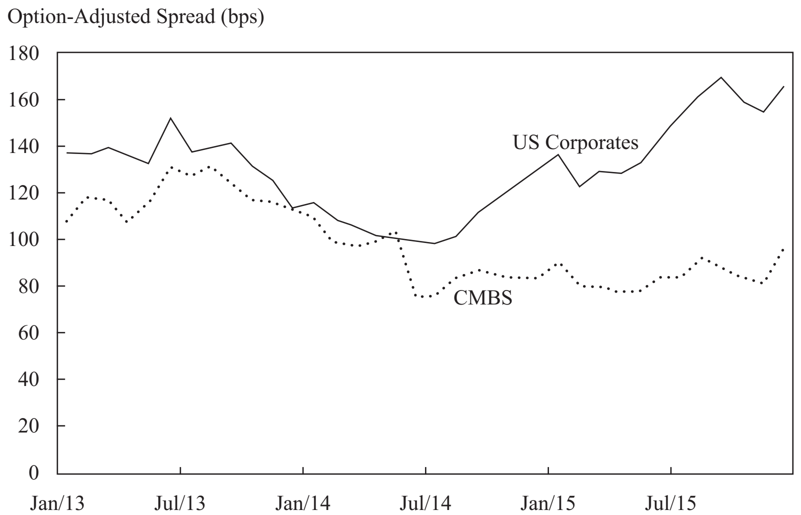
8 https://www.federalreserve.gov/econresdata/notes/feds-notes/2014/measuring-agency-mbs-market-liquidity-with-transaction-data-20140131.html. US Treasury volume was measured as daily interdealer nominal trading volume of on-the-run 10-year US Treasury bonds. Agency MBS volume was measured as daily averages of trading volume of 3.0%, 3.5%, and 4.0% coupon, 30-year, To-Be-Announced MBS issued by Fannie Mae. US Corporate volume was measured as daily trading volume per bond of 100 of the most frequently traded investment-grade bonds.

companies such as property developers, real estate investment trusts (REITs), and certain banks may offer exposure to real estate, MBS can be used to express targeted or levered investment views on the real estate sector.

3 *Exposure to expected changes in interest rate volatility*. Agency MBS have low default risk because their interest and principal payments are guaranteed by either a US government agency or a US government-sponsored enterprise. A primary risk of agency MBS is prepayment risk, which is the uncertainty that the timing of the actual cash flows from the MBS will differ from and occur earlier than the scheduled cash flows as a result of interest rate decreases. Agency MBS are also subject to extension risk, which is the uncertainty that the timing of the actual cash flows will differ from and occur *later* than the scheduled cash flows because of interest rate *increases*. The performance of agency MBS is thus closely linked to expectations for interest rate volatility. If an investor wants to express a view that market expectations of interest rate volatility will decrease, she can buy agency MBS in her portfolio. Corporate bonds with optionality also have meaningful sensitivity to expectations of changes in interest rate volatility, but they typically have less liquidity and more default risk than agency MBS.

MBS are a useful tool for investing based on views of the credit cycle and the real estate cycle. These cycles can behave differently in response to economic conditions. For example, partly in response to concerns about global growth and falling commodity prices, corporate bond spreads widened from July 2014 through the end of 2015. During the same period, US commercial real estate prices stayed relatively stable, and securitized assets such as CMBS backed by US-based properties performed relatively well. Exhibit 17 displays the price behavior during this period, illustrated by OAS for both US CMBS and US corporate bonds from 2013 through 2015. As the exhibit shows, CMBS spreads were significantly more stable than corporate spreads during this period. An investor who recognized the divergent fundamental trends in the corporate and commercial real estate markets in 2013 or early 2014 could have improved portfolio returns and lowered portfolio volatility by selling (or underweighting) US corporate bonds and buying (or overweighting) US CMBS.

Exhibit 17 US CMBS and US Corporate Bond OAS, 2013–2015



Source: Barclays Capital.

7.2 Asset-Backed Securities

Several types of non-mortgage assets are used as collateral for ABS, including automobile loans, automobile lease receivables, credit card receivables, student (or other personal) loans, bank loans, and accounts receivable.

In addition to possible portfolio diversification and return benefits, ABS may provide a way for investors to express views on consumer credit. At the end of 2015, the credit card and auto loan components of the Bloomberg Barclays US Aggregate Index together had a market value of more than $97 billion, and the Consumer Cyclical Services sector of the index had a market value of about $51 billion. ABS are more-liquid alternatives to corporate bonds for expressing views on some sectors.

7.3 Collateralized Debt Obligations

A collateralized debt obligation is a security backed by a diversified pool of one or more debt obligations. Nearly all CDOs include some form of subordination, also referred to as credit tranching. With subordination, a CDO has more than one bond class or tranche, such as senior bond classes, mezzanine bond classes (bond classes with credit ratings between senior and subordinated bond classes), and subordinated bond classes (often referred to as the residual or equity tranches).

The collateral for a CDO is usually corporate loans or bonds. As a result, CDOs do not provide much diversification benefit compared with corporate bonds, and they do not offer unique exposure to a sector or market factor. There are potential benefits to including CDOs in a credit portfolio, however.

1 *Relative Value.* The valuation of CDOs may vary from the valuation of their underlying collateral. For example, during the global financial crisis, many CDOs were trading at prices well below theoretical levels based purely on the default rate expectations priced into the underlying collateral. All collateralized loan obligations (CLOs)—which are CDOs collateralized by leveraged loans—rated AAA and AA by Standard and Poor's withstood the crisis without experiencing a default or loss of principal. Yet during certain times in this period, spreads of AAA– and AA rated CLOs were comparable to the spreads of high-yield corporate bonds. An investor with a sufficiently long holding period could have taken advantage of this opportunity by selling (or selling short or buying credit default swaps on) investment-grade-rated corporate bonds and purchasing CLO tranches with more spread than the corporate bonds he sold. As the CLOs recovered in price or matured without experiencing default losses, his portfolio would likely have profited.

2 *Exposure to Default Correlations.* The correlation of expected defaults on the collateral of a CDO affects the relative value between the senior and subordinated tranches of the CDO: As correlations increase, the value of mezzanine tranches usually *increases* relative to the value of senior and equity tranches.

   To understand this phenomenon, consider a CDO consisting of a senior tranche, Class A, and a subordinated tranche, Class B, each with issue size of ¥10 billion. Suppose that the collateral pool contains two loans, each of which is also ¥10 billion. Finally, assume that in the event of default, either loan would have zero recovery value.

   If the correlation of expected defaults between these two loans is −1, then one loan will default and the other will not. In this scenario, the subordinated tranche has little value (it may receive a few interest payments but will lose all principal). The senior tranche, however, will receive the entire principal and thus has much more value. If an investor expects the default correlation to be substantially negative, she can try to profit by selling (or selling short) Class B, the subordinated tranche, and buying Class A, the senior tranche.

On the other hand, if the default correlation between the loans is one, then either both loans will default, or neither will default. In this case, the senior and subordinated tranches have the same chance of receiving their principal. If the junior tranche pays a higher interest rate than the senior tranche, then it may in fact be *more* valuable than the senior tranche. If the investor expects the correlation to be highly positive, she can try to profit by selling (or selling short) Class A and buying Class B.

Although the complexity of the mathematics increases for both less-than-perfect correlations and the addition of credit tranches in a CDO's structure, the basic point remains. The market prices of CDOs are based in part on investors' expectations of credit default correlations, and investors can use CDO tranches to express such views.

3 *Leveraged Exposure to Credit*. Mezzanine and equity tranches of CDOs provide a mechanism for investors to gain additional return if the underlying collateral has strong returns. Conversely, these tranches also face heightened risk of losses in an adverse credit environment. This risk–return trade-off of mezzanine and equity tranches of CDOs thus essentially provide leveraged exposure to the underlying collateral.

7.4 Covered Bonds

Covered bonds constitute another class of structured financial instruments. A covered bond is a debt obligation issued by a financial institution, usually a bank, and backed by a segregated pool of assets called a "cover pool." In the event of default, bondholders have recourse against both the financial institution and the assets in the cover pool. Because of this dual protection for creditors, covered bonds usually carry lower credit risks and offer lower yields than otherwise similar corporate bonds or ABS.

Investors typically view covered bonds as a lower-risk alternative to financial sector bonds. An investor who wants to reduce his portfolio's risk to the financial sector may sell corporate debt issued by banks and buy covered bonds instead. The most common type of covered bonds are Pfandbriefe,[9] which are issued by German banks. The Pfandbrief bond market is the biggest segment of the euro-denominated private bond market in Europe.[10]

EXAMPLE 11

Structured Financial Instruments

Describe how an investor may benefit from adding structured financial instruments to a credit portfolio.

Solution:

In credit portfolios, structured financial instruments may provide several benefits when added to a credit portfolio. One potential benefit is the possibility of higher portfolio returns of structured financial instruments compared with corporate credit securities; potential relative value opportunities may exist for

9 Pfandbriefe is the plural form. One such bond is called a Pfandbrief.
10 "Pfandbrief-Style Products in Europe," Orazio Mastroeni, European Central Bank.

structured financial instruments because of different features, valuation, and risk exposures compared with corporate credit securities. Another benefit of structured financial instruments is the possibility of more-targeted exposure to a certain market or sector. For example, if an investor wants exposure to the real estate sector, structured financial instruments provide investment opportunities that may be more difficult to implement through corporate credit. Finally, structured financial instruments improve the diversification to a credit portfolio.

SUMMARY

This reading covers strategies and risk considerations in the construction and management of credit portfolios. Key points include the following:

- Credit risk is usually the most important consideration for high-yield portfolio managers. For investment-grade portfolio managers, interest rate risk, spread risk, and credit migration (or credit downgrade) risk are typically the most relevant considerations.
- The risk in a portfolio of investment-grade bonds is typically measured in terms of spread duration.
- Credit spreads tend to be negatively correlated with risk-free interest rates.
- When default losses are low and credit spreads are relatively tight, high-yield bonds tend to behave more like investment-grade bonds; that is, with greater interest rate sensitivity.
- High-yield bonds tend to be less liquid than investment-grade bonds because of higher return volatility in the high-yield bond market; smaller inventories of high-yield bonds than of investment-grade bonds held by broker/dealers; and smaller size of the high-yield market compared with the investment-grade market.
- Reflecting differences in liquidity between high-yield and investment-grade bonds, bid–offer spreads are larger for high-yield bonds.
- Credit spread measures include spread over the benchmark, the G-spread, the I-spread, the Z-spread, and option-adjusted spread. Each measure has advantages and disadvantages in use.
- Excess return is the compensation that a bond investor receives for assuming credit risk. When considering excess return, credit portfolio managers typically manage interest rate risk separately.
- A bottom-up approach to credit strategy involves selecting the individual bonds or issuers that the investor views as having the best relative value from among a set of bonds or issuers with similar characteristics (usually the same industry and often the same country of domicile).
- A spread curve is the fitted curve of credit spreads for each bond of an issuer plotted against either the maturity or duration of each of those bonds. A spread curve may be useful in conducting bottom-up relative value analysis.
- A top-down approach to credit strategy involves the investor formulating a view on major macroeconomic trends, such as economic growth and corporate default rates, and then selecting the bonds that she expects to perform best in the expected environment.

- Top-down portfolio managers commonly use several measures to gauge the credit quality of their portfolios: (1) average credit quality; (2) average OAS; (3) average spread duration; (4) duration multiplied by spread.
- In practice, investors often employ a combination of a top-down and bottom-up approach to credit strategy.
- Some fixed-income mandates include a requirement that the portfolio consider environmental, social, and governance factors in the investment process. ESG factors are particularly relevant to the credit component of fixed-income portfolio mandates.
- Liquidity risk is prominent in the credit markets, particularly following the global financial crisis. Measures of secondary market liquidity include trading volume, spread sensitivity to fund outflows, and bid–ask spreads.
- Liquidity management tools used by credit portfolio managers include cash, position sizing, credit default swap index derivatives, exchange-traded funds, and liquid bonds outside the benchmark.
- Scenario analysis is a common tool for assessing tail risk in credit portfolios. Two principal tools that investors use to manage tail risk include portfolio diversification and tail risk hedges.
- Many investors manage bonds that are issued in multiple countries and currencies and therefore need to consider international (global) implications.
- Credit portfolio managers can improve returns through geographic diversification (investing across various countries and regions). Risks of geographic diversification include geopolitical risk, elevated liquidity risk, currency risk, and legal risk.
- Credit investors sometimes use structured financial instruments as alternatives to corporate bonds. Common types of structured financial instruments include mortgage-backed securities, asset-backed securities, collateralized debt obligations, and covered bonds.

REFERENCES

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PRACTICE PROBLEMS

The following information relates to Questions 1–9

Emma Gerber and Juliette Petit are senior and junior credit portfolio managers, respectively, for a European money management firm. They are discussing credit management strategies and preparing for an annual meeting with a major client.

One of their high-yield bond holdings is a 10-year bond issued by EKN Corporation (EKN). The bond has a price of 91.82, a modified duration of 8.47, and a spread duration of 8.47. For this bond, Petit speculates on the effects of an interest rate increase of 20 bps and, because of a change in its credit risk, an increase in the EKN bond's credit spread of 20 bps. Petit comments that because the modified duration and credit spread duration of the EKN bond are equal, the bond's price will not change (all else being equal) in response to the interest rate and credit spread changes.

Gerber explains the concept of empirical duration to Petit and makes the following points.

Point 1: A common way to calculate a bond's empirical duration is to run a regression of its price returns on changes in a benchmark interest rate.

Point 2: A bond's empirical duration tends to be larger than its effective duration.

Point 3: The price sensitivity of high-yield bonds to interest rate changes is typically higher than that of investment-grade bonds.

Exhibit 1 shows information for three BBB rated bonds issued by a large automotive company. Gerber asks Petit to interpret the data in the table and notes that the current interest rate environment is characterized by a positively sloped yield curve.

Exhibit 1 Selected Data for Three BBB Rated Bonds

	Bond 1	Bond 2	Bond 3
Price	99.350	130.054	101.135
Coupon (%)	3.100	7.500	4.300
G-spread (bps)	162.3	228.3	148.6
I-spread (bps)	176.9	242.8	103.3
Z-spread (bps)	178.4	246.9	102.4
OAS (bps)	70.2	234.9	78.8

Petit makes three observations about these bonds.

Observation 1 We should buy Bond 1 because the difference between its Z-spread and OAS is the largest.

Observation 2 We prefer Bond 1 to Bond 3 because Bond 1 has a greater Z-spread.

Observation 3 Bond 2 is a non-callable bond because its option-adjusted spread (OAS) is similar to the bond's other three spread levels.

Petit observes that credit spread levels for bonds are currently higher than normal, and she recommends that the firm increase its investment in high-yield bonds. She mentions three reasons for increasing high-yield bond exposure.

- Reason 1: The portfolio's liquidity will improve.
- Reason 2: Defaults on high-yield bonds will be relatively low.
- Reason 3: The firm's view is that economic growth will be greater than the consensus forecast.

Petit develops investment recommendations for a currency-hedged portfolio of US and European corporate bonds. She expects US interest rates to decline relative to European interest rates. Furthermore, the spread curve for US corporate bonds indicates that the average spread of five-year BB bonds exceeds the average spread of two-year BB bonds by +90 bps. Petit expects the difference between average credit spreads for these two sectors to narrow to +50 bps.

Gerber is looking at the high-yield portfolio and investigates secondary market characteristics that would increase the portfolio's liquidity.

On another topic, Gerber is concerned that the scenario analysis models for the credit portfolio underestimate tail risk, and she asks Petit how to address this issue. Petit responds, "We can change the expected correlations between prices in our models to generate more extremely unusual outcomes."

Gerber is preparing for the annual meeting with one of the firm's largest clients. The client wants to explore more international credit investing. Gerber anticipates that the client will ask about differences between investing in emerging markets (EM) credits and developed markets credits. To address this potential inquiry, Gerber plans to emphasize the following differences.

Difference 1:	Commodity producers and banks represent a higher proportion of EM indexes than of developed market indexes.
Difference 2:	Total or partial government ownership of EM issuers is common, which results in a higher average recovery rate for defaulted senior unsecured bonds for EM markets than for developed markets.
Difference 3:	Compared with developed markets, the credit quality of EM issuers tends to be more concentrated at the very high and very low portions of the credit spectrum.

Gerber also is preparing a more general discussion about domestic versus international portfolio management. In Gerber's written report, Petit identifies three statements that she wants to check for accuracy.

Statement 1	Currency risk in global credit portfolios can be mitigated by using currency swaps or by investing in credits denominated in currencies that are pegged or tightly managed by the government.
Statement 2	Liquidity concerns for EM credits are mitigated by their frequency of trading and modest legal risk.
Statement 3	Sectors tend to perform similarly across regions.

1 Is Petit's prediction correct that the EKN bond price will not change in response to the interest rate and credit spread changes, all else being equal?

A Yes

B No, the bond price should decrease.

C No, the bond price should increase.

2 Which of Gerber's points about empirical duration is correct?

A Point 1

B Point 2

C Point 3

3 Which of Petit's observations about the three BBB rated bonds is *most likely* correct?

A Observation 1

B Observation 2

C Observation 3

4 Which reason *best* supports Petit's recommendation to increase the firm's investment in high-yield bonds?

A Reason 1

B Reason 2

C Reason 3

5 Based on Petit's expectations for US and European corporate bonds, which of the following positions relative to the portfolio's benchmark should she recommend?

	US Bonds	European Bonds	US Two-Year BB	US Five-Year BB
A	Overweight	Underweight	Overweight	Underweight
B	Overweight	Underweight	Underweight	Overweight
C	Underweight	Overweight	Underweight	Overweight

6 What secondary market characteristics would *most likely* have Gerber's desired effect on portfolio liquidity?

A Decreased trading volume

B Less spread sensitivity to fund outflows

C A decrease in broker/dealer holdings

7 To address Gerber's tail risk concern, Petit should recommend that expected correlations with their models:

A decrease.

B do not change.

C increase.

8 Which of Gerber's three differences about investing in EM credits compared with developed market credits is most correct?

A Difference 1

B Difference 2

C Difference 3

9 Which of Gerber's statements about international credit management is correct?

A Statement 1

B Statement 2

C Statement 3

The following information relates to Question 10–15

Megan Easton is a portfolio manager with Dynamo Investment Partners (Dynamo) and manages a bond portfolio that invests primarily in investment-grade corporate bonds with a limited amount of US government bonds. Easton meets with John Avelyn, a newly hired analyst, to discuss the structure and management of this investment portfolio, as well as some possible changes to the portfolio composition.

Easton begins the meeting by stating her belief that the credit spread is the single most important measure that investors use when selecting bonds. Among the various credit spread measures, including the G-spread, I-spread, and Z-spread, Easton prefers the G-spread.

Easton and Avelyn next discuss credit strategy approaches. Dynamo uses a bottom-up approach that selects bonds with the best relative value from the universe of bonds with similar characteristics. Avelyn comments on the following considerations in a bottom-up approach.

Comment 1	Callable debt has a smaller option-adjusted spread than comparable non-callable debt.
Comment 2	Benchmark corporate bond issues normally have wider spreads than older bonds of the same issuer.
Comment 3	The announcement of a new corporate bond issue often leads to an increase in the credit spread on the existing bonds.

Dynamo is changing the bond portfolio's investment constraints so that it can invest up to 20% of the assets in high-yield corporate bonds and 20% in structured financial instruments. Easton makes the following statement about these changes:

> Liquidity and trading issues for high-yield bonds, such as investment-grade bonds, will be a key consideration in our security selection. Although both high-yield and investment-grade bonds are quoted as spreads over benchmark government bonds, we must be aware that dealers are likely to hold larger inventories of high-yield bonds and their bid–offer spreads will be larger.

Avelyn makes the following statements about the differences between investment-grade and high-yield bonds.

Statement 1	When default losses are low and credit spreads are relatively tight, high-yield bonds tend to perform more like investment-grade bonds.
Statement 2	Investment-grade bonds have greater exposure to credit risk than high-yield bonds.
Statement 3	High-yield bonds have more exposure to interest rate risk than investment-grade bonds.

Two of the structured financial instruments that Easton and Avelyn are considering for Dynamo's portfolio are collateralized debt obligations (CDOs) and covered bonds. Easton and Avelyn make the following comments about the securities.

(continued)

Easton:	If the correlation of the expected defaults on the CDO collateral of the senior and subordinated tranches is positive, the relative value of the mezzanine tranche compared with the senior and equity tranches will increase.
Avelyn:	Replacing a portion of the corporate bonds with CDOs will provide meaningful diversification to the investment portfolio.
Avelyn:	Investing in covered bonds will give us the yield increase we are seeking compared with investing in corporate bonds or asset-backed securities.

10 A benefit of Easton's preferred credit spread measure is that it:

A provides a good measure of credit spread for bonds with optionality.

B uses swap rates denominated in the same currency as the credit security.

C reduces the potential for maturity mismatch.

11 Which of the following is *most likely* to be used when selecting securities based on Dynamo's credit strategy approach?

A Macro factors

B Expected excess returns

C Average option-adjusted spread

12 Which of Avelyn's comments regarding considerations in the bottom-up approach is *most* accurate?

A Comment 1

B Comment 2

C Comment 3

13 Which of Easton's statements about the liquidity and trading characteristics of high-yield and investment-grade bonds is *most* correct?

A Dealers generally hold larger inventories of high-yield bonds than investment-grade bonds.

B Both high-yield and investment-grade bonds are quoted as spreads over benchmark government bonds.

C The bid–offer spread of high-yield bonds is normally larger than that of investment-grade bonds with similar maturities.

14 Which of Avelyn's statements about the differences between investment-grade and high-yield bonds is accurate?

A Statement 1

B Statement 2

C Statement 3

15 Which comment regarding CDOs and covered bonds is accurate?

A Easton's comment

B Avelyn's first comment

C Avelyn's second comment

SOLUTIONS

1 B is correct. An increase in interest rates results in a decrease in the bond price. An increase in the credit spread also results in a decrease in the bond price. For the EKN bond, its modified duration shows the effect of the 20 bp increase in interest rates. The approximate percentage price change resulting from the increase in interest rates is $-8.47 \times 0.0020 = -1.694\%$. The spread duration shows the effect of the 20 bp increase in the credit spread. The approximate percentage price change resulting from the increase in the credit spread is $-8.47 \times 0.0020 = -1.694\%$. The combined effect is a total change of –3.388%, or a price decrease of roughly 3.4%.

2 A is correct. A bond's empirical duration is often estimated by running a regression of its price returns on changes in a benchmark interest rate.

3 C is correct. The OAS for Bond 2 is close to the bond's other spread levels and thus indicates that there is little embedded optionality in the bond. As a result, Bond 2 is most likely not callable.

4 C is correct. Better-than-expected economic growth is typically associated with narrower credit spreads and lower default rates for high-yield bonds.

5 B is correct. Petit should recommend markets in which yields are expected to decline relative to other markets. As a result, Petit should recommend overweighting US bonds relative to European bonds and overweighting US five-year BB bonds relative to US two-year BB bonds.

6 B is correct. Spread sensitivity is the effect on credit spreads of large withdrawals by investors from credit funds. Spread sensitivity can be measured as the spread widening (in basis points) divided by the percentage outflow from high-yield funds (funds withdrawn divided by assets under management). A decrease in the spread sensitivity to fund outflows would most likely indicate an increase in liquidity.

7 C is correct. Increasing the correlations would likely increase the number of extremely unusual outcomes and, thereby, increase estimated tail risk. Higher correlations in the model increase the dispersion of outcomes (effectively decreasing diversification).

8 A is correct. EM indexes have a higher proportion of commodity producers and banks than developed market indexes have.

9 A is correct. Global credit managers do use currency swaps and invest in pegged currencies to hedge foreign exchange exposures.

10 C is correct. The G-spread is the spread over an actual or interpolated benchmark (usually government) bond. A benefit of the G-spread is that when the maturity of the credit security differs from that of the benchmark bond, the yields of two government bonds can be weighted so that their weighted average maturity matches the credit security's maturity.

11 B is correct. Analyzing expected excess returns against the expected magnitude of the credit-related risks is key to the bottom-up approach. Once the credit universe has been divided into sectors, the investor identifies the bonds with the best relative value within each sector. If Dynamo decides that two issuers have similar credit-related risks, then it will typically compare credit spread measures and buy the bonds of the issuer with the higher spread because those bonds likely have a higher potential for excess returns. For issuers with different credit-related risk, Dynamo must decide whether the additional spread adequately compensates for the additional credit risk.

12 C is correct. When an issuer announces a new corporate bond issue, the issuer's existing bonds often decline in value and their spreads widen. This dynamic is often explained by market participants as an effect of increased supply. A related reason is that because demand is not perfectly elastic, new issues are often given a price concession to entice borrowers to buy the new bonds. This price concession may result in all of an issuer's existing bonds repricing based on the new issue's relatively wider spread. A third reason is that more debt issuance may signal an increase in an issuer's credit risk.

13 C is correct. Bid–offer spreads are larger for high-yield bonds than for investment-grade bonds of similar maturity.

14 A is correct. Investment-grade corporate bonds have meaningful interest rate sensitivity, and therefore, investment-grade portfolio managers usually manage their portfolio durations and yield curve exposures closely. In contrast, high-yield portfolio managers are more likely to focus on credit risk and less likely to focus on interest rate and yield curve dynamics. When default losses are low and credit spreads are relatively tight, however, high-yield bonds tend to behave more like investment-grade bonds—that is, with greater interest rate sensitivity.

15 A is correct. CDOs typically include some form of subordination. With subordination, a CDO has more than one bond class or tranche, including senior bond classes, mezzanine bond classes (which have credit ratings between senior and subordinated bond classes), and subordinated bond classes (often referred to as residual or equity tranches). The correlation of expected defaults on a CDO's collateral affects the relative value between the senior and subordinated tranches of the CDO. As correlations increase, the values of the mezzanine tranches usually increase relative to the values of the senior and equity tranches.

PORTFOLIO MANAGEMENT

STUDY SESSION 9

Equity Portfolio Management (1)

Because equity securities represent a significant portion of many investment portfolios, equity portfolio management is often an important component of overall investment success. This study session begins by explaining the role played by equity investments in portfolios, with consideration given to costs and shareholder responsibilities. It then discusses two approaches to equity portfolio management: passive or index-based investing and active equity strategies. The reading on passive equity investing addresses important issued such as alternative approaches to index replication and factor-based passive strategies. Tracking error, risk, and return considerations from an indexing perspective are examined.

READING ASSIGNMENT

Reading 22	Overview of Equity Portfolio Management by James Clunie, PhD, CFA, and James Alan Finnegan, CAIA, RMA, CFA
Reading 23	Passive Equity Investing by David M. Smith, PhD, CFA, and Kevin K. Yousif, CFA

READING

22

Overview of Equity Portfolio Management

by James Clunie, PhD, CFA, and James Alan Finnegan, CAIA, RMA, CFA

James Clunie, PhD, CFA, is at Jupiter Asset Management (United Kingdom). James Alan Finnegan, CAIA, RMA, CFA (USA).

LEARNING OUTCOMES

Mastery	The candidate should be able to:
☐	**a.** describe the roles of equities in the overall portfolio;
☐	**b.** describe how an equity manager's investment universe can be segmented;
☐	**c.** describe the types of income and costs associated with owning and managing an equity portfolio and their potential effects on portfolio performance;
☐	**d.** describe the potential benefits of shareholder engagement and the role an equity manager might play in shareholder engagement;
☐	**e.** describe rationales for equity investment across the passive–active spectrum.

1 INTRODUCTION

Equities represent a sizable portion of the global investment universe and thus often represent a primary component of investors' portfolios. Rationales for investing in equities include potential participation in the growth and earnings prospects of an economy's corporate sector as well as an ownership interest in a range of business entities by size, economic activity, and geographical scope. Publicly traded equities are generally more liquid than other asset classes and thus may enable investors to more easily monitor price trends and purchase or sell securities with low transaction costs.

This reading provides an overview of equity portfolio management. Section 2 discusses the roles of equities in a portfolio. Section 3 discusses the equity investment universe, including several ways the universe can be segmented. Section 4 covers the income and costs in an equity portfolio. Section 5 discusses shareholder engagement between equity investors and the companies in which they invest. Section 6 discusses equity investment across the passive–active investment spectrum. A summary of key points completes the reading.

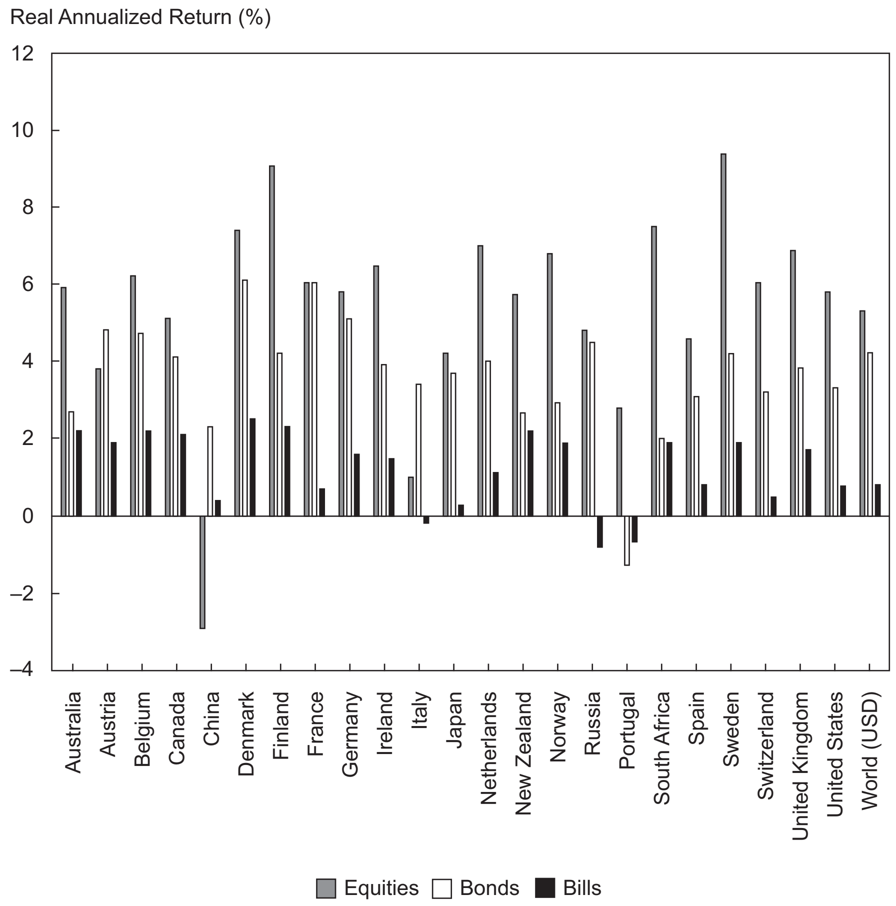
2 THE ROLES OF EQUITIES IN A PORTFOLIO

Equities provide several roles in (or benefits to) an overall portfolio, such as capital appreciation, dividend income, diversification with other asset classes, and a potential hedge against inflation. In addition to these benefits, client investment considerations play an important role for portfolio managers when deciding to include equities in portfolios.

2.1 Capital Appreciation

Long-term returns on equities, driven predominantly by capital appreciation, have historically been among the highest among major asset classes. Exhibit 1 demonstrates the average annual real returns on equities versus bonds and bills—both globally and within various countries—from 1967–2016. With a few exceptions, equities outperformed both bonds and bills, in particular, during this period across the world.

Exhibit 1 Real Returns on Equities (1967–2016)



* China data are from 1993 to 2016.
** Russia data are from 1995 to 2016.
Source: Credit Suisse Global Investment Returns Yearbook 2017, Summary Edition.

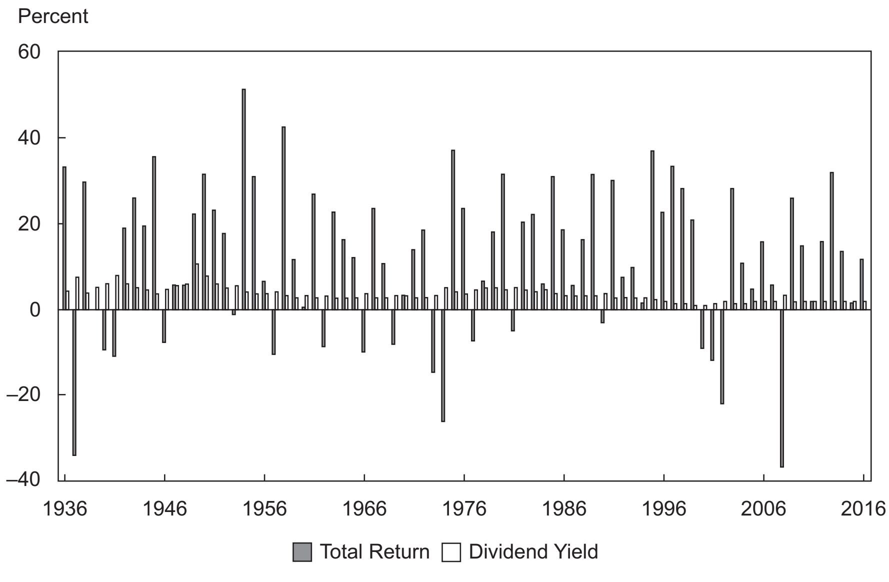
Equities tend to outperform other asset classes during periods of strong economic growth, and they tend to underperform other asset classes during weaker economic periods. Capital (or price) appreciation of equities often occurs when investing in companies with growth in earnings, cash flows, and/or revenues—as well as in companies with competitive success. Capital appreciation can occur, for example, in such growth-oriented companies as small technology companies as well as in large, mature companies where management successfully reduces costs or engages in value-added acquisitions.

2.2 Dividend Income

The most common sources of income for an equity portfolio are dividends. Companies may choose to distribute internally generated cash flows as common dividends rather than reinvest the cash flows in projects, particularly when suitable projects do not exist or available projects have a high cost of equity or a low probability of future value creation. Large, well-established corporations often provide dividend payments that increase in value over time, although there are no assurances that common dividend payments from these corporations will grow or even be maintained. In addition to common dividends, preferred dividends can provide dividend income to those shareholders owning preferred shares.

Dividends have comprised a significant component of long-term total returns for equity investors. Over shorter periods of time, however, the proportion of equity returns from dividends (reflected as dividend yield) can vary considerably relative to capital gains or losses. Exhibit 2 illustrates this effect of dividend returns relative to annual total returns on the S&P 500 Index from 1936 through 2016. Since 1990, the dividend yield on the S&P 500 has been in the 1–3% range; thus, the effect of dividends can clearly be significant during periods of weak equity market performance. Also note that the dividend yield may vary considerably by sector within the S&P 500.

Exhibit 2 S&P 500 Dividend Contribution (1936–2016)



Source: Bloomberg.

2.3 Diversification with Other Asset Classes

Individual equities clearly have unique characteristics, although the correlation of returns among equities is often high. In a portfolio context, however, equities can provide meaningful diversification benefits when combined with other asset classes (assuming less than perfect correlation). Recall that a major reason why portfolios can effectively reduce risk (typically expressed as standard deviation of returns) is that combining securities whose returns are less than perfectly correlated reduces the standard deviation of the diversified portfolio below the weighted average of the standard deviations of the individual investments. The challenge in diversifying risk is to find assets that have a correlation that is much lower than +1.0.

Exhibit 3 provides a correlation matrix across various global equity indexes and other asset classes using total monthly returns from January 2001 to February 2017.[1] The correlation matrix shows that during this period, various broad equity indexes and, to a lesser extent, country equity indexes were highly correlated with each other. Conversely, both the broad and country equity indexes were considerably less correlated with indexes in other asset classes, notably global treasury bonds and gold. Overall, Exhibit 3 indicates that combining equities with other asset classes can result in portfolio diversification benefits.

It is important to note that correlations are not constant over time. During a long historical period, the correlation of returns between two asset classes may be low, but in any given period, the correlation can differ from the long term. Correlation estimates can vary based on the capital market dynamics during the period when the correlations are measured. During periods of market crisis, correlations across asset classes and among equities themselves often increase and reduce the benefit of diversification. As with correlations, volatility (standard deviation) of asset class returns may also vary over time.

1 Monthly return data cover January 2001 to February 2017 for all indexes except the FTSE EPRA/NAREIT Global Real Estate Index (whose inception date was November 2008).

Exhibit 3 Correlation Matrix, January 2001 to February 2017

		MSCI World	MSCI ACWI	MSCI EM	MSCI EAFE	MSCI AC Far East	MSCI BRIC	S&P 500	Bloomberg Barclays Global Aggregate Bond	Bloomberg Barclays Global Treasury	Bloomberg Barclays Global Credit	S&P GSCI Commodities	S&P GSCI Gold	FTSE EPRA/NAREIT Global REITs
Equity Indexes	MSCI World	1.000												
	MSCI ACWI	0.998	1.000											
	MSCI EM	0.858	0.889	1.000										
	MSCI EAFE	0.969	0.971	0.864	1.000									
	MSCI AC Far East	0.831	0.848	0.866	0.877	1.000								
	MSCI BRIC	0.814	0.846	0.958	0.829	0.827	1.000							
	S&P 500	0.969	0.960	0.786	0.881	0.732	0.732	1.000						
Other Indexes	Bloomberg Barclays Global Aggregate Bond	0.317	0.331	0.369	0.364	0.389	0.365	0.245	1.000					
	Bloomberg Barclays Global Treasury	0.162	0.174	0.213	0.258	0.222	0.210	0.057	0.526	1.000				
	Bloomberg Barclays Global Credit	0.564	0.580	0.592	0.639	0.579	0.582	0.448	0.818	0.753	1.000			
	S&P GSCI Commodities	0.406	0.422	0.460	0.445	0.412	0.486	0.317	0.133	0.203	0.400	1.000		
	S&P GSCI Gold	0.109	0.133	0.268	0.153	0.203	0.294	0.031	0.254	0.475	0.409	0.312	1.000	
	FTSE EPRA/NAREIT Global REITs	0.577	0.575	0.466	0.572	0.494	0.391	0.555	0.374	0.291	0.475	0.198	0.025	1.000

Equities tend to be highly correlated with each other

But exhibit lower correlations to other asset classes

■ Correlation = 1.00 □ 0.7 < Correlation < 1.00 ■ 0.3 < Correlation < 0.07 □ Correlation < 0.3

Source: Morningstar Direct.

2.4 Hedge Against Inflation

Some individual equities or sectors can provide some protection against inflation, although the ability to do so varies. For example, certain companies may be successful at passing along higher input costs (such as raw materials, energy, or wages) to customers. This ability to pass along costs to customers can protect a company's or industry's profit margin and cash flow and can be reflected in their stock prices. As another example, companies within sectors that produce broad-based commodities (e.g., oil or industrial metals producers) can more directly benefit from increases in commodity prices. Although individual equities or sectors can protect against inflation, the success of equities as an asset class in hedging inflation has been mixed. Certain empirical studies have indeed shown that real returns on equities and inflation have positive correlation over the long-term, thus in theory forming a hedge. However, the degree of correlation typically varies by country and is dependent on the time period assessed. In fact, for severe inflationary periods, some studies have shown that real returns on equities and inflation have been *negatively* correlated. When assessing the relationship between equity returns and inflation, investors should be aware that inflation is typically a lagging indicator of the business cycle, while equity prices are often a leading indicator.

2.5 Client Considerations for Equities in a Portfolio

The inclusion of equities in a portfolio can be driven by a client's goals or needs. A client's investment considerations are typically described in an investment policy statement (IPS), which establishes, among other things, a client's return objectives, risk tolerance, constraints, and unique circumstances. By understanding these client considerations, a financial adviser or wealth manager can determine whether—and how much—equities should be in a client's portfolio.

Equity investments are often characterized by such attributes as growth potential, income generation, risk and return volatility, and sensitivity to various macro-economic variables (e.g., energy prices, GDP growth, interest rates, and inflation). As a result, a portfolio manager can adapt such specific factors to an equity investor's investment goals and risk tolerance. For example, a risk-averse and conservative investor may prefer some exposure to well-established companies with strong and stable cash flow that pay meaningful dividends. Conversely, a growth-oriented investor with an aggressive risk tolerance may prefer small or large growth-oriented companies (e.g., those in the social media or alternative energy sectors).

Wealth managers and financial advisers often consider the following investment objectives and constraints when deciding to include equities (or asset classes in general, for that matter) in a client's portfolio:

- *Risk objective* addresses how risk is measured (e.g., in absolute or relative terms); the investor's willingness to take risk; the investor's ability to take risk; and the investor's specific risk objectives.
- *Return objective* addresses how returns are measured (e.g., in absolute or relative terms); stated return objectives.
- *Liquidity requirement* is a constraint in which cash is needed for anticipated or unanticipated events.
- *Time horizon* is the time period associated with an investment objective (e.g., short term, long term, or some combination of the two).
- *Tax concerns* include tax policies that can affect investor returns; for example, dividends may be taxed at a different rate than capital gains.
- *Legal and regulatory factors* are external factors imposed by governmental, regulatory, or oversight authorities.
- *Unique circumstances* are an investor's considerations other than liquidity requirements, time horizon, or tax concerns that may constrain portfolio choices. These considerations may include environmental, social, and governance (ESG) issues or religious preferences.

ESG considerations often occur at the request of clients becauses interest in sustainable investing has grown. With regard to equities, these considerations often determine the suitability of certain sectors or individual company stocks for designated investor portfolios. Historically, ESG approaches used by portfolio managers have largely represented **negative screening** (or exclusionary screening), which refers to the practice of excluding certain sectors or companies that deviate from accepted standards in such areas as human rights or environmental concerns. More recently, portfolio managers have increasingly focused on **positive screening** or **best-in-class** approaches, which attempt to identify companies or sectors that score most favorably with regard to ESG-related risks and/or opportunities. **Thematic investing** is another approach that focuses on investing in companies within a specific sector or following a specific theme, such as energy efficiency or climate change. **Impact investing** is a related approach that seeks to achieve targeted social or environmental objectives along with measurable financial returns through engagement with a company or by direct investment in projects or companies.

EXAMPLE 1

Roles of Equities

Alex Chang, Lin Choi, and Frank Huber manage separate equity portfolios for the same investment firm. Chang's portfolio objective is conservative in nature, with a regular stream of income as the primary investment objective. Choi's portfolio is more aggressive in nature, with a long-term horizon and with growth as the primary objective. Finally, Huber's portfolio consists of wealthy entrepreneurs who are concerned about rising inflation and wish to preserve the purchasing power of their wealth.

Discuss the investment approach that each portfolio manager would likely use to achieve his or her portfolio objectives.

Solution:

Given that his portfolio is focused on a regular stream of income, Chang is likely to focus on companies with regular dividend income. More specifically, Chang is likely to invest in large, well-established companies with stable or growing dividend payments. With a long-term horizon, Choi is most interested in capital appreciation of her portfolio, so she is likely to focus on companies with earnings growth and competitive success. Finally, Huber's clients are concerned about the effects of inflation, so he will likely seek to invest in shares of companies that can provide an inflation hedge. Huber would likely seek companies that can successfully pass on higher input costs to their customers, and he may also seek commodity producers that may benefit from rising commodity prices.

3 EQUITY INVESTMENT UNIVERSE

Given the extensive range of companies in which an equity portfolio manager may invest, an important task for the manager is to segment companies or sectors according to similar characteristics. This segmentation enables portfolio managers to better evaluate and analyze their equity investment universe, and it can help with portfolio diversification. Several approaches to segmenting the equity investment universe are discussed in the following sections.

3.1 Segmentation by Size and Style

A popular approach to segmenting the equity universe incorporates two factors: (1) size and (2) style. Size is typically measured by market capitalization and often categorized by large cap, mid cap, and small cap. Style is typically classified as value, growth, or a combination of value and growth (typically termed "blend" or "core"). In addition, style is often determined through a "scoring" system that incorporates multiple metrics or ratios, such as price-to-book ratios, price-to-earnings ratios, earnings growth, dividend yield, and book value growth. These metrics are then typically "scored" individually for each company, assigned certain weights, and then aggregated. The result is a composite score that determines where the company's stock is positioned along the value–growth spectrum. A combination of growth and value style is not uncommon, particularly for large corporations that have both mature and higher growth business lines.

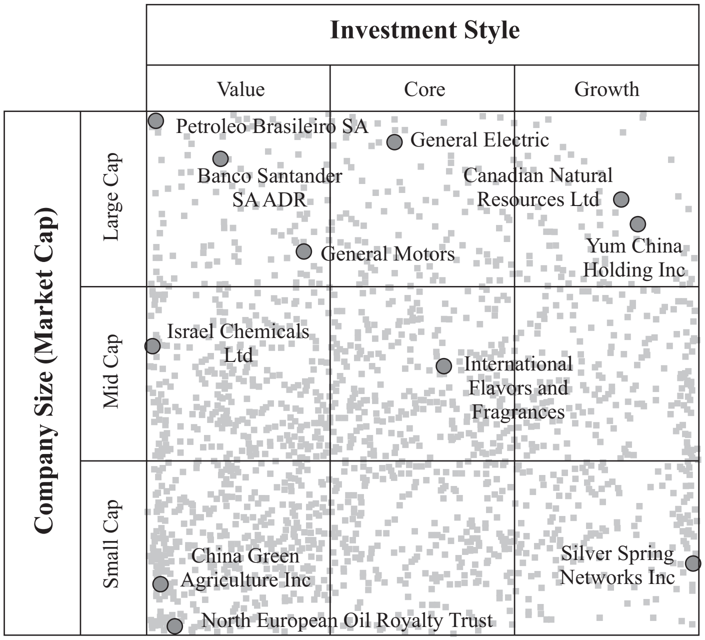
Exhibit 4 illustrates a common matrix that reflects size and style dimensions. Each category in the matrix can be represented by companies with considerably different business activities. For example, both a small, mature metal fabricating business and a small health care services provider may fall in the Small Cap Value category. In practice, individual stocks may not clearly fall into one of the size/style categories. As a result, the size/style matrix tends to be more of a scatter plot than a simple set of nine categories. An example of a scatter plot is demonstrated in Exhibit 5, which includes all listed equities on the New York Stock Exchange as of March 2017. Each company represents a single dot in Exhibit 5. This more granular representation enables the expansion of size and style categories, such as blue chip and micro-cap companies in size and deep value and high growth in style. It should be noted that Morningstar applies the term “core” for those stocks in which neither value nor growth characteristics dominate, and the term “blend” for those funds with a combination of both growth and value stocks or mostly core stocks.

Exhibit 4 Equity Size and Style Matrix

		Investment Style		
		Value	Core	Growth
Company Size (Market Cap)	Large Cap	Large Cap value	Large Cap core	Large Cap growth
	Mid Cap	Mid Cap value	Mid Cap core	Mid Cap growth
	Small Cap	Small Cap value	Small Cap core	Small Cap growth

Source: Morningstar.

Exhibit 5 Equity Size and Style Scatter Plot



Source: Morningstar Direct.

Segmentation by size/style can provide several advantages for portfolio managers. First, portfolio managers can construct an overall equity portfolio that reflects desired risk, return, and income characteristics in a relatively straightforward and manageable way. Second, given the broad range of companies within each segment, segmentation by size/style results in diversification across economic sectors or industries. Third, active equity managers—that is, those seeking to outperform a given benchmark portfolio—can construct performance benchmarks for specific size/style segments. Generally, large investment management firms may have sizable teams dedicated toward specific size/style categories, while small firms may specialize in a specific size/style category, particularly mid-cap and small-cap companies, seeking to outperform a standard benchmark or comparable peer group.

The final advantage of segmentation by size/style is that it allows a portfolio to reflect a company's maturity and potentially changing growth/value orientation. Specifically, many companies that undertake an IPO (initial public offering) are small and in a growth phase, and thus they may fall in the small-cap growth category. If these companies can successfully grow, their size may ultimately move to mid cap or even large cap, while their style may conceivably shift from high growth to value or a combination of growth and value (e.g., a growth and income stock). Accordingly, over the life cycle of companies, investor preferences for these companies may shift increasingly from capital appreciation to dividend income. In addition, segmentation also helps fund managers adjust holdings over time—for example, when stocks that were previously considered to be in the growth category mature and possibly become value stocks. The key disadvantages of segmentation by size/style are that the categories may change over time and may be defined differently among investors.

3.2 Segmentation by Geography

Another common approach to equity universe segmentation is by geography. This approach is typically based on the stage of markets' macroeconomic development and wealth. Common geographic categories are *developed markets*, *emerging markets*, and *frontier markets*. Exhibit 6 demonstrates the commonly used geographic segmentation of international equity indexes according to MSCI. Other major index providers—such as FTSE, Standard & Poor's, and Russell—also provide similar types of international equity indexes.

Geographic segmentation is useful to equity investors who have considerable exposure to their domestic market and want to diversify by investing in global equities. A key weakness of geographic segmentation is that investing in a specific market (e.g., market index) may provide lower-than-expected exposure to that market. As an example, many large companies domiciled in the United States, Europe, or Asia may be global in nature as opposed to considerable focus on their domicile. Another key weakness of geographic segmentation is potential currency risk when investing in different global equity markets.

Exhibit 6 MSCI International Equity Indexes (as of November 2016)

Developed Markets

Americas	Europe and Middle East	Pacific
Canada	Austria	Australia
United States	Belgium	Hong Kong SAR
	Denmark	Japan
	Finland	New Zealand
	France	Singapore
	Germany	
	Ireland	
	Israel	
	Italy	
	Netherlands	
	Norway	
	Portugal	
	Spain	
	Sweden	
	Switzerland	
	United Kingdom	

Emerging Markets

Americas	Europe, Middle East, and Africa	Asia Pacific
Brazil	Czech Republic	Chinese mainland
Chile	Egypt	India
Colombia	Greece	Indonesia
Mexico	Hungary	Korea
Peru	Poland	Malaysia
	Qatar	Philippines
	Russia	Taiwan Region
	South Africa	Thailand
	Turkey	Pakistan
	United Arab Emirates	

Exhibit 6 (Continued)

Frontier Markets				
Americas	**Europe and CIS**	**Africa**	**Middle East**	**Asia**
Argentina	Croatia Estonia Lithuania Kazakhstan Romania Serbia Slovenia	Kenya Mauritius Morocco Nigeria Tunisia	Bahrain Jordan Kuwait Lebanon Oman	Bangladesh Sri Lanka Vietnam

Notes:

1 The following markets are not included in the developed, emerging, or frontier indexes but have their own market-specific indexes: Saudi Arabia, Jamaica, Trinidad & Tobago, Bosnia Herzegovina, Bulgaria, Ukraine, Botswana, Ghana, Zimbabwe, and Palestine.

2 Pakistan was reclassified from the frontier market to the emerging market category as of May 2017.

3 CIS: Commonwealth of Independent States (formerly the USSR).

3.3 Segmentation by Economic Activity

Economic activity is another approach that portfolio managers may use to segment the equity universe. Most commonly used equity classification systems group companies into industries/sectors using either a *production-oriented* approach or a *market-oriented* approach. The production-oriented approach groups companies that manufacture similar products or use similar inputs in their manufacturing processes. The market-oriented approach groups companies based on the markets they serve, the way revenue is earned, and the way customers use companies' products. For example, using a production-oriented approach, a coal company may be classified in the basic materials or mining sector. However, using a market-oriented approach, this same coal company may be classified in the energy sector given the primary market (heating) for the use of coal. As another example, a commercial airline carrier may be classified in the transportation sector using the production-oriented approach, while the same company may be classified in the travel and leisure sector using the market-oriented approach.

Four main global classification systems segment the equity universe by economic activity: (1) the Global Industry Classification Standard (GICS); (2) the Industrial Classification Benchmark (ICB); (3) the Thomson Reuters Business Classification (TRBC); and (4) the Russell Global Sectors Classification (RGS). The GICS uses a market-oriented approach, while the ICB, TRBC, and RGS all use a production-oriented approach. These classification systems help standardize industry definitions so that portfolio managers can compare and analyze companies and industries/sectors. In addition, the classification systems are useful in the creation of industry performance benchmarks.

Exhibit 7 compares the four primary classification systems mentioned. Each system is classified broadly and then increasingly more granular to compare companies and their underlying businesses.

Exhibit 7 Primary Sector Classification Systems

Level/System	GICS	ICB	TRBC	RGS
1st	11 Sectors	10 Industries	10 Economic Sectors	9 Economic Sectors
2nd	24 Industry Groups	19 Super Sectors	28 Business Sectors	33 Sub-Sectors
3rd	68 Industries	41 Sectors	54 Industry Groups	157 Industries
4th	157 Sub-Industries	114 Sub-Sectors	136 Industries	Not Applicable

Source: Thomson Reuters, S&P/MSCI, FTSE/Dow Jones.

To illustrate how segmentation of the classification systems may be used in practice, Exhibit 8 demonstrates how GICS, perhaps the most prominent classification system, sub-divides selected sectors—in this case, Consumer Discretionary, Consumer Staples, and Information Technology—into certain industry group, industry, and sub-industry levels.

Exhibit 8 GICS Classification Examples

Sector	Consumer Discretionary	Consumer Staples	Information Technology
Industry Group Example	Automobiles & Components	Food, Beverage & Tobacco	Technology Hardware & Equipment
Industry Example	Automobiles	Beverages	Electronic Equipment, Instruments & Components
Sub-Industry Example	Motorcycle Manufacturers	Soft Drinks	Electronic Manufacturing Services

Source: MSCI.

As with other segmentation approaches mentioned previously, segmentation by economic activity enables equity portfolio managers to construct performance benchmarks for specific sectors or industries. Portfolio managers may also obtain better industry representation (diversification) by segmenting their equity universe according to economic activity. The key disadvantage of segmentation by economic activity is that the business activities of companies—particularly large ones—may include more than one industry or sub-industry.

EXAMPLE 2

Segmenting the Equity Investment Universe

A portfolio manager is initiating a new fund that seeks to invest in the Chinese robotics industry, which is experiencing rapidly accelerating earnings. To help identify appropriate company stocks, the portfolio manager wants to select an approach to segment the equity universe.

Recommend which segmentation approach would be most appropriate for the portfolio manager.

Solution:

Based on his desired strategy to invest in companies with rapidly accelerating (growing) earnings, the portfolio manager would most likely segment his equity universe by size/style. The portfolio manager would most likely use an investment style that reflects growth, with size (large cap, mid cap, or small cap) depending on the company being analyzed. Other segmentation approaches, including those according to geography and economic activity, would be less appropriate for the portfolio manager given the similar geographic and industry composition of the Chinese robotics industry.

3.4 Segmentation of Equity Indexes and Benchmarks

Segmentation of equity indexes or benchmarks reflects some of or all the approaches previously discussed in this section. For example, the MSCI Europe Large Cap Growth Index, the MSCI World Small Cap Value Index, the MSCI Emerging Markets Large Cap Growth Index, or the MSCI Latin America Midcap Index combine various geographic, size, and style dimensions. This combination of geography, size, and style also sometimes applies to individual countries—particularly those in large, developed markets.

A more focused approach to segmentation of equity indexes uses industries or sectors. Because many industries and sectors are global in scope, the most common types of these indexes are comprised of companies in different countries. A few examples include the following:

- Global Natural Resources—the *S&P Global Natural Resources Index* includes 90 of the largest publicly traded companies in natural resources and commodities businesses across three primary commodity-related sectors: agribusiness; energy; and metals and mining.
- Worldwide Oil and Natural Gas—the *MSCI World Energy Index* includes the large-cap and mid-cap segments of publicly traded oil and natural gas companies within the developed markets.
- Multinational Financials—the *Thomson Reuters Global Financials Index* includes the 100 largest publicly traded companies within the global financial services sector as defined by the TRBC classification system.

Finally, some indexes reflect specific investment approaches, such as ESG. Such ESG indexes are comprised of companies that reflect certain considerations, such as sustainability or impact investing.

4 INCOME AND COSTS IN AN EQUITY PORTFOLIO

Dividends are the primary source of income for equity portfolios. In addition, some portfolio managers may use securities lending or option-writing strategies to generate income. On the cost side, equity portfolios incur various fees and trading costs that adversely affect portfolio returns. The primary types of income and costs are discussed in this section.

4.1 Dividend Income

Investors requiring regular income may prefer to invest in stocks with large or frequent dividend payments, whereas growth-oriented investors may have little interest in dividends. Taxation is an important consideration for dividend income received, particularly for individuals. Depending on the country where the investor is domiciled, where dividends are issued, and the type of investor, dividends may be subject to withholding tax and/or income tax.

Beyond regular dividends, equity portfolios may receive **special dividends** from certain companies. Special dividends occur when companies decide to distribute excess cash to shareholders, but the payments may not be maintained over time. **Optional stock dividends** are another type of dividend in which shareholders may elect to receive either cash or new shares. When the share price used to calculate the number of stock dividend shares is established before the shareholder's election date, the choice between a cash or stock dividend may be important. This choice represents "optionality" for the shareholder, and the optionality has value. Some market participants, typically investment banks, may offer to purchase this "option," providing an additional, if modest, source of income to an equity investor.

4.2 Securities Lending Income

For some investors, **securities lending**—a form of collateralized lending—may be used to generate income for portfolios. Securities lending can facilitate short sales, which involve the sale of securities the seller does not own. When a securities lending transaction involves the transfer of equities, the transaction is generally known as **stock lending** and the securities are generally known as *stock loans.* Stock loans are collateralized with either cash or other high-quality securities to provide some financial protection to the lender. Stock loans are usually open-ended in duration, but the borrower must return the shares to the lender on demand.

Stock lenders generally receive a fee from the stock borrower as compensation for the loaned shares. Most stock loans in developed markets earn a modest fee, approximately 0.2–0.5% on an annualized basis. In emerging markets, fees are typically higher, often 1–2% annualized for large-cap stocks. In many equity markets, certain stocks—called "specials"—are in high demand for borrowing. These specials can earn fees that are substantially higher than average (typically 5–15% annualized), and in cases of extreme demand, they could be as high as 25–100% annually. However, such high fees do not normally persist for long periods of time.

In addition to fees earned, stock lenders can generate further income by reinvesting the cash collateral received (assuming a favorable interest rate environment). However, as with virtually any other investment, the collateral would be subject to market risk, credit risk, liquidity risk, and operational risk. The administrative costs of a securities lending program, in turn, will reduce the collateral income generated. Dividends on loaned stock are "manufactured" by the stock borrower for the stock lender—that is, the stock borrower ensures that the stock lender is compensated for any dividends that the lender would have received had the stock not been loaned.

Index funds are frequent stock lenders because of their large, long-term holdings in stocks. In addition, because index funds merely seek to replicate the performance of an index, portfolio managers of these funds are normally not concerned that borrowed stock used for short-selling purposes might decrease the prices of the corresponding equities. Large, actively managed pension funds, endowments, and institutional investors are also frequent stock lenders, although these investors are likely more concerned with the effect on their returns if the loaned shares are used to facilitate short-selling. The evidence on the impact of stock lending on asset prices has, however, been mixed (see, for example, Kaplan, Moskowitz, and Sensoy 2013).

4.3 Ancillary Investment Strategies

Additional income can be generated for an equity portfolio through a trading strategy known as **dividend capture**. Under this strategy, an equity portfolio manager purchases stocks just before their ex-dividend dates, holds these stocks through the ex-dividend date to earn the right to receive the dividend, and subsequently sells the shares. Once a stock goes ex-dividend, the share price should, in theory, decrease by the value of the dividend. In this way, capturing dividends would increase portfolio income, although the portfolio would, again in theory, experience capital losses of similar magnitude. However, the share price movement could vary from this theoretical assumption given income tax considerations, stock-specific supply/demand conditions, and general stock market moves around the ex-dividend date.

Selling (writing) options can also generate additional income for an equity portfolio. One such options strategy is writing a *covered call*, whereby the portfolio manager already owns the underlying stock and sells a call option on that stock. Another options strategy is writing a *cash-covered put* (also called a *cash-secured put*), whereby the portfolio manager writes a put option on a stock and simultaneously deposits money equal to the exercise price into a designated account. Under both covered calls and cash-covered puts, income is generated through the writing of options, but clearly the risk profile of the portfolio would be altered. For example, writing a covered call would limit the upside from share price appreciation of the underlying shares.

EXAMPLE 3

Equity Portfolio Income

Isabel Cordova is an equity portfolio manager for a large multinational investment firm. Her portfolio consists of several dividend-paying stocks, and she is interested in generating additional income to enhance the portfolio's total return. Describe potential sources of additional income for Cordova's equity portfolio.

Solution:

Cordova's primary source of income for her portfolio would likely be "regular" and, in some cases, special dividends from those companies that pay them. Another potential source of income for Cordova is securities (stock) lending, whereby eligible equities in her portfolio can be loaned to other market participants, including those seeking to sell short securities. In this case, income would be generated from fees received from the stock borrower as well as from reinvesting the cash collateral received. Another potential income-generating strategy available to Cordova is dividend capture, which entails purchasing stocks just before their ex-dividend dates, holding the stocks through the ex-dividend date to earn the right to receive the dividend, and subsequently selling the shares. Selling (writing) options, including covered call and cash-covered put (cash-secured put) strategies, is another way Cordova can generate additional income for her equity portfolio.

4.4 Management Fees

Management fees are typically determined as a percentage of the funds under management (an *ad-valorem* fee) at regular intervals. For actively managed portfolios, the level of management fees involves a balance between fees that are high enough to fund investment research but low enough to avoid detracting too much from investor returns. Management fees for actively managed portfolios include direct costs of research (e.g., remuneration and expenses for investment analysts and portfolio managers) and the direct costs of portfolio management (e.g., software, trade processing costs, and compliance). For passively managed portfolios, management fees are typically low because of lower direct costs of research and portfolio management relative to actively managed portfolios.

4.5 Performance Fees

In addition to management fees, portfolio managers sometimes earn performance fees (also known as incentive fees) on their portfolios. Performance fees are generally associated with hedge funds and long/short equity portfolios, rather than long-only portfolios. These fees are an incentive for portfolio managers to achieve or outperform return objectives, to the benefit of both the manager and investors. As an example, a performance fee might represent 10–20% of any capital appreciation in a portfolio that exceeds some stated annual absolute return threshold (e.g., 8%). Several performance fee structures exist, although performance fees tend to be "upwards only"—that is, fees are earned by the manager when performance objectives are met, but fund investors are not reimbursed when performance is negative. However, performance fees could be reduced following a period of poor performance. Fee calculations also reflect high-water marks. A **high-water mark** is the highest value, net of fees, that the fund has reached. The use of high-water marks protects clients from paying twice for the same performance. For example, if a fund performed well in a given year, it might earn a performance fee. If the value of the same fund fell the following year, no performance fee would be payable. Then, if the fund's value increased in the third year to a point just below the value achieved at the end of the first year, no performance fee would be earned because the fund's value did not exceed the high-water mark. This basic fee structure is used by many alternative investment funds and partnerships, including hedge funds.

Investment managers typically present a standard schedule of fees to a prospective client, although actual fees can be negotiated between the manager and investors. For a fund, fees are established in the prospectus, although investors could negotiate special terms (e.g., a discount for being an early investor in a fund).

4.6 Administration Fees

Equity portfolios are subject to administration fees. These fees include the processing of corporate actions, such as rights issues; the measurement of performance and risk of a portfolio; and voting at company meetings. Generally, these functions are provided by an investment management firm itself and are included as part of the management fee.

Some functions, however, are provided by external parties, with the fees charged to the client in addition to management fees. These externally provided functions include:

- *Custody fees* paid for the safekeeping of assets by a custodian (often a subsidiary of a large bank) that is independent of the investment manager.
- *Depository fees* paid to help ensure that custodians segregate the assets of the portfolio and that the portfolio complies with any investment limits, leverage requirements, and limits on cash holdings.
- *Registration fees* that are associated with the registration of ownership of units in a mutual fund.

4.7 Marketing and Distribution Costs

Most investment management firms market and distribute their services to some degree. Marketing and distribution costs typically include the following:

- Costs of employing marketing, sales, and client servicing staff
- Advertising costs
- Sponsorship costs, including costs associated with sponsoring or presenting at conferences
- Costs of producing and distributing brochures or other communications to financial intermediaries or prospective clients
- "Platform" fees, which are costs incurred when an intermediary offers an investment management firm fund services on the intermediary's platform of funds (e.g., a "funds supermarket")
- Sales commissions paid to such financial intermediaries as financial planners, independent financial advisers, and brokers to facilitate the distribution of funds or investment services

When marketing and distribution services are performed by an investment management firm, the costs are likely included as part of the management fee. However, those marketing and distribution services that are performed by external parties (e.g., consultants) typically incur additional costs to the investor.

4.8 Trading Costs

Buying and selling equities incurs a series of trading (or transaction) costs. Some of these trading costs are explicit, including brokerage commission costs, taxes, stamp duties, and stock exchange fees. In addition, many countries charge a modest regulatory fee for certain types of equity trading.

In contrast to explicit costs, some trading costs are implicit in nature. These implicit costs include the following:

- Bid–offer spread
- Market impact (also called price impact), which measures the effect of the trade on transaction prices
- Delay costs (also called slippage), which arise from the inability to complete desired trades immediately because of order size or lack of market liquidity

In an equity portfolio, total trading costs are a function of the size of trades, the frequency of trading, and the degree to which trades demand liquidity from the market. Unlike many other equity portfolio costs, such as management fees, the total cost of trading is generally not revealed to the investor. Rather, trading costs are incorporated into a portfolio's total return and presented as overall performance data. One final trading cost relates to stock lending transactions that were previously discussed. Equity portfolio managers who borrow shares in these transactions must pay fees on shares borrowed.

4.9 Investment Approaches and Effects on Costs

Equity portfolio costs tend to vary depending on their underlying strategy or approach. As mentioned previously, passively managed strategies tend to charge lower management fees than active strategies primarily because of lower research costs to manage the portfolios. Passively managed equity portfolios also tend to trade less frequently than actively managed equity portfolios, with trading in passive portfolios typically involving rebalancing or changes to index constituents. Index funds, however, do face a "hidden" cost from potential predatory trading. As an illustration, a predatory trader may purchase (or sell short) shares prior to their effective inclusion (or deletion) from an index, resulting in price movement and potential profit for a predatory trader. Such predatory trading strategies can be regarded as a cost to investors in index funds, albeit a cost that is not necessarily evident to a portfolio manager or investor.

Some active investing approaches "demand liquidity" from the market. For example, in a momentum strategy, the investor seeks to buy shares that are already rising in price (or sell those that are already falling). In contrast, some active investing approaches are more likely to "provide liquidity" to the market, such as deep value strategies (i.e., those involving stocks that are deemed to be significantly undervalued). Investment strategies that involve frequent trading and demand liquidity are, unsurprisingly, likely to have higher trading costs than long-term, buy-and-hold investment strategies.

5 SHAREHOLDER ENGAGEMENT

Shareholder engagement refers to the process whereby investors actively interact with companies. Shareholder engagement often includes voting on corporate matters at general meetings as well as other forms of communication (e.g., quarterly investor calls or in-person meetings) between shareholders and representatives of a company. Generally, shareholder engagement concerns issues that can affect the value of a company and, by extension, an investor's shares.

When shareholders engage with companies, several issues may be discussed. Some of these issues include the following:

- *Strategy*—a company's strategic goals, resources, plans for growth, and constraints. Also of interest may be a company's research, product development, culture, sustainability and corporate responsibility, and industry and competitor developments. Shareholders may ask the company how it balances short-term requirements and long-term goals and how it prioritizes the interests of its various stakeholders.
- *Allocation of capital*—a company's process for selecting new projects as well as its mergers and acquisitions strategy. Shareholders may be interested to learn about policies on dividends, financial leverage, equity raising, and capital expenditures.
- *Corporate governance* and regulatory and political risk—including internal controls and the operation of its audit and risk committees.
- *Remuneration*—compensation structures for directors and senior management, incentives for certain behaviors, and alignment of interests between directors and shareholders. In some cases, investors may be able to influence future remuneration structures. Such influence, especially regarding larger companies, often involves the use of remuneration consultants and an iterative process with large, long-term shareholders.
- *Composition of the board of directors*—succession planning, director expertise and competence, culture, diversity, and board effectiveness.

5.1 Benefits of Shareholder Engagement

Shareholder engagement can provide benefits for both shareholders and companies. From a company's perspective, shareholder engagement can assist in developing a more effective corporate governance culture. In turn, shareholder engagement may lead to better company performance to the benefit of shareholders (as well as other stakeholders).

Investors may also benefit from engagement because they will have more information about companies or the sectors in which companies operate. Such information may include a company's strategy, culture, and competitive environment within an industry. Shareholder engagement is particularly relevant for active portfolio managers given their objective to outperform a benchmark portfolio. By contrast, passive (or index) fund managers are primarily focused on tracking a given benchmark or index while minimizing costs to do so. Any process, such as shareholder engagement, that takes up management time (and adds to cost) would detract from the primary goal of a passive manager. This would be less of an issue for very large passively managed portfolios, where any engagement costs could be spread over a sizable asset base.

In theory, some investors could benefit from the shareholder engagement of others under the so-called "free rider problem." Specifically, assume that a portfolio manager using an active strategy actively engages with a company to improve its operations and was successful in increasing the company's stock price. The manager's actions in this case improved the value of his portfolio and also benefitted other investors who own the same stock in their portfolios. Investors who did not participate in shareholder engagement benefitted from improved performance but without the costs necessary for engagement.

In addition to shareholders, other stakeholders of a company may also have an interest in the process and outcomes of shareholder engagement. These stakeholders may include creditors, customers, employees, regulators, governmental bodies, and certain other members of society (e.g., community organizations and citizen groups). These other stakeholders can gain or lose influence with companies depending on the outcomes of shareholder engagement. For example, employees can be affected by cost reduction programs requested by shareholders. Another example is when creditors of a company are affected by a change in a company's vendor payment terms, which can impact the company's working capital and cash flow. Such external forces as the media, the academic community, corporate governance consultants, and proxy voting advisers can also influence the process of shareholder engagement.

Shareholders that also have non-financial interests, such as ESG considerations, may also benefit from shareholder engagement. However, these benefits are difficult to quantify. Empirical evidence relating shareholder returns to a company's adherence to corporate governance and ESG practices is mixed. This mixed evidence could be partly attributable to the fact that a company's management quality and effective ESG practices may be correlated with one another. As a result, it is often difficult to isolate non-financial factors and measure the direct effects of shareholder engagement.

5.2 Disadvantages of Shareholder Engagement

Shareholder engagement also has several disadvantages. First, shareholder engagement is time consuming and can be costly for both shareholders and companies. Second, pressure on company management to meet near-term share price or earnings targets could be made at the expense of long-term corporate decisions. Third, engagement can result in selective disclosure of important information to a certain subset of shareholders, which could lead to a breach of insider trading rules while in possession of specific, material, non-public information about a company. Finally, conflicts of interest can result for a company. For example, a portfolio manager could engage with a company that also happens to be an investor in the manager's portfolio. In such a situation, a portfolio manager may be unduly influenced to support the company's management so as not to jeopardize the company's investment mandate with the portfolio manager.

5.3 The Role of an Equity Manager in Shareholder Engagement

Active managers of equity portfolios typically engage, to some degree, with companies in which they currently (or potentially) invest. In fact, investment firms in some countries have legal or regulatory responsibilities to establish written policies on stewardship and/or shareholder engagement. Engagement activities for equity portfolio managers often include regular meetings with company management or investor relations teams. Such meetings can occur at any time but are often held after annual, semi-annual, or quarterly company results have been published.

For such non-financial issues as ESG, large investment firms, in particular, sometimes employ an analyst (or team of analysts) who focuses on ESG issues. These ESG-focused analysts normally work in conjunction with traditional fundamental investment analysts, with primary responsibility for shareholder voting decisions or environmental or social issues that affect equity investments. In lieu of—or in addition to—dedicated ESG analyst teams, some institutional investors have retained outside experts to assist with corporate governance monitoring and proxy voting. In response to this demand, an industry that provides corporate governance services, including governance ratings and proxy advice, has developed.

5.3.1 *Activist Investing*

A distinct and specialized version of engagement is known as activist investing. Activist investors (or activists) specialize in taking stakes in companies and creating change to generate a gain on the investment. Hedge funds are among the most common activists, possibly because of the potential for, in many cases, high performance fees. In addition, because hedge funds are subject to limited regulation, have fewer investment constraints, and can often leverage positions, these investors often have more flexibility as activists.

Engagement through activist investing can include meetings with management as well as shareholder resolutions, letters to management, presentations to other investors, and media campaigns. Activists may also seek representation on a company's board of directors as a way of exerting influence. Proxy contests are one method used to obtain board representation. These contests represent corporate takeover mechanisms in which shareholders are persuaded to vote for a group seeking a controlling position on a company's board of directors. Social media and other communication tools can help activists coordinate the actions of other shareholders.

5.3.2 *Voting*

The participation of shareholders in general meetings, also known as general assemblies, and the exercise of their voting rights are among the most influential tools available for shareholder engagement. General meetings enable shareholders to participate in discussions and to vote on major corporate matters and transactions that are not delegated to the board of directors. By engaging in general meetings, shareholders can exercise their voting rights on major corporate issues and better monitor the performance of the board and senior management.

Proxy voting enables shareholders who are unable to attend a meeting to authorize another individual (e.g., another shareholder or director) to vote on their behalf. Proxy voting is the most common form of investor participation in general meetings. Although most resolutions pass without controversy, sometimes minority shareholders attempt to strengthen their influence at companies via proxy voting. Occasionally, multiple shareholders may use this process to collectively vote their shares in favor of or in opposition to a certain resolution.

Some investors use external proxy advisory firms that provide voting recommendations and reduce research efforts by investors. Portfolio managers need not follow the recommendations of proxy advisory firms, but these external parties can highlight potential controversial issues. An investor's voting instructions are typically processed electronically via third-party proxy voting agents.

When an investor loans shares, the transaction is technically an assignment of title with a repurchase option; that is, the voting rights are transferred to the borrower. The transfer of voting rights with stock lending could potentially result in the borrower having different voting opinions from the lending investor. To mitigate this problem, some stock lenders recall shares ahead of voting resolutions to enable exercise of their voting rights. The downside of this action would be the loss of stock lending revenue during the period of stock loan recall and potential reputation risk as an attractive lender. Investors, in some cases, may borrow shares explicitly to exercise the voting rights attached. This process is called *empty voting*, whereby no capital is invested in the voted shares.

EXAMPLE 4

Shareholder Engagement

An investor manages a fund with a sizable concentration in the transportation sector and is interested in meeting with senior management of a small aircraft manufacturer. Discuss how the investor may benefit from his/her shareholder engagement activities, as well as from the shareholder engagement of other investors, with this manufacturer.

Solution:

The investor may benefit from information obtained about the aircraft manufacturer, such as its strategy, allocation of capital, corporate governance, remuneration of directors and senior management, culture, and competitive environment within the aerospace industry. The investor may also benefit as a "free rider," whereby other investors may improve the manufacturer's operating performance through shareholder engagement—to the benefit of all shareholders. Finally, if the investor has non-financial interests, such as ESG, he or she may address these considerations as part of shareholder engagement.

6 EQUITY INVESTMENT ACROSS THE PASSIVE–ACTIVE SPECTRUM

The debate between passive management and active management of equity portfolios has been a longstanding one in the investment community. In reality, the decision between passive management and active management is not an "either/or" (binary) alternative. Instead, equity portfolios tend to exist across a passive–active spectrum, ranging from portfolios that closely track an equity market index or benchmark to unconstrained portfolios that are not subject to any benchmark or index. In some cases, portfolios may resemble a "closet index" in which the portfolio is advertised as actively managed but essentially resembles a passively managed fund. For an equity manager (or investment firm), several rationales exist for positioning a portfolio along the passive–active spectrum. Each of these rationales is discussed further.

6.1 Confidence to Outperform

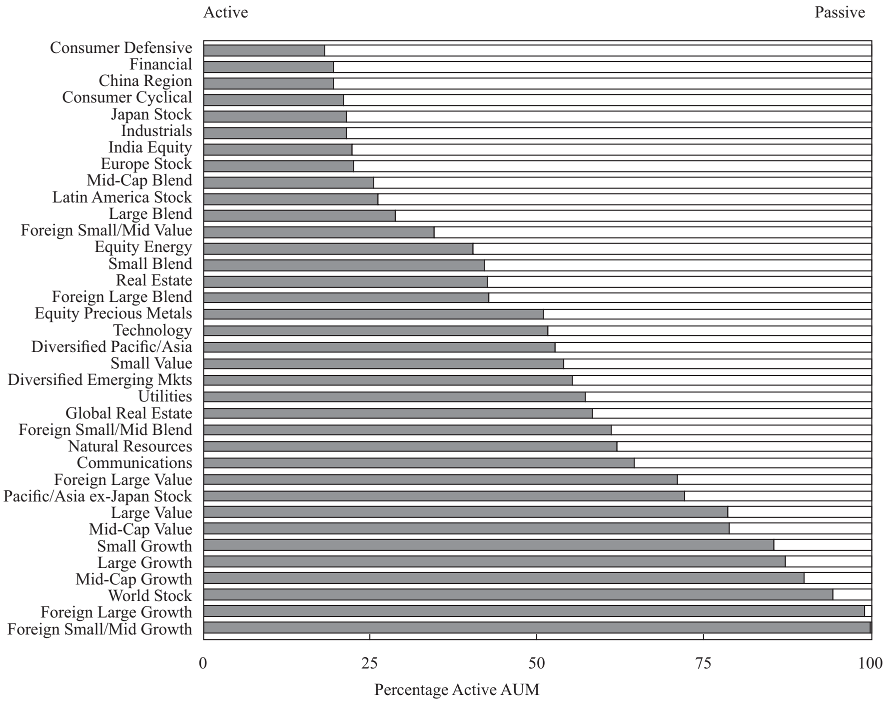
An active investment manager typically needs to be confident that she can adequately outperform her benchmark. This determination requires an understanding of the manager's equity investment universe as well as a competitive analysis of other managers that have a similar investment universe.

6.2 Client Preference

For equity portfolio managers, client preference is a primary consideration when deciding between passive or active investing. Portfolio managers must assess whether their passive or active investment strategies will attract sufficient funds from clients to make the initiatives viable. Another consideration reflects investors' beliefs regarding the potential for active strategies to generate positive alpha. For example, in some equity market categories, such as large-cap/developed markets, companies are widely known and have considerable equity analyst coverage. For such categories as these, investors often believe that potential alpha is substantially reduced because all publicly available information is efficiently disseminated, analyzed, and reflected in stock prices.

A comparison of passive and active equities is illustrated in Exhibit 9. The exhibit demonstrates the relative proportion of investment passive and active equities in US open-ended mutual funds and exchange-traded funds (ETFs) by equity category. Nearly all equities in some categories, such as foreign small/mid-cap growth, are managed on an active basis. Conversely, equities in other categories, such as large-cap blend, are predominantly managed on a passive basis.

Exhibit 9 Passive versus Active Equities in US Open-Ended Mutual Funds and ETFs



Source: Morningstar Direct. Data as of August 2016.

6.3 Suitable Benchmark

An investor or equity manager's choice of benchmark can play a meaningful role in the ability to attract new funds. This choice is particularly relevant in the institutional equity market, where asset owners (and their consultants) regularly screen new managers in desired equity segments. As part of the selection process in desired equity segments, active managers normally must have benchmarks with sufficient liquidity of underlying securities (thus maintaining a reasonable cost of trading). In addition, the number of securities underlying the benchmark typically must be broad enough to generate sufficient alpha. For this reason, many country or sector-specific investment strategies (e.g., consumer defensive companies) are managed passively rather than actively.

6.4 Client-Specific Mandates

Client-specific investment mandates, such as those related to ESG considerations, are typically managed actively rather than passively. This active approach occurs because passive management may not be particularly efficient or cost effective when managers must meet a client's desired holdings (or holdings to avoid). For example, a mandate to avoid investments in companies involved in certain "unacceptable" activities (e.g., the sale of military technology or weapons, tobacco/alcohol, or gambling) requires ongoing monitoring and management. As part of this *exclusionary (or negative) screening* process, managers need to determine those companies that are directly, as well as indirectly, involved in such "unacceptable" industries. Although ESG investing is typically more active than passive, several investment vehicles enable a portfolio manager to invest passively according to ESG-related considerations.

6.5 Risks/Costs of Active Management

As mentioned previously, active equity management is typically more expensive to implement than passive management. Another risk that active managers face—perhaps more so than with passive managers—is reputation risk from the potential violation of rules, regulations, client agreements, or ethical principles. Lastly, "key person" risk is relevant for active managers if the success of an investment manager's firm is dependent on one or a few individuals ("star managers") who may potentially leave the firm.

6.6 Taxes

Compared with active strategies, passive strategies generally have lower turnover and generate a higher percentage of long-term gains. An index fund that replicates its benchmark can have minimal rebalancing. In turn, active strategies can be designed to minimize tax consequences of gains/income at the expense of higher trading costs. One overall challenge is that tax legislation differs widely across countries.

EXAMPLE 5

Passive–Active Spectrum

James Drummond, an equity portfolio manager, is meeting with Marie Goudreaux, a wealthy client of his investment firm. Goudreaux is very cost conscious and believes that equity markets are highly efficient. Goudreaux also has a narrow investment focus, seeking stocks in specific country and industry sectors.

Discuss where Goudreaux's portfolio is likely to be positioned across the passive–active spectrum.

Solution:

Goudreaux's portfolio is likely to be managed passively. Because she believes in market efficiency, Goudreaux likely believes that Drummond's ability to generate alpha is limited. Goudreaux's cost consciousness also supports passive management, which is typically less expensive to implement than active management. Finally, Goudreaux's stated desire to invest in specific countries and sectors would likely be better managed passively.

SUMMARY

This reading provides an overview of the roles equity investments may play in the client's portfolio, how asset owners and investment managers segment the equity universe for purposes of defining an investment mandate, the costs and obligations of equity ownership (including shareholder engagement) and issues relevant to the decision to pursue active or passive management of an equity portfolio. Among the key points made in this reading are the following:

- Equities can provide several roles or benefits to an overall portfolio, including capital appreciation, dividend income, diversification with other asset classes, and a potential hedge against inflation.
- The inclusion of equities in a portfolio can be driven by a client's goals or needs. Portfolio managers often consider the following investment objectives and constraints when deciding to include equities (or asset classes in general, for that matter) in a client's portfolio: *risk objective; return objective; liquidity requirement; time horizon; tax concerns; legal and regulatory factors*; and *unique circumstances.*
- Investors often segment the equity universe according to (1) size and style; (2) geography; and (3) economic activity.
- Sources of equity portfolio income include dividends; securities lending fees and interest; dividend capture; covered calls; and cash-covered puts (or cash-secured puts).
- Sources of equity portfolio costs include management fees; performance fees; administration fees; marketing/distribution fees; and trading costs.
- Shareholder engagement is the process whereby companies engage with their shareholders. The process typically includes voting on corporate matters at general meetings and other forms of communication, such as quarterly investor calls or in-person meetings.
- Shareholder engagement can provide benefits for both shareholders and companies. From a company's perspective, shareholder engagement can assist in developing a more effective corporate governance culture. In turn, shareholder engagement may lead to better company performance to the benefit of shareholders (as well as other stakeholders).
- Disadvantages of shareholder engagement include costs and time involved, pressure on a company to meet near-term share price or earnings targets, possible selective disclosure of information, and potential conflicts of interest.
- Activist investors (or activists) specialize in taking stakes in companies and creating change to generate a gain on the investment.
- The participation of shareholders in general meetings, also known as general assemblies, and the exercise of their voting rights are among the most influential tools available for shareholder engagement.
- The choice of using active management or passive management is not an "either/or" (binary) alternative but rather a decision involving a passive–active spectrum. Investors may decide to position their portfolios across the passive–active spectrum based on their confidence to outperform, client preference, suitable benchmarks, client-specific mandates, risks/costs of active management, and taxes.

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PRACTICE PROBLEMS

The following information relates to questions 1–8

Three years ago, the Albright Investment Management Company (Albright) added four new funds—the Barboa Fund, the Caribou Fund, the DoGood Fund, and the Elmer Fund—to its existing fund offering. Albright's new funds are described in Exhibit 1.

Exhibit 1 Albright Investment Management Company New Funds

Fund	Fund Description
Barboa Fund	Invests solely in the equity of companies in oil production and transportation industries in many countries.
Caribou Fund	Uses an aggressive strategy focusing on relatively new, fast-growing companies in emerging industries.
DoGood Fund	Investment universe includes all US companies and sectors that have favorable environmental, social, and governance (ESG) ratings and specifically excludes companies with products or services related to aerospace and defense.
Elmer Fund	Investments selected to track the S&P 500 Index. Minimizes trading based on the assumption that markets are efficient.

Hans Smith, an Albright portfolio manager, makes the following notes after examining these funds:

Note 1 The fee on the Caribou Fund is a 15% share of any capital appreciation above a 7% threshold and the use of a high-water mark.

Note 2 The DoGood Fund invests in Fleeker Corporation stock, which is rated high in the ESG space, and Fleeker's pension fund has a significant investment in the DoGood Fund. This dynamic has the potential for a conflict of interest on the part of Fleeker Corporation but not for the DoGood Fund.

Note 3 The DoGood Fund's portfolio manager has written policies stating that the fund does not engage in shareholder activism. Therefore, the DoGood Fund may be a free-rider on the activism by these shareholders.

Note 4 Of the four funds, the Elmer Fund is most likely to appeal to investors who want to minimize fees and believe that the market is efficient.

Note 5 Adding investment-grade bonds to the Elmer Fund will decrease the portfolio's short-term risk.

Smith discusses means of enhancing income for the three funds with the junior analyst, Kolton Frey, including engaging in securities lending or writing covered calls. Frey tells Smith the following:

Statement 1	Securities lending would increase income through reinvestment of the cash collateral but would require the fund to miss out on dividend income from the lent securities.
Statement 2	Writing covered calls would generate income, but doing so would limit the upside share price appreciation for the underlying shares.

1 The Barboa Fund can be *best* described as a fund segmented by:

A size/style.

B geography.

C economic activity.

2 The Caribou Fund is *most likely* classified as a:

A large-cap value fund.

B small-cap value fund.

C small-cap growth fund.

3 The DoGood Fund's approach to the aerospace and defense industry is *best* described as:

A positive screening.

B negative screening.

C thematic investing.

4 The Elmer fund's management strategy is:

A active.

B passive.

C blended.

5 Based on Note 1, the fee on the Caribou Fund is *best* described as a:

A performance fee.

B management fee.

C administrative fee.

6 Which of the following notes about the DoGood Fund is correct?

A Only Note 2

B Only Note 3

C Both Note 2 and Note 3

7 Which of the notes regarding the Elmer Fund is correct?

A Only Note 4

B Only Note 5

C Both Note 4 and Note 5

8 Which of Frey's statements about securities lending and covered call writing is correct?

A Only Statement 1

B Only Statement 2

C Both Statement 1 and Statement 2

SOLUTIONS

1 C is correct. The Barboa Fund invests solely in the equity of companies in the oil production and transportation industries in many countries. The fund's description is consistent with the production-oriented approach, which groups companies that manufacture similar products or use similar inputs in their manufacturing processes.

A is incorrect because the fund description does not mention the firms' size or style (i.e., value, growth, or blend). Size is typically measured by market capitalization and often categorized as large cap, mid-cap, or small cap. Style is typically classified as value, growth, or a blend of value and growth. In addition, style is often determined through a "scoring" system that incorporates multiple metrics or ratios, such as price-to-book ratios, price-to-earnings ratios, earnings growth, dividend yield, and book value growth. These metrics are then typically "scored" individually for each company, assigned certain weights, and then aggregated.

B is incorrect because the fund is invested across many countries, which indicates that the fund is not segmented by geography. Segmentation by geography is typically based upon the stage of countries' macroeconomic development and wealth. Common geographic categories are developed markets, emerging markets, and frontier markets.

2 C is correct because the fund focuses on new funds that are generally classified as small firms, and the fund has a style classified as aggressive. A widely used approach to segment the equity universe incorporates two factors: size and style. Size is typically measured by market capitalization and often categorized as large cap, mid-cap, or small cap. Style is typically classified as value, growth, or a blend of value and growth.

3 B is correct. The DoGood fund excludes companies based on specified activities (e.g., aerospace and defense), which is a process of negative screening. Negative or exclusionary screening refers to the practice of excluding certain sectors or companies that deviate from accepted standards in areas such as human rights or environmental concerns

A is incorrect because positive screening attempts to identify companies or sectors that score most favorably regarding ESG-related risks and/or opportunities. The restrictions on investing indicates that a negative screen is established.

C is incorrect because thematic investing focuses on investing in companies within a specific sector or following a specific theme, such as energy efficiency or climate change. The DoGood Fund's investment universe includes all companies and sectors that have favorable ESG (no specific sectors or screens) but with specific exclusions.

4 B is correct. The fund is managed assuming that the market is efficient, and investments are selected to mimic an index. Compared with active strategies, passive strategies generally have lower turnover and generate a higher percentage of long-term gains. An index fund that replicates its benchmark can have minimal rebalancing.

5 A is correct. Performance fees serve as an incentive for portfolio managers to achieve or outperform return objectives, to the benefit of both the manager and investors. Several performance fee structures exist, although performance fees tend to be "upward only"—that is, fees are earned by the manager when performance objectives are met, but fund investors are not reimbursed when

performance is negative. Performance fees could be reduced following a period of poor performance, however. Fee calculations also reflect high-water marks. As described in Note 1, the fee for the Caribou Fund is a 15% share of any capital appreciation above a 7% threshold, with the use of a high-water mark, and is therefore a performance fee.

B is incorrect because management fees include direct costs of research (such as remuneration and expenses for investment analysts and portfolio managers) and the direct costs of portfolio management (e.g., software, trade processing costs, and compliance). Management fees are typically determined as a percentage of the funds under management.

C is incorrect because administrative fees include the processing of corporate actions such as rights issues and optional stock dividends, the measurement of performance and risk of a portfolio, and voting at company meetings. Generally, these functions are provided by an investment management firm itself and are included as part of the management fee.

6 B is correct because the fund becomes a free-rider if it allows other shareholders to engage in actions that benefit the fund, and therefore Note 3 is correct. In theory, some investors could benefit from the shareholder engagement of others under the so-called "free rider problem." Specifically, assume that a portfolio manager using an active strategy actively engages with a company to improve its operations and was successful in increasing the company's stock price. The manager's actions in this case improved the value of his portfolio and also benefitted other investors that own the same stock in their portfolios. Those investors that did not participate in shareholder engagement benefit from improved performance but without the costs necessary for engagement.

Note 2 is incorrect because a conflict of interest arises on the part of the DoGood Fund if it owns shares of a company that invests in the fund. Conflicts of interest can result for a company. For example, a portfolio manager could engage with a company that also happens to be an investor in the manager's portfolio. In such a situation, a portfolio manager may be unduly influenced to support the company's management so as not to jeopardize the company's investment mandate with the portfolio manager.

7 A is correct. For passively managed portfolios, management fees are typically low because of lower direct costs of research and portfolio management relative to actively managed portfolios. Therefore, Note 4 is correct.

Note 5 is incorrect because the predictability of correlations is uncertain.

8 B is correct. Writing covered calls also generates additional income for an equity portfolio, but doing so limits the upside from share price appreciation of the underlying shares. Therefore, Statement 2 is correct.

A is incorrect because dividends on loaned stock are "manufactured" by the stock borrower for the stock lender—that is, the stock borrower ensures that the stock lender is compensated for any dividends that the lender would have received had the stock not been loaned. Therefore, Statement 1 is incorrect. Frey is incorrect in stating that the funds would miss out on dividend income on lent securities.

READING

23

Passive Equity Investing

by David M. Smith, PhD, CFA, and Kevin K. Yousif, CFA

David M. Smith, PhD, CFA, is at the University at Albany, New York (USA). Kevin K. Yousif, CFA, is at LSIA Wealth & Institutional (USA).

LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	**a.** discuss considerations in choosing a benchmark for a passively managed equity portfolio;
☐	**b.** compare passive factor-based strategies to market-capitalization-weighted indexing;
☐	**c.** compare different approaches to passive equity investing;
☐	**d.** compare the full replication, stratified sampling, and optimization approaches for the construction of passively managed equity portfolios;
☐	**e.** discuss potential causes of tracking error and methods to control tracking error for passively managed equity portfolios;
☐	**f.** explain sources of return and risk to a passively managed equity portfolio.

INTRODUCTION

1

This reading provides a broad overview of passive equity investing, including index selection, portfolio management techniques, and the analysis of investment results.

Although they mean different things, passive equity investing and indexing have become nearly synonymous in the investment industry. Indexing refers to strategies intended to replicate the performance of benchmark indexes, such as the S&P 500 Index, the Topix 100, the FTSE 100, and the MSCI All-Country World Index. The main advantages of indexing include low costs, broad diversification, and tax efficiency. Indexing is the purest form of a more general idea: passive investing. Passive investing refers to any rules-based, transparent, and investable strategy that does not involve identifying mispriced individual securities. Unlike indexing, however, passive investing can include investing in a changing set of market segments that are selected by the portfolio manager.

Studies over the years have reported support for passive investing. Renshaw and Feldstein (1960) observe that the returns of professionally managed portfolios trailed the returns on the principal index of that time, the Dow Jones Industrial Average. They also conclude that the index would be a good basis for what they termed an "unmanaged investment company." French (2008) indicates that the cost of passive investing is lower than the cost of active management.

Further motivation for passive investing comes from studies that examine the return and risk consequences of stock selection, which involves identifying mispriced securities. This differs from asset allocation, which involves selecting asset class investments that are, themselves, essentially passive indexed-based portfolios. Brinson, Hood, and Beebower (1986) find a dominant role for asset allocation rather than security selection in explaining return variability. With passive investing, portfolio managers eschew the idea of security selection, concluding that the benefits do not justify the costs.

The efficient market hypothesis gave credence to investors' interest in indexes by theorizing that stock prices incorporate all relevant information—implying that after costs, the majority of active investors could not consistently outperform the market. With this backdrop, investment managers began to offer strategies to replicate the returns of stock market indexes as early as 1971.

In comparison with passive investing strategies, active management of an investment portfolio requires a substantial commitment of personnel, technological resources, and time spent on analysis and management that can involve significant costs. Consequently, passive portfolio fees charged to investors are generally much lower than fees charged by their active managers. This fee differential represents the most significant and enduring advantage of passive management.

Another advantage is that passive managers seeking to track an index can generally achieve their objective. Passive managers model their clients' portfolios to the benchmark's constituent securities and weights as reported by the index provider, thereby replicating the benchmark. The skill of a passive manager is apparent in the ability to trade, report, and explain the performance of a client's portfolio. Gross-of-fees performance among passive managers tends to be similar, so much of the industry views passive managers as undifferentiated apart from their scope of offerings and client-servicing capabilities.

Investors of passively managed funds may seek market return, otherwise known as beta exposure, and do not seek outperformance, known as alpha. A focus on beta is based on a single-factor model: the capital asset pricing model.

Since the turn of the millennium, passive factor-based strategies, which are based on more than a single factor, have become more prevalent as investors gain a different understanding of what drives investment returns. These strategies maintain the low-cost advantage of index funds and provide a different expected return stream based on exposure to such factors as style, capitalization, volatility, and quality.

This reading contains the following sections. Section 2 focuses on how to choose a passive benchmark, including weighting considerations. Section 3 looks at how to gain exposure to the desired index, whether through a pooled investment, a derivatives-based approach, or a separately managed account. Section 4 describes passive portfolio construction techniques. Section 5 discusses how a portfolio manager can control tracking error against the benchmark, including the sources of tracking error. Section 6 introduces methods a portfolio manager can use to attribute the sources of return in the portfolio, including country returns, currency returns, sector returns, and security returns. This section also describes sources of portfolio risk. A summary of key points concludes the reading.

CHOOSING A BENCHMARK

2

Investors initially used benchmark indexes solely to compare the performance of an active portfolio manager against the performance of an unmanaged market portfolio. Indexes are now used as a basis for investment strategies. Many investment vehicles try to replicate index performance, which has contributed to a proliferation of indexes. Indeed, many indexes are developed specifically as a basis for new investment securities.

Successful investors choose their performance benchmarks with care. It is surprising that investors who spend countless hours analyzing the investment process and past performance of an active management strategy may accept a strategy based on a benchmark index without question. A comprehensive analysis of the creation methodology and performance of an index is just as important to investors as the analysis of an active strategy.

2.1 Indexes as a Basis for Investment

For an index to become the basis for an equity investment strategy, it must meet three initial requirements. It must be rules-based, transparent, and investable.

Examples of rules include criteria for including a constituent stock and the frequency with which weights are rebalanced. An active manager may use rules and guidelines, but it is often impossible for others to replicate the active manager's decision process. Index rules, on the other hand, must be objective, consistent, and predictable.

Transparency may be the most important requirement because passive investors expect to understand the rules underlying their investment choices. Benchmark providers disclose the rules used and constituents in creating their indexes without any black-box methodologies, which assures investors that indexes will continue to represent the intended strategy.

Equity index benchmarks are investable when their performance can be replicated in the market. For example, the FTSE 100 Index is an investable index because its constituent securities can be purchased easily on the London Stock Exchange. In contrast, most investors cannot track hedge fund-of-funds indexes, such as the HFRI series of indexes, because of the difficulty of buying the constituent hedge funds. Another example of a non-investable index is the Value Line Geometric Index, which is a multiplicative average price. In other words, the value of the index is obtained by multiplying the prices and taking a root corresponding to the number of stocks. This index is not useful for investing purposes because it cannot be replicated.

Certain features of individual securities make them non-investable as index constituents. Many stock indexes "free-float adjust" their shares outstanding, which means that they count only shares available for trade by the public, excluding those shares that are held by founders, governments, or other companies. When a company's shares that are floated in the market are a small fraction of the total shares outstanding, trading can result in disproportionate effects. Similarly, stocks for which trading volume is a small fraction of the total shares outstanding are likely to have low liquidity and commensurately high trading costs. Many indexes consequently require that stocks have float and average shares traded above a certain percent of shares outstanding.

Equity index providers include CRSP, FTSE Russell, Morningstar, MSCI, and S&P Dow Jones. These index providers publicize the rules underlying their indexes, communicate changes in the constituent securities, and report performance. For a fee, they may also provide data to investors who want to replicate the underlying basket of securities.

Index providers have taken steps to make their indexes more investable. One key decision concerns when individual stocks will migrate from one index to another. As a stock increases in market capitalization (market cap) over time, it might move from small-cap to mid-cap to large-cap status. Some index providers have adopted policies intended to limit stock migration problems and keep trading costs low for investors who replicate indexes. Among these policies are buffering and packeting. **Buffering** involves establishing ranges around breakpoints that define whether a stock belongs in one index or another. As long as stocks remain within the buffer zone, they stay in their current index. For example, the MSCI USA Large Cap Index contains the 300 largest companies in the US equity market. But a company currently in the MSCI USA Mid Cap Index must achieve a rank as the 200th largest stock to move up to the Large Cap Index. Similarly, a large-cap constituent must shrink and be the 451st largest stock to move down to the Mid Cap Index. Size rankings may change almost every day with market price movements, so buffering makes index transitions a more gradual and orderly process.

The effect of buffering is demonstrated with the MSCI USA Large Cap Index during the regularly scheduled May 2016 reconstitution. The MSCI USA Large Cap Index consists of stocks of US-based companies that meet the criterion to be considered for large cap. Further, the MSCI USA Large Cap Index is intended to represent the largest 70% of the market capitalization of the US equity market.

At each rebalance date, MSCI sets a cutoff value for the smallest company in the index and then sets the buffer value at 67% of the cutoff value. During the May 2016 rebalance, the cutoff market capitalization (market cap) of the smallest company in the index was USD 15,707 million; so, the buffer value was USD 10,524 million or approximately USD 10.5 billion.

Whole Foods Market, a grocery store operating primarily in the United States, had experienced a drop in market value from USD 15.3 billion in May of 2015 to USD 10.4 billion in May of 2016. The drop in value put the market cap of Whole Foods Market at a lower value than the acceptable buffer. That is, Whole Foods Market was valued at USD 10.4 billion, which was below the buffer point of USD 10.5 billion. Per the stated rules, Whole Foods Market was removed from the MSCI USA Large Cap Index and was added to the MSCI USA Mid Cap Index.

Packeting involves splitting stock positions into multiple parts. Let us say that a stock is currently in a mid-cap index. If its capitalization increases and breaches the breakpoint between mid-cap and large-cap indexes, a portion of the total holding is transferred to the large-cap index but the rest stays in the mid-cap index. On the next reconstitution date, if the stock value remains large-cap and all other qualifications are met, the remainder of the shares are moved out of the mid-cap and into the large-cap index. A policy of packeting can keep portfolio turnover and trading costs low. The Center for Research in Security Prices (CRSP) uses packeting in the creation of the CRSP family of indexes.

2.2 Considerations When Choosing a Benchmark Index

The first consideration when choosing a benchmark index is the desired *market exposure*, which is driven by the objectives and constraints in the investor's investment policy statement (IPS). For equity portfolios, the choices to be made include the market segment (broad versus sectors; domestic versus international), equity capitalization (large, mid, or small), style (value, growth, or blend/core), exposure, and other constituent characteristics (e.g., high or low momentum, low volatility, and quality) that are considered risk factors.

The choice of market depends on the investor's perspective. The investor's domicile, risk tolerance, liquidity needs, and legal considerations all influence the decision. For example, the decision will proceed differently for an Indian institutional investor than for a US-based individual investor. In India, the domestic equity universe is much smaller than in the United States, making the Indian investor more likely to invest globally. But a domestic investment does not carry with it the complexities of cross-border transactions.

A common way to implement the domestic/international investment decision is to use country indexes. Some indexes cover individual countries, and others encompass multiple country markets. For example, the global equity market can also be broken into geographic regions or based on development status (developed, emerging, or frontier markets). The US market is frequently treated as distinct from other developed markets because of its large size.

Another decision element is the *risk-factor exposure* that the index provides. As described later, equity risk factors can arise from several sources, including the holdings' market capitalization (the Size factor), investment style (growth vs. value, or the Value factor), price momentum (the Momentum factor), and liquidity (the Liquidity factor).

The Size factor is perhaps the best known of these. Market history and empirical studies show that small-cap stocks tend to be riskier and provide a higher long-term return than large-cap stocks. This return difference is considered a risk factor. To the extent that a benchmark's return is correlated with this risk factor, the benchmark has exposure to the Size factor. A similar argument applies to the Value factor, which is calculated as the return on value stocks less the return on growth stocks.

Practically speaking, some investors consider certain size ranges (e.g., small cap) to be more amenable to alpha generation using active management and others (e.g., large cap) amenable to lower-cost passive management. Size classifications range from mega cap to micro cap. Classifications are not limited to individual size categories. For example, many indexes seek to provide equity exposure to both small- and mid-cap companies ("smid-cap" indexes). Investors who desire exposure across the capitalization spectrum may use an "all-cap" index. Such indexes do not necessarily contain all stocks in the market; they usually just combine representative stocks from each of the size ranges. Note that a large-cap stock in an emerging market may have the same capitalization as a small-cap stock in a developed country. Accordingly, index providers usually classify company capitalizations in the context of the local market environment.

Equity benchmark selection also involves the investor's preference for exposure on the growth vs. value style spectrum. Growth stocks exhibit such characteristics as high price momentum, high P/Es, and high EPS growth. Value stocks, however, may exhibit high dividend yields, low P/Es, and low price-to-book value ratios. Depending on their basic philosophy and market outlook, investors may have a strong preference for growth or value.

Exhibit 1 shows the number of available total-return equity indexes[1] in various classifications available worldwide. Broad market exposure is provided by nearly two-thirds of all indexes, while the others track industry sectors. Developed market indexes are about twice as common as emerging-market indexes. The majority of broad market indexes cover the all-cap space or are otherwise focused on large-cap and mid-cap stocks.

1 Total-return indexes account for both price and income (e.g., from cash dividends) returns to the constituent securities. The value of price-return indexes changes only because of return from the constituents' price changes.

Exhibit 1 Characteristics of Equity Indexes

Equity indexes	9,165
Broad market indexes	5,658
Sector indexes	3,479
Not classified	28
Of the 5,658 broad market indexes:	
Developed markets	2,903
Emerging markets	1,701
Developed & emerging markets	1,050
Not classified	4
Of the 5,658 broad market indexes:	
All-cap stocks	1,892
Large-cap stocks	121
Large-cap and mid-cap stocks	2,100
Mid-cap stocks	657
Mid- and small-cap stocks	39
Small-cap stocks	846
Not classified	3

Source: Morningstar Direct, May 2017.

Once the investor has settled on the market, capitalization, and style of benchmark, the next step is to explore the method used in constructing and maintaining the benchmark index.

2.3 Index Construction Methodologies

Equity index providers differ in their stock inclusion methods, ranging from **exhaustive** to **selective** in their investment universes. Exhaustive stock inclusion strategies are those that select every constituent of a universe, while selective approaches target only those securities with certain characteristics. The CRSP US Total Market Index has perhaps the most exhaustive set of constituents in the US market. This market-cap-weighted index includes approximately 4,000 publicly traded stocks from across the market-cap spectrum. In contrast, the S&P 500 Index embodies a selective approach and aims to provide exposure to US large-cap stocks. Its constituent securities are selected using a committee process and are based on both size and broad industry affiliation.

The weighting method used in constructing an index influences its performance. One of the most common weighting methods is market-cap weighting. The equity market cap of a constituent company is its stock price multiplied by the number of shares outstanding. Each constituent company's weight in the index is calculated as its market capitalization divided by the total market capitalization of all constituents of the index. In the development of the capital asset pricing model, the capitalization-weighted market portfolio is mean–variance efficient, meaning that it offers the highest return for a given level of risk. To the extent a capitalization-weighted equity index is a reasonable proxy for the market portfolio, the tracking portfolio may be close to mean–variance efficient.

A further advantage of the capitalization-weighted approach is that it reflects a strategy's investment capacity. A cap-weighted index can be thought of as a liquidity-weighted index because the largest-cap stocks tend to have the highest liquidity and the greatest capacity to handle investor flows at a manageable cost. Many investor portfolios tend to be biased toward large-cap stocks and use benchmarks that reflect that bias.

The most common form of market-cap weighting is free-float weighting, which adjusts each constituent's shares outstanding for closely held shares that are not generally available to the investing public. The process to determine the free-float-adjusted shares outstanding relies on publicly available information to determine the holders of the shares and whether those shares would be available for purchase in the marketplace. One reason to adjust a company's share count may include strategic holdings by governments, affiliated companies, founders, and employees. Another less common reason is to account for limitations on foreign ownership of a company; these limitations typically represent rules that are generally set up by a governmental entity through regulation.

Adjusting a company's shares outstanding for float can be a complex task and often requires an index provider to reach out to the company's shareholder services unit or to rely on analytical judgements. Although all data used in determining a company's free-float-adjusted shares outstanding are public information, the various index providers often report a different number of shares outstanding for the same security. This variation in reported shares outstanding can often be attributed to small differences in their methodologies.

In a *price-weighted* index, the weight of each stock is its price per share divided by the sum of all share prices in the index. A price-weighted index can be interpreted as a portfolio that consists of one share of each constituent company. Although some price-weighted indexes, such as the Dow Jones Industrial Average and the Nikkei 225, have high visibility as indicators of day-to-day market movements, price-weighted investment approaches are not commonly used by portfolio managers. A stock split for any constituent of the index complicates the index calculation. The weight in the index of the stock that split decreases, and the index divisor decreases as well. With its divisor changed, the index ceases to be a simple average of the constituent stocks' prices. For price-weighted indexes, the assumption that the same number of shares is held in each component stock is a shortcoming, because very few market participants invest in that way.

Equally weighted indexes produce the least-concentrated portfolios. Such indexes have constituent weights of $1/n$, where n represents the number of stocks in the index. Equal weighting of stocks within an index is considered a naive strategy because it does not show preference toward any single stock. The reduction of single stock concentration risk and slow changing sector exposures make equal weighting attractive to many investors.

As noted by Zeng and Luo (2013), broad market equally weighted indexes are factor-indifferent and the weighting randomizes factor mispricing. Equal weighting also produces higher volatility than cap weighting, one reason being that it imparts a small-cap bias to the portfolio. Equal weights deviate from market weights most dramatically for large-cap indexes, which contain mega-cap stocks. Constrained market-cap ranges such as mid-cap indexes, even if market weighted, tend to have relatively uniform weights.

Equally weighted indexes require regular rebalancing because immediately after trading in the constituent stocks begins, the weights are no longer equal. Most investors use a regular reweighting schedule. Standard & Poor's offers its S&P 500 Index in an equally weighted format and rebalances the index to equal weights once each quarter. Therein would appear to lie a misleading aspect of equally weighted indexes. For a 91-day quarter, the index is not equally weighted for 90/91 = 99% of the time.

Another drawback of equal weighting is its limited investment capacity. The smallest-cap constituents of an equally weighted index may have low liquidity, which means that investors cannot purchase a large number of shares without causing price changes. Zeng and Luo (2013) address this issue by assuming that 10% of shares in the cap-weighted S&P 100 and 500 and 5% of shares in the cap-weighted S&P 400 and 600 indexes are currently held in cap-weighted indexing strategies without any appreciable liquidity problems. They then focus on the smallest-cap constituent of each index as of December 2012, and they determine the value that 10% (5%) of its market capitalization represents. Finally, they multiply this amount by the number of stocks in the index to estimate the total investment capacity for tracking each of the S&P equally weighted equity indexes. Zeng's and Luo's estimates are shown in Exhibit 2.

Exhibit 2 Estimated Investment Capacity of Equally Weighted (EW) Equity Indexes

Index	Capitalization Category	Estimated Capacity
S&P 100 EW	Mega cap	USD 176 billion
S&P 500 EW	Large cap	USD 82 billion
S&P 400 EW	Mid cap	USD 8 billion
S&P 600 EW	Small cap	USD 2 billion

Source: Zeng and Luo (2013).

Qin and Singal (2015) show that equally weighted portfolios have a natural advantage over cap-weighted portfolios. To the extent that any of the constituent stocks are mispriced, equally weighted portfolios will experience return superiority as the stock prices move up or down toward their correct intrinsic value. Because of the aforementioned need to rebalance back to equal weights, Qin and Singal find that the advantage largely vanishes when taxes and transaction costs are considered. However, based on their results, tax-exempt institutional investors could experience superior returns from equal weighting.

Other non-cap-weighted indexes are weighted based on such attributes as a company or stock's fundamental characteristics (e.g., sales, income, or dividends). Discussed in more detail later, fundamental weighting delinks a constituent stock's portfolio weight from its market value. The philosophy behind fundamental weighting is that although stock prices may become over- or undervalued, the market price will eventually converge to a level implied by the fundamental attributes.

Market-cap-weighted indexes and fundamentally weighted indexes share attractive characteristics, including low cost, rules-based construction, transparency, and investability. Their philosophies, however, are different. Market-cap-weighted portfolios are based on the efficient market hypothesis, while fundamentally weighted indexes look to exploit possible inefficiencies in market pricing.

An important concern in benchmark selection relates to how concentrated the index is. In this case, the concept of the effective number of stocks, which is an indication of portfolio concentration, can provide important information. An index that has a high degree of stock concentration or a low effective number of stocks may be relatively undiversified. Woerheide and Persson (1993) show that the Herfindahl–Hirschman

Index (HHI) is a valid measure of stock-concentration risk in a portfolio, and Hannam and Jamet (2017) demonstrate its use by practitioners. The HHI is calculated as the sum of the constituent weightings squared, as shown in Equation 1:

$$\text{HHI} = \sum_{i=1}^{n} w_i^2 \tag{1}$$

where w_i is the weight of stock i in the portfolio.

The HHI can range in value from $1/n$, where n is equal to the number of securities held, to 1.0. An HHI of $1/n$ would signify an equally weighted portfolio, and a value of 1.0 would signify portfolio concentration in a single security.

Using the HHI, one can estimate the effective (or equivalent) number of stocks, held in equal weights, that would mimic the concentration level of the chosen index. The effective number of stocks for a portfolio is calculated as the reciprocal of the HHI, as shown in Equation 2.

$$\text{Effective number of stocks} = \frac{1}{\sum_{i=1}^{n} w_i^2} = 1/\text{HHI} \tag{2}$$

Malevergne, Santa-Clara, and Sornette (2009) demonstrate that cap-weighted indexes have a surprisingly low effective number of stocks. Consider the NASDAQ 100, a US-based market-cap-weighted index consisting of 100 stocks. If the index were weighted uniformly, each stock's weight would be 0.01 (1%). In May 2017, the constituent weights ranged from 0.123 for Apple, Inc., to 0.0016 for Liberty Global plc, a ratio of 77:1. Weights for the top five stocks totaled almost 0.38 (38%), a significant allocation to those securities. Across all stocks in the index, the median weight was 0.0039 (that is, 0.39%). The effective number of stocks can be estimated by squaring the weights for the stocks, summing the results, and calculating the reciprocal of that figure. The squared weights for the NASDAQ 100 stocks summed to 0.0404, the reciprocal of which is 1/0.0404 = 24.75, the effective number of stocks. Thus, the 100 stocks in the index had a concentration level that can be thought of as being equivalent to approximately 25 stocks held in equal weights.

EXAMPLE 1

Effective Number of Stocks

A market-cap-weighted index contains 50 stocks. The five largest-cap stocks have weights of 0.089, 0.080, 0.065, 0.059, and 0.053. The bottom 45 stocks represent the remaining weight of 0.654, and the sum of the squares of those weights is 0.01405. What are the portfolio's Herfindahl–Hirschman Index and effective number of stocks held?

Solution:

The stocks, their weights, and their squared weights are shown in Exhibit 3.

Exhibit 3 Calculations for Effective Number of Stocks

Stock	Weight	Squared Weight
1	0.089	0.00792
2	0.080	0.00640
3	0.065	0.00423
4	0.059	0.00348

(continued)

Exhibit 3 (Continued)

Stock	Weight	Squared Weight
5	0.053	0.00281
Stocks 6–50	0.654	Sum of squared weights for stocks 6–50: 0.01405
Total for stocks 1–50	1.000	0.03889

The HHI is shown in the final row: 0.03889. The reciprocal of the HHI is 1/0.03889 = 25.71. Thus, the effective number of stocks is approximately 26. The fact that the portfolio weights are far from being a uniform 2% across the 50 stocks makes the effective number of stocks held in equal weights less than 26.

The stock market crises of 2000 and 2008 brought heightened attention to investment strategies that are defensive or volatility reducing. For example, some income-oriented investors are drawn to strategies that weight benchmark constituents based on the dividend yield of each stock. Volatility weighting calculates the volatility of each constituent stock and weights the index based on the inverse of each stock's relative volatility. A related method produces a minimum-variance index using mean–variance optimization.

Exhibit 4 shows the various methods for weighting the constituent securities of broad-based, non-industry-sector, total-return equity indexes.

Exhibit 4. Equity Index Constituent Weighting Methods

Weighting Method	Number of Indexes
Market-cap, free-float adjusted	5,182
Market-cap-weighted	169
Multi-factor-weighted	143
Equal-weighted	63
Dividend-weighted	36

Source: Morningstar Direct, May 2017.

Another consideration in how an index is constructed involves its periodic rebalancing and reconstitution schedule. Reconstitution of an index frequently involves the addition and deletion of index constituents, while rebalancing refers to the periodic reweighting of those constituents. Index reconstitution and rebalancing create turnover. The turnover for developed-market, large-cap indexes that are infrequently reconstituted tends to be low, while benchmarks constructed using stock selection rather than exhaustive inclusion have higher turnover. As seen in Exhibit 5, both rebalancing and reconstitution occur with varied frequency, although the former is slightly more frequent.

Exhibit 5 Index Rebalancing/Reconstitution Frequency for Broad Equity Market Total-Return Indexes

Frequency	Rebalancing	Reconstitution
Daily	3	2
Monthly	4	3
Quarterly	2,481	1,379
Semi-annually	2,743	3,855
Annually	260	308
As needed	74	13

Note: The totals for the Rebalancing and Reconstitution columns differ slightly, as does the index total in Exhibit 4.
Source: Morningstar Direct, May 2017.

The method of reconstitution may produce additional effects. When reconstitution occurs, index-tracking portfolios, mutual funds, and ETFs will want to hold the newly included names and sell the deleted names. The demand created by investors seeking to track an index can push up the stock prices of added companies while depressing the prices of the deleted ones. Research shows that this produces a significant price effect in each case. Depending on the reconstitution method used by index publishers, arbitrageurs may be able to anticipate the changes and front-run the trades that will be made by passive investors. In some cases, the index rules are written so that the decision to add or remove an index constituent is voted on by a committee maintained by the index provider. Where a committee makes the final decision, the changes become difficult to guess ahead of time. In other cases, investors know the precise method used for reconstitution so guessing is often successful.

Chen, Noronha, and Singal (2004) find that constituent changes for indexes that reconstitute using subjective criteria are often more difficult for arbitrageurs to predict than indexes that use objective criteria. Even indexes that use objective criteria for reconstitution often announce the changes several weeks before they are implemented. Stocks near the breakpoint between small-cap and large-cap indexes are especially vulnerable to reconstitution-induced price changes. The smallest-cap stocks in the Russell 1000 Large-Cap Index have a low weight in that cap-weighted index. After any of those stocks are demoted to the Russell 2000 Small-Cap Index, they are likely to have some of the highest weights. Petajisto (2010) shows that the process of moving in that direction tends to be associated with increases in stock prices, while movements into the large-cap index tend to have negative effects. He also concludes that transparency in reconstitution is a virtue rather than a drawback.

A final consideration is investability. As stated in a prior section, an effective benchmark must be investable in that its constituent stocks are available for timely purchase in a liquid trading environment. Indexes that represent the performance of a market segment that is not available for direct ownership by investors must be replicated through derivatives strategies, which for reasons explained later may be sub-optimal for many investors.

2.4 Factor-Based Strategies

Traditional indexing generally involves tracking the returns to a market-cap-weighted benchmark index. Yet most benchmark returns are driven by factors, which are risk exposures that can be identified and isolated. An investor who wants access only to specific aspects of an index's return stream can invest in a subset of constituent securities that best reflect the investor's preferred risk factors, such as Size, Value, Quality, and Momentum. The goal of being exposed to one or more specific risk factors will also drive the choice of a benchmark index.

Factor-based strategies are an increasingly popular variation on traditional indexing, and they have important implications for benchmark selection. Some elaboration on the topic is warranted. The origin of passive factor-based strategies dates to at least the observation by Banz (1981) that small-cap stocks tend to outperform large-cap stocks. Work by Fama and French (2015) shows that at least five risk factors explain US equity market returns. Their asset pricing model incorporates the market risk premium from the CAPM plus factors for a company's size, book-to-market (value or growth style classification), operating profitability, and investment intensity. Consistent with prior research, they find a positive risk premium for small companies and value stocks over large companies and growth stocks. They measure operating profitability as the previous year's gross profit minus selling, general, and administrative expenses as well as interest expense—all divided by the beginning book value of equity. Investment intensity is measured as the growth rate in total assets in the previous year.

Although the concepts underlying passive factor investing, sometimes marketed as "smart beta," have been known for a long time, investors' use of the technique increased dramatically over time. There presently exist many passive investment vehicles and indexes that allow access to such factors as Value, Size, Momentum, Volatility, and Quality, which are described in Exhibit 6. Many investors use their beliefs about market conditions to apply factor tilts to their portfolios. This is the process of intentionally overweighting and underweighting certain risk factors. Passive factor-based strategies can be used in place of or to complement a market-cap-weighted indexed portfolio.

Exhibit 6 Common Equity Risk Factors

Factor	Description
Growth	Growth stocks are generally associated with high-performing companies with an above-average net income growth rate and high P/Es.
Value	Value stocks are generally associated with mature companies that have stable net incomes or are experiencing a cyclical downturn. Value stocks frequently have low price-to-book and price-to-earnings ratios as well as high dividend yields.
Size	A tilt toward smaller size involves buying stocks with low float-adjusted market capitalization.
Yield	Yield is identified as dividend yield relative to other stocks. High dividend-yielding stocks may provide excess returns in low interest rate environments.
Momentum	Momentum attempts to capture further returns from stocks that have experienced an above-average increase in price during the prior period.
Quality	Quality stocks might include those with consistent earnings and dividend growth, high cash flow to earnings, and low debt-to-equity ratios.
Volatility	Low volatility is generally desired by investors seeking to lower their downside risk. Volatility is often measured as the standard deviation of stock returns.

Passive factor-based equity strategies use passive rules, but they frequently involve active decision making: Decisions on the timing and degree of factor exposure are being made. As Jacobs and Levy (2014) note, the difference between passive factor investing and conventional active management is that with the former, active management takes place up front rather than continuously. Relative to broad-market-cap-weighting, passive factor-based strategies tend to concentrate risk exposures, leaving investors exposed during periods when a chosen risk factor is out of favor. The observation that even strong risk factors experience periods of underperformance has led many investors toward multi-factor approaches. Passive factor-based strategies tend to be transparent in terms of factor selection, weighting, and rebalancing. Possible risks include ease of replication by other investors, which can produce overcrowding and reduce the realized advantages of a strategy.

Fundamental Factor Indexing

Capitalization weighting of indexes and index-tracking portfolios involve treating each constituent stock as if investors were buying all the available shares. Arnott, Hsu, and Moore (2005) developed an alternative weighting method based on the notion that if stock market prices deviate from their intrinsic value, larger-cap stocks will exhibit this tendency more than smaller-cap stocks. Thus, traditional cap weighting is likely to overweight overpriced stocks and underweight underpriced stocks. The combination is intended to make cap-weighting inferior to a method that does not use market prices as a basis for weighting.

The idea advanced by Arnott, Hsu, and Moore is to use a cluster of company fundamentals—book value, cash flow, revenue, sales, dividends, and employee count—as a basis for weighting each company. A separate weighting is developed for each fundamental measure. In the case of a large company, its sales might be 1.3% of the total sales for all companies in the index, so its weight for this criterion would be 0.013. For each company, the weightings are averaged across all of the fundamental measures, and those average values represent the weight of each stock in a “composite fundamentals” index.

The authors show that over a 43-year period, a fundamental index would have outperformed a related cap-weighted index by an average of almost 200 basis points per year. They hasten to add that the result should not necessarily be considered alpha, because the fundamental portfolio provides heightened exposure to the Value and Size factors.

Since the time of the seminal article’s publication, fundamental-weighted indexing strategies for country markets as well as market segments have gained in popularity and attracted a large amount of investor funds.

No matter the style of a passive factor-based strategy, its ultimate goal is to improve upon the risk or return performance of the market-cap-weighted strategy. Passive factor-based approaches gain exposure to many of the same risk factors that active managers seek to exploit. The strategies can be return oriented, risk oriented, or diversification oriented.

Return-oriented factor-based strategies include dividend yield strategies, momentum strategies, and fundamentally weighted strategies. Dividend yield strategies can include dividend growth as well as absolute dividend yield. The low interest rate environment, which followed the 2008–2009 global financial crisis, led to an increase in dividend yield strategies as investors sought reliable income streams. An example index is the S&P 1500 High Yield Dividend Aristocrats Index. This index selects securities within the S&P 1500 that increased dividends in each of the past 20 years and then weights those securities by their dividend yield, with the highest dividend-yielding stocks receiving the highest weight.

Another return-oriented strategy is momentum, which is generally defined by the amount of a stock's excess price return relative to the market over a specified time period. Momentum can be determined in various ways. One example is MSCI's Momentum Index family, in which a stock's most recent 12-month and 6-month price performance are determined and then used to weight the securities in the index.[2]

Risk-oriented strategies take several forms, seeking to reduce downside volatility and overall portfolio risk. For example, risk-oriented factor strategies include volatility weighting, where all of an index's constituents are held and then weighted by the inverse of their relative price volatility. Price volatility is defined differently by each index provider, but two common methods include using standard deviation of price returns for the past 252 trading days (approximately one calendar year) or the weekly standard deviation of price returns for the past 156 weeks (approximately three calendar years).

Volatility weighting can take other forms as well. Minimum variance investing is another risk reducing strategy, and it requires access to a mean–variance optimizer. Minimum variance weights are those that minimize the volatility of the portfolio's returns based on historical price returns, subject to certain constraints on the index's construction. Constraints can include limitations on sector over/under weights, country selection limits, and limits on single stock concentration levels. Mean–variance optimizer programs can be accessed from such vendors as Axioma, BARRA, and Northfield.

Risk weighting has the advantages of being simple to understand and providing a way to reduce absolute volatility and downside returns. However, the development of these strategies is based on past return data, which may not reflect future returns. Thus, investors will not always achieve their objectives despite the strategy's stated goal.

Diversification-oriented strategies include equally weighted indexes and maximum-diversification strategies. Equal weighting is intuitive and is discussed elsewhere in the reading as having a low amount of single-stock risk. The low single-stock risk comes by way of the weighting structure of $1/n$, where n is equal to the number of securities held. Choueifaty and Coignard (2008) define maximum diversification by calculating a "diversification ratio" as the ratio of the weighted average volatilities divided by the portfolio volatility. Diversification strategies then can attempt to maximize future diversification by determining portfolio weights using past price return volatilities.

Portfolio managers who pursue factor-based strategies often use multiple benchmark indexes, including a factor-based index and a broad market-cap-weighted index. This mismatch in benchmarks can also produce an unintended mismatch in returns, known as tracking error, from the perspective of the end investor who has modeled a portfolio against a broad market-cap-weighted index. Tracking error indicates how closely the portfolio behaves like its benchmark and is measured as the standard deviation of the differences between a portfolio's returns and its benchmark returns. The concept of tracking error is discussed in detail later.

Finally, passive factor-based strategies can involve higher management fees and trading commissions than broad-market indexing. Factor-based index providers and managers demand a premium price for the creation and management of these strategies, and those fees decrease performance. Also, commission costs can be higher in factor-based strategies than they are in market-cap-weighted strategies. All else equal, higher costs will lead to lower net performance.

Passive factor-based approaches may offer an advantage for those investors who believe it is prudent to seek out groups of stocks that are poised to have desirable return patterns. Active managers also believe in seeking those stocks, but active

2 The indexes are rebalanced semi-annually. More information can be found at www.msci.com/eqb/methodology/meth_docs/MSCI_Momentum_Indices_Methodology.pdf.

management brings the burden of higher fees that can eat into any outperformance. Active managers may also own stocks that are outside the benchmark and are, thus, incompatible with the investment strategy. In contrast, passive factor-based strategies can provide nearly pure exposure to specific market segments, and there are numerous benchmarks against which to measure performance. Fees are restricted because factor-based strategies are rules based and thus do not require constant monitoring. An investor's process of changing exposures to specific risk factors as market conditions change is known as factor rotation. With factor rotation, investors can use passive vehicles to make active bets on future market conditions.

3 APPROACHES TO PASSIVE EQUITY INVESTING

Passive equity investment strategies may be implemented using several approaches, from the do-it-yourself method of buying stocks to hiring a subadviser to create and maintain the investment strategy. Passively managed investment strategies can be replicated by any internal or external portfolio manager who has the index data, trading tools, and necessary skills. In contrast, actively managed funds each, in theory, have a unique investment strategy developed by the active portfolio manager.

This section discusses different approaches to gain access to an investment strategy's desired performance stream: pooled investments (e.g., mutual funds and exchange-traded funds), derivatives-based portfolios (using options, futures, and swaps contracts), and direct investment in the stocks underlying the strategy.

Some passive investments are managed to establish a target beta, and managers are judged on how closely they meet that target. Portfolio managers commonly use futures and open-end mutual funds to transform a position (in cash, for example) and obtain the desired equity exposure. This process is known as "equitizing." The choice of which method to use is largely determined by the financing costs of rolling the futures contracts over time.[3] With multinational indexes, it can be expedient to buy a set of complementary exchange-traded funds to replicate market returns for the various countries.

3.1 Pooled Investments

Pooled investments are the most convenient approach for the average investor because they are easy to purchase, hold, and sell. This section covers conventional open-end mutual funds and exchange-traded funds (ETFs).

The Qualidex Fund, started in 1970, was the first open-end index mutual fund available to retail investors. It was designed to track the Dow Jones Industrial Average. The Vanguard S&P 500 Index Fund, started in 1975, was the first retail fund to attract investors on a large scale. The primary advantage provided by a mutual fund purchase is its ease of investing and record keeping.

Investors who want to invest in a passively managed mutual fund must take the same steps as those investing in actively managed ones. First, a needs analysis must be undertaken to decide on the investor's return and risk objectives as well as investment constraints, and then to find a corresponding strategy. For example, risk-averse equity

3 Rolling a futures contract involves closing out a contract prior to its last trading day before expiration while taking a similar position in the next month's contract. Contracts that are cash-settled are marked to market, and any resulting funds in the account are available as margin that is used to initiate a position in the next month's contract.

investors may seek a low volatility strategy, while investors looking to match the broad market may prefer an all-cap market-cap-weighted strategy. Once the need has been identified, it is likely that a mutual fund-based strategy can be built to match that need.

Traditional mutual fund shares can be purchased directly from the adviser who manages the fund, through a fund marketplace, or through an individual financial adviser. The process is the same for any mutual fund whether passively or actively managed. Investment companies generally have websites and call centers to help their prospective investors transact shares.

A fund marketplace is a brokerage company that offers funds from different providers. The advantage of buying a mutual fund from a fund marketplace is the ease of purchasing a mutual fund from different providers while maintaining a single account for streamlined record keeping.

A financial adviser can also help in purchasing a fund by offering the guidance needed to identify the strategy, providing the single account to house the fund shares, and gaining access to lower-cost share classes that may not be available to all investors.

No matter how mutual fund shares are purchased, the primary benefits of investing passively using mutual funds are low costs and the convenience of the fund structure. The manager of the passively managed fund handles all of the needed rebalancing, reconstitution, and other changes that are required to keep the investment portfolio in line with the index. Passively managed strategies require constant maintenance and care to reinvest cash from dividends and to execute the buys and sells required to match the additions and deletions of securities to the index. The portfolio manager of a passively managed mutual fund also has most of the same responsibilities as a direct investor. These include trading securities, managing cash, deciding how to proceed with corporate actions, voting proxies, and reporting performance. Moreover, index-replicating mutual funds bear costs in such areas as registration, custodial, and audit, which are similar to those for actively managed mutual funds.

Record keeping functions for a mutual fund include maintaining a record of who owns the shares and when and at what price those shares were purchased. Record keepers work closely with both the custodian of the fund shares to ensure that the security is safely held in the name of the investor and the mutual fund sponsor who communicates those trades.

In the United States, mutual funds are governed by provisions of the Investment Company Act of 1940. In Europe, Undertakings for Collective Investment in Transferable Securities (UCITS) is an agreement among countries in the European Union that governs the management and sale of collective investment funds (mutual funds) across European borders.

ETFs are another form of pooled investment vehicle. The first ETF was launched in the Canadian market in 1990 to track the return of 35 large stocks listed on the Toronto Stock Exchange. ETFs were introduced in the US market in 1993. They are registered funds that can be bought and sold throughout the trading day and change hands like stocks. Advantages of the ETF structure include ease of trading, low management fees, and tax efficiency. Unlike with traditional open-end mutual funds, ETF shares can be bought by investors using margin borrowing; moreover, investors can take short positions in an ETF. ETFs offer flexibility in that they track a wide array of indexes.

ETFs have a unique structure that requires a fund manager as well as an authorized participant who can deliver the assets to the manager. The role of the authorized participant is to be the market maker for the ETF and the intermediary between investors and the ETF fund manager when shares are created or redeemed. To create shares of the ETF, the authorized participant delivers a basket of the underlying stocks to the fund manager and, in exchange, receives shares of the ETF that can be sold to the public. When an authorized participant needs to redeem shares, the process is reversed so that the authorized participant delivers shares of the ETF in exchange for a basket of the underlying stocks that can then be sold in the market.

The creation/redemption process is used when the authorized participant is either called upon to deliver new shares of the ETF to meet investor needs or when large redemptions are requested. The redemption process occurs when an authorized participant needs to reduce its exposure to the ETF holding and accepts shares of the underlying securities in exchange for shares of the ETF.

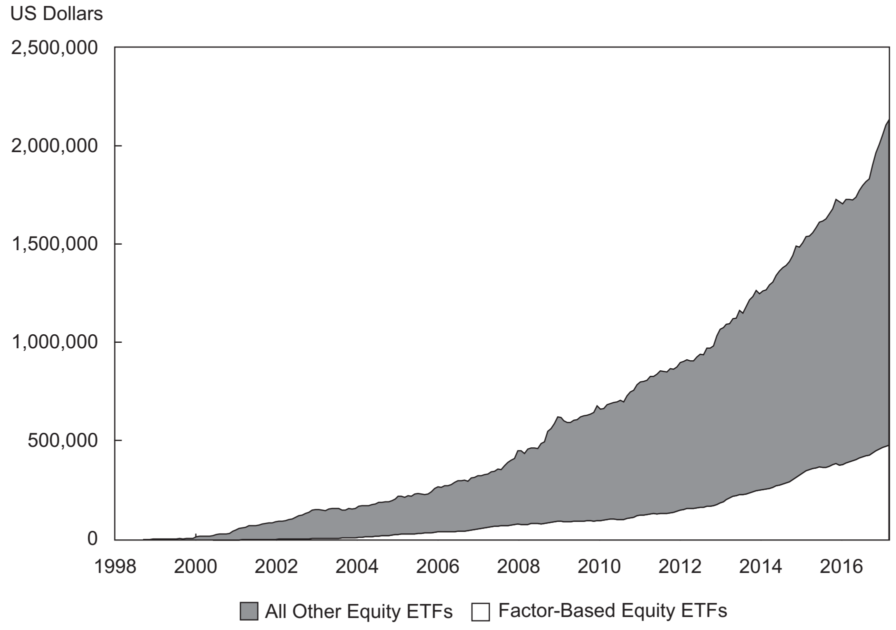
All else equal, taxable investors in an ETF will have a smaller taxable event than those in a similarly managed mutual fund. Managers of mutual funds must sell their portfolio holdings to fulfill shareholder redemptions, creating a taxable event where gains and losses are realized. ETFs have the advantage of accommodating those redemptions through an in-kind delivery of stock, which is the redemption process. Capital gains are not recorded when a redemption is fulfilled through an in-kind delivery of securities, so the taxable gain/loss passed to the investor becomes smaller.

Disadvantages of the ETF structure include the need to buy at the offer and sell at the bid price, commission costs, and the risk of an illiquid market when the investor needs to buy or sell the actual ETF shares.

ETFs that track indexes are used to an increasing degree by financial advisers to provide targeted exposure to different sectors of the investable market. Large investors find it more cost effective to build their own portfolios through replication, stratified sampling, and optimization, concepts to be introduced later. Other investors find ETFs to be a relatively low-cost method of tracking major indexes. Importantly, like traditional open-end mutual funds, ETFs are an integrated approach in that portfolio management and accounting are conducted by the fund adviser itself. A limitation is that there are far more benchmark indexes than ETFs, so not all indexes have an exchange-traded security that tracks them, although new ETFs are constantly being created. Exhibit 7 depicts the strong global trend in investor net flows into index-tracking equity ETFs since 1998. The exhibit does not reflect changes in value caused by market fluctuations, but rather purely investments and redemptions.

Exhibit 7 also shows that, over time, factor-based ETFs have become a large segment of the market. Factor-based ETFs provide exposure to such single factors as Size, Value, Momentum, Quality, Volatility, and Yield. Among the most important innovations are ETFs that track multiple factors simultaneously. For example, the iShares Edge MSCI Multifactor USA ETF emphasizes exposure to Size, Value, Momentum, and Quality factors. Meanwhile, the ETF attempts to maintain characteristics that are similar to the underlying MSCI USA Diversified Multiple-Factor Index, including industry sector exposure. As of 2017, the fund's expense ratio is 0.20% and it holds all 139 of the stocks in the index.

Exhibit 7 Cumulative Monthly Flows (USD millions) into Index-Tracking Equity ETF Shares Listed in 33 Markets, January 1997–April 2017



Source: Morningstar Direct, May 2017.

Exhibit 8 shows that, among 33 major exchange locations, the market value of equity ETFs that track indexes approaches USD 3 trillion. US exchanges have about one-third of the individual ETFs and more than 75% of the total market value as of May 2017. Japan, the United Kingdom, and Switzerland have more than half of the remaining market value. These numbers reflect purely passive ETFs, including factor-based securities.

Exhibit 8 Number of Index-Tracking Equity ETFs and Their Market Values (in USD millions) May 2017

Exchange Location	ETFs	Market Value
United States	1,104	2,236,166
Japan	99	200,965
United Kingdom	365	139,900
Switzerland	272	104,025
Germany	205	81,047
France	260	66,680
Canada	252	47,625
Netherlands	24	22,350
South Korea	177	12,162
Hong Kong SAR	63	9,605
Italy	22	3,724
Singapore	41	3,451
Australia	55	2,873
Mexico	12	2,319

Exhibit 8 (Continued)

Exchange Location	ETFs	Market Value
Sweden	4	1,922
Spain	6	1,654
Brazil	13	1,411
South Africa	27	1,347
New Zealand	11	566
Finland	1	234
Next 13 Locations	52	794
Total for 33 Locations	3,166	2,940,818

Source: Morningstar Direct, May 2017.

The decision of whether to use a conventional open-end mutual fund versus an ETF often comes down to cost and flexibility. Investors who seek to mimic an index must identify a suitable tracking security. According to Morningstar, in the United States, ETFs track 1,354 distinct equity indexes while conventional open-end mutual funds track only 184. Of the ETFs, 38 benchmarks are for price-only returns and the remainder are for total returns, which also include the return from reinvested dividends. Long-term investors benefit from the slightly lower expense ratios of ETFs than otherwise equivalent conventional open-end mutual funds. However, the brokerage fees associated with frequent investor trades into ETF shares can negate the expense ratio advantage and thus make ETFs less economical.

3.2 Derivatives-Based Approaches

Beyond purchasing a third-party-sponsored pooled investment and building it themselves, investors can access index performance through such derivatives as options, swaps, or futures contracts. Derivative strategies are advantageous in that they can be low cost, easy to implement, and provide leverage. However, they also present a new set of risks, including counterparty default risk for derivatives that are not traded on exchanges or cleared through a clearing house. Derivatives can also be relatively difficult to access for individual investors.

Options, swaps, and futures contracts can be found on many of the major indexes, such as the MSCI EAFE Index (EAFE stands for Europe, Australasia, and the Far East) and the S&P 500 Index. Options and futures are traded on exchanges and so are processed through a clearing house. This is important because a clearing house eliminates virtually all of the default risk present in having a contract with a single counterparty. Equity swaps, on the other hand, are generally executed with a single counterparty and so add the risk of default by that counterparty.

Derivatives allow for leverage through their notional value amounts. Notional value of the contracts can be many times greater than the initial cash outlay. However, derivatives expire, whereas stocks can be held indefinitely. The risk of an expiring options contract is a complete loss of the relatively small premium paid to acquire the exposure. Futures and swaps can be extended by "rolling" the contract forward, which means selling the expiring contract and buying a longer dated one.

Futures positions must be initiated with a futures commission merchant (FCM), a clearing house member assigned to trade on behalf of the investor. The FCM posts the initial margin required to open the position and then settles on a daily basis to comply with the maintenance margin required by the clearing house. The FCM also helps close the position upon expiration. However, futures accounts are not free of effort on the client's part. Having a futures account requires the management of daily cash flows, sometimes committing additional money and sometimes drawing it down.

It is uncommon for passive portfolio managers to use derivatives in the long term to synthetically mimic the return from physical securities. Derivatives are typically used to adjust a pre-existing portfolio to move closer to meeting its objectives. These derivative positions are often referred to as an **overlay**. A **completion overlay** addresses an indexed portfolio that has diverged from its proper exposure. A common example is a portfolio that has built up a surplus of cash from investor flows or dividends, causing the portfolio's beta to be significantly less than that of the benchmark. Using derivatives can efficiently restore the overall portfolio beta to its target. A **rebalancing overlay** addresses a portfolio's need to sell certain constituent securities and buy others. Particularly in the context of a mixed stock and bond portfolio, using equity index derivatives to rebalance toward investment policy target weights can be efficient and cost-effective. A **currency overlay** assists a portfolio manager in hedging the returns of securities that are held in a foreign currency back to the home country's currency.

Equity index derivatives offer several advantages over cash-based portfolio construction approaches. A passive portfolio manager can increase or decrease exposure to the entire index portfolio in a single transaction. Managers who want to make tactical adjustments to portfolio exposure often find derivatives to be a more efficient tool than cash-market transactions for achieving their goals. Many derivatives contracts are highly liquid, sometimes more so than the underlying cash assets. Especially in this case, portfolio exposures can be tactically adjusted quickly and at low cost.

For the longer term, strategic changes to portfolios are usually best made using cash instruments, which have indefinite expirations and do not necessitate rolling over expiring positions. Futures markets, for example, can impose position limits on such instruments that constrain the scale of use. Derivatives usage is also sometimes restricted by regulatory bodies or investment policy statement stipulations, so in this case cash could be a preferred approach. Finally, depending on the index that is being tracked by the passive portfolio manager, a suitable exchange-traded futures contract may not be available.

In addition to options, which have nonlinear payoffs[4], the two primary types of equity index derivatives contracts are futures and swaps. Equity index futures provide exposure to a specific index. Unlike many commodity futures contracts, index futures are cash-settled, which means the counterparties exchange cash rather than the underlying shares.

The buyer of an equity index futures contract obtains the right to buy the underlying (in this case, an index) on the expiration date of the contract at the futures price prevailing at the time the derivative was purchased. For exchange-traded futures, the buyer is required to post margin (collateral) in the account to decrease the credit risk to the exchange, which is the effective counterparty. For S&P 500 Index futures contracts as traded on the Chicago Mercantile Exchange, every USD change in the futures price produces a USD 250 change in the contract value (thus a "multiplier" of 250). On 4 August 2016, the September S&P 500 futures contract settled at a price of 2,159.30, after settling at 2,157 the day before. The change in contract value was thus 250 × USD (2,159.30 – 2,157) = USD 575.

Equity index futures contracts for various global markets are shown in Exhibit 9.

4 The nonlinearity of option payoffs arises because all prices of the underlying that cause the option to be out-of-the-money at expiration produce zero payoff for the investor who holds the option. When an option is in the money, the investor holding it experiences a linearly increasing payoff at all prices of the underlying in that range. In the case of futures and swaps, the payoffs are two-sided and linear for price changes in the underlying that are in the investor's favor as well as those that are against the investor.

Exhibit 9 Representative Equity-Index Futures Contracts

Index Futures Contract	Market	Contract Currency and Multiplier
Americas		
Dow Jones mini	United States	USD 5
S&P 500	United States	USD 250
S&P 500 mini	United States	USD 50
NASDAQ 100 mini	United States	USD 20
Mexican IPC	Mexico	MXN 10
S&P/TSX Composite mini	Canada	CAD 5
S&P/TSX 60	Canada	CAD 200
Ibovespa	Brazil	BRL 1
Europe, Middle East, and Africa		
Euro STOXX 50	Europe	EUR 10
FTSE 100	United Kingdom	GBP 10
DAX 30	Germany	EUR 25
CAC 40	France	EUR 10
FTSE/Athens 20	Greece	EUR 5
OMX Stockholm 30	Sweden	SEK 100
Swiss Market	Switzerland	CHF 10
OMX Copenhagen 20	Denmark	DKK 100
PSI-20	Portugal	EUR 1
IBEX 35	Spain	EUR 10
WIG20	Poland	PLN 10
BIST 30	Turkey	TRY 100
FTSE/JSE Top 40	South Africa	ZAR 10
Asia Pacific		
S&P/ASX 200	Australia	AUD 25
CSI 300	Chinese mainland	CNY 300
Hang Seng	Hong Kong SAR	HKD 50
H-Shares	Hong Kong SAR	HKD 50
Nifty 50	India	INR 50
Nikkei 225	Japan	JPY 1,000
Topix	Japan	JPY 10,000
KOSPI 200	Korea	KRW 500,000

Source: Please see www.investing.com/indices/indices-futures, May 2017.

Given that futures can be traded using only a small amount of margin, it is clear that futures provide a significant degree of potential leverage to a portfolio. Leverage can be considered either a positive or negative characteristic, depending on the manner with which the derivative instrument is used. Unlike some institutional investors' short-sale constraints on stock positions, many investors do not face constraints on opening a futures position with a sale of the contracts. Among other benefits of futures is the high degree of liquidity in the market, as evidenced by low bid–ask spreads.

Both commission and execution costs also tend to be low relative to the exposure achieved. The low cost of transacting makes it easy for portfolio managers to use futures contracts to modify the equity risk exposure of their portfolios.

Equity index futures do come with some disadvantages. Futures are used by index fund managers because the instruments are expected to move in line with the underlying index. To the extent that the futures and spot prices do not move in concert, the portfolio may not track the benchmark perfectly. The extent to which futures prices do not move with spot prices is known as basis risk. Basis risk results from using a hedging instrument that is imperfectly matched to the investment being hedged. Basis risk can arise when the underlying securities pay dividends, while the futures contract tracks only the price of the underlying index. The difference can be partially mitigated when futures holders combine that position with interest-bearing securities.

As noted, futures account holders also must post margin. The margin amount varies by trading exchange. In the case of an ASX-200 futures contract, the initial margin required by the Sydney Futures Exchange in January 2017 for an overnight position is AUD 6,700. The minimum maintenance margin for one contract is AUD 5,300.

By way of example, assume an investor buys an ASX-200 futures contract priced at AUD 5,700, and the futures contract has a multiplier of 25. The investor controls AUD 142,500 [= 25 × AUD 5,700] in value. This currency amount is known as the contract unit value. With the initial margin of AUD 6,700 and a maintenance margin of AUD 5,300, a margin call will be triggered if the contract unit value decreases by more than AUD 1,400. A decrease of AUD 1,400 in the margin is associated with a contract unit value of AUD 142,500 – AUD 1,400 = AUD 141,100. This corresponds to an ASX-200 futures price of AUD 5,644 [= AUD 141,100/25]. Thus, a futures price decrease of 0.98% [= (AUD 5,644 – AUD 5,700)/AUD 5,700] is associated with a decrease in the margin account balance of 20%. This example demonstrates how even a small change in the index value can result in a margin call once the mark-to-market process occurs.

Another derivatives-based approach is the use of equity index swaps. Equity index swaps are negotiated arrangements in which two counterparties agree to exchange cash flows in the future. For example, consider an investor who has a EUR 20 million notional amount and wants to be paid the return on her benchmark index, the Euro STOXX 50, during the coming year. In exchange, the investor agrees to pay a floating rate of return of Libor + 0.20% per year, with settlement occurring semi-annually. Assuming a six-month stock index return of 2.3% and annualized Libor of 0.18% per year, the first payment on the swap agreement would be calculated as follows. The investor would receive EUR 20 million × 0.023 = EUR 460,000. The investor would be liable to the counterparty for EUR 20 million × (0.0018 + 0.0020) × (180/360) = EUR 38,000; so, when the first settlement occurs the investor would receive EUR 460,000 – EUR 38,000 = EUR 422,000. In this case, the payment received by the passive portfolio manager is from the first leg of the swap, and the payment made by that manager is from the second leg. Libor is used in this example, but the second leg can also involve the return on a different index, stock, or other asset, or even a fixed currency amount per period.

Disadvantages of swaps include counterparty, liquidity, interest rate, and tax policy risks. Relatively frequent settlement decreases counterparty risk and reduces the potential loss from a counterparty's failure to perform. Equity swaps tend to be nonmarketable instruments, so once the agreement is made there is not a highly liquid market that allows them to be sold to another party (though it is usually possible to go back to the dealer and enter into an offsetting position). Although the equity index payment recipient is an equity investor, this investor must deliver an amount linked to Libor; the investor bears interest rate risk. One prime motivation for initiating equity swaps is to avoid paying high taxes on the full return amount from an equity investment. This advantage is dependent on tax laws remaining favorable, which means that equity swaps carry tax policy risk.

There are a number of advantages to using an equity swap to gain synthetic exposure to index returns. Exchange-traded futures contracts are available only on a limited number of equity indexes. Yet as long as there is a willing counterparty, a swap can be initiated on virtually any index. So swaps can be customized with respect to the underlying as well as to settlement frequency and maturity. Although most swap agreements are one year or shorter in maturity, they can be negotiated for as long a tenor as the counterparties are willing. If a swap is used, it is not necessary for an investor to pay transaction costs associated with buying all of the index constituents. Like futures, a swap can help a portfolio manager add leverage or hedge a portfolio, which is usually done on a tactical or short-term basis.

3.3 Separately Managed Equity Index-Based Portfolios

Building an index-based equity portfolio as a separately managed portfolio requires a certain set of capabilities and tools. An equity investor who builds an indexed portfolio will need to subscribe to certain data on the index and its constituents. The investor also requires a robust trading and accounting system to manage the portfolio, broker relationships to trade efficiently and cheaply, and compliance systems to meet applicable laws and regulations.

The data subscription can generally be acquired directly from the index provider and may be offered on a daily or less-frequent basis. Generally, the data are provided for analysis only and a separate license must be purchased for index replication strategies. The index subscription data should include company and security identifiers, weights, cash dividend, return, and corporate action information. Corporate actions can include stock dividends and splits, mergers and acquisitions, liquidations, and other reasons for index constituent inclusion and exclusion. These data are generally provided in electronic format and can be delivered via file downloads or fed through a portfolio manager's analytical systems, such as Bloomberg or FactSet. The data are then used as the basis for the indexed portfolio.

Certain trading systems, such as those provided by Charles River Investment Management Solution, SS&C Advent (through Moxy), and Eze Castle Integration, allow the manager to see her portfolio and compare it to the chosen benchmark. Common features of trading systems include electronic communication with multiple brokers and exchanges, an ability to record required information on holdings for taxable investors, and modeling tools so that a portfolio can be traded to match its benchmark.

Accounting systems should be able to report daily performance, record historical transactions, and produce statements. Portfolio managers rely heavily on their accounting systems and teams to help them understand the drivers of portfolio performance.

Broker relationships are an often-overlooked advantage of portfolio managers that are able to negotiate better commission rates. Commissions are a negative drag on a portfolio's returns. The commission rates quoted to a manager can differ on the basis of the type of securities being traded, the size of the trade, and the magnitude of the relationship between the manager and broker.

Finally, compliance tools and teams are necessary. Investors must adhere to a myriad of rules and regulations, which can come from client agreements and regulatory bodies. Sanctions for violating compliance-related rules can range from losing a client to losing the registration to participate in the investment industry; thus, a robust compliance system is essential to the success of an investment manager.

Compliance rules can be company-wide or specific to an investor's account. Company-wide rules take such forms as restricting trades in stocks of affiliated companies. Rules specific to an account involve such matters as dealing with a directed broker or steps to prevent cash overdrafts. Compliance rules should also be written to prohibit manager misconduct, such as front-running in a personal account prior to executing client trades.

To ensure that their portfolios closely match the return stream of the chosen index, indexed portfolio managers must review their holdings and their weightings versus the index each day. Although a perfect match is a near impossibility because of rounding errors and trading costs, the manager must always weigh the benefits and costs of maintaining a close match.

To establish the portfolio, the manager creates a trading file and transmits the file to an executing broker, who buys the securities using a program trade. **Program trading** is a strategy of buying or selling many stocks simultaneously. Index portfolio managers may trade thousands of positions in a single trade file and are required to deliver the orders and execute the trades quickly. The creation of trades may be done on something as rudimentary as an Excel spreadsheet, but it is more likely to be created on an order management system (OMS), such as Charles River

Portfolio managers use their OMS to model their portfolios against the index, decide which trades to execute, and transmit the orders. Transmitting an order in the United States is generally done on a secure communication line, such as through FIX Protocol. FIX Protocol is an electronic communication protocol to transmit the orders from the portfolio manager to the broker or directly to the executing market place. The orders are first transmitted via FIX Protocol to a broker who executes the trade and then delivers back pricing and settlement instructions to the OMS. International trading is usually communicated using a similar protocol through SWIFT. SWIFT stands for "Society for Worldwide Interbank Financial Telecommunication," and is a service that is used to securely transmit trade instructions.

Index-based strategies seek to replicate an index that is priced at the close of business each day. Therefore, most index-based trade executions take place at the close of the business day using market-on-close (MOC) orders. Matching the trade execution to the benchmark price helps the manager more closely match the performance of the index.

Beyond the portfolio's initial construction, managers maintain the portfolio by trading any index changes, such as adds/deletes, rebalances, and reinvesting cash dividend payments. These responsibilities require the manager to commit time each day to oversee the portfolio and create the necessary trades. Best practice would be to review the portfolio's performance each day and its composition at least once a month.

Dividends paid over time can accumulate to significant amounts that must be reinvested into the securities in the index. Index fund managers must determine when the cash paid out by dividends should be reinvested and then create trades to purchase the required securities.

4 PORTFOLIO CONSTRUCTION

This section discusses the principal approaches that equity portfolio managers use when building a passive-indexed portfolio by transacting in individual securities. The three approaches are full replication, stratified sampling, and optimization. According to Morningstar, among index-tracking equity ETF portfolios globally:

- 38% of funds (representing 42% of July 2016 assets) use full replication,
- 41% of funds (representing 54% of assets) use stratified sampling or optimization techniques, and
- 21% of funds (representing only about 4% of assets) use synthetic replication, using over-the-counter derivatives).

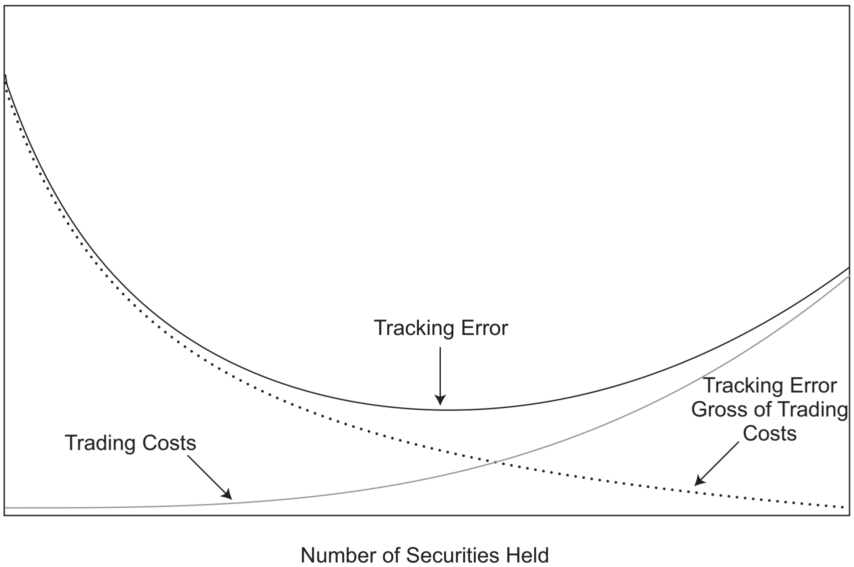
4.1 Full Replication

Full replication in index investing occurs when a manager holds all securities represented by the index in weightings that closely match the actual index weightings. Advantages of full replication include the fact that it usually accomplishes the primary goal of matching the index performance, and it is easy to comprehend. Full replication, however, requires that the asset size of the mandate is sufficient and that the index constituents are available for trading.

Not all indexes lend themselves to full replication. For example, the MSCI ACWI Investable Markets Index consists of over 8,000 constituents,[5] but not all securities need be held to closely match the characteristics and performance of that index. Other indexes, such as the S&P 500, have constituents that are readily available for trading and can be applied to portfolios as small as USD 10 million.

With respect to the choice between index replication versus sampling, as the number of securities held increases, tracking error decreases because the passive portfolio gets closer to replicating the index perfectly. Yet as the portfolio manager adds index constituent stocks that are smaller and more thinly traded than average, trading costs increase. The trading costs can take the form of brokerage fees and upward price pressure as a result of the portfolio's purchases. These transaction costs can depress performance and start to impose a small negative effect on tracking effectiveness. As the portfolio manager moves to the least liquid stocks in the index, transaction costs begin to dominate and tracking error increases again. Thus, for an index that has some constituent securities that are relatively illiquid, the conceptual relationship between tracking error and the number of securities held is U-shaped. The relation can be depicted as shown in Exhibit 10.

Exhibit 10 Relation Between Tracking Error and Transaction Costs versus Number of Benchmark Index Constituent Stocks Held



Source: Author team.

5 The MSCI ACWI Investable Markets Index captures large, mid-, and small-cap stocks across developed and emerging market countries and represents 8,609 securities as of April 2016.

Many managers attempt to match an index's characteristics and performance through a full replication technique, but how does a manager create the portfolio? As mentioned in a prior section, the passive equity manager needs data from the index provider to construct the portfolio. This includes the constituent stocks, their relevant identifiers (ticker, CUSIP, SEDOL, or ISIN), shares outstanding, and price. Additional data, such as constituents' dividends paid and total return, facilitate management of the portfolio.

The manager then uses the index data to create the portfolio by replicating as closely as possible the index constituents and weights. The portfolio construction method may vary by investor, but the most common method is to import the provided data into a data compiler such as Charles River, Moxy, or some other external or internally created OMS. The imported data show the manager the trades that are needed to match the index. Exhibit 11 contains an example for a portfolio that has an initial investment of USD 10 million.

Exhibit 11 Sample Index Portfolio Positions and Transactions

Identifier	Security Description	Price	Current Weight	Model Weight	Current Weight – Model Weight = Variance	Current Shares	New Shares	Shares to Trade
Cash	Cash	1	50%	0%	50%	5,000,000	0	–5,000,000
SECA	Security 1	100	50%	50%	0%	50,000	50,000	0
SECB	Security 2	50	0%	50%	–50%	0	100,000	100,000

Exhibit 11 shows a current portfolio made up of one security and a cash holding that needs to be traded to match a two-security index. The index becomes the model for the portfolio, and that model is used to match the portfolio. This type of modeling can easily and cheaply be conducted using spreadsheet and database programs, such as Excel and Access. However, the modeling is only a part of the portfolio management process.

The OMS should also be programmed to provide the investor with pre-trade compliance to check for client-specific restrictions, front-running issues, and other compliance rules. The OMS is also used to deliver the buy and sell orders for execution using FIX or SWIFT Protocol, as described previously.

After initial creation of the indexed portfolio, the manager must maintain the portfolio according to any changes in the index. The changes are announced publicly by the index provider. Index fund managers use those details to update their models in the OMS and to determine the number of shares to buy or sell. A fully replicated portfolio must make those changes in a timely manner to maintain its performance tracking with the index. Again, a perfectly replicated index portfolio must trade at the market-on-close price where available to match the price used by the index provider in calculating the index performance.

4.2 Stratified Sampling

Despite their preference to realize the benefits of pure replication of an index, portfolio managers often find it impractical to hold all the constituent securities. Some equity indexes have a large number of constituents, and not all constituents offer high trading liquidity. This can make trading expensive, especially if a portfolio manager needs to scale up the portfolio. Brokerage fees can also become excessive if the number of constituents is large.

Holding a limited sample of the index constituents can produce results that track the index return and risk characteristics closely. But such sampling is not done randomly. Rather, portfolio managers use stratified sampling. To stratify is to arrange a population into distinct strata or subgroupings. Arranged correctly, the various strata will be mutually exclusive and also exhaustive (a complete set), and they should closely match the characteristics and performance of the index. Common stratification approaches include using industry membership and equity style characteristics. Investors who use stratified sampling to track the S&P 500 commonly assign each stock to one of the eleven sectors designated by the Global Industry Classification Standard (GICS). For multinational indexes, stratification is often done first on the basis of country affiliation. Indexes can be stratified along multiple dimensions (e.g., country affiliation and then industry affiliation) within each country. An advantage of stratifying along multiple dimensions is closer index tracking.

In equity indexing, stratified sampling is most frequently used when the portfolio manager wants to track indexes that have many constituents or when dealing with a relatively low level of assets under management. Indexes with many constituents are usually multi-country or multi-cap indexes, such as the S&P Global Broad Market Index that consists of more than 11,000 constituents. Most investors are reluctant to trade and maintain 11,000 securities when a significantly smaller number of constituents would achieve most portfolios' tracking objectives. Regardless of the stratified sampling approach used, passive equity managers tend to weight portfolio holdings proportionately to each stratum's weight in the index.

EXAMPLE 2

Stratified Sampling

A portfolio manager responsible for accounts of high-net-worth individuals is asked to build an index portfolio that tracks the S&P 500 Value Index, which has more than 300 constituents. The manager and the client agree that the minimum account size will be USD 750,000, but the manager explains to the client that full replication is not feasible at a reasonable cost because of the mandate size. How can the manager use stratified sampling to achieve her goal of tracking the S&P 500 Value Index?

Solution:

The manager recommends that the client set a maximum number of constituents (for example, 200) to limit the average lot size and to reduce commission costs. Next, the manager seeks to identify the constituents to hold based on their market capitalization. That is, the manager selects the 200 securities with the largest market capitalizations. Then the manager seeks to more closely match the performance of the index by matching the sector weightings of the sampled portfolio to the sector weightings of the index. After comparing sector weights, the manager reweights the sampled portfolio. Using this method of stratified sampling meets the manager's stated goal of closely tracking the performance of the index at a reasonable cost.

4.3 Optimization

Optimization approaches for index portfolio construction, such as full replication and stratified sampling, have index-tracking goals. Optimization typically involves maximizing a desirable characteristic or minimizing an undesirable characteristic, subject to one or more constraints. For an indexed portfolio, optimization could involve minimizing index tracking error, subject to the constraint that the portfolio holds 50 constituent securities or fewer. The desired output from the optimization process is identification of the 50 securities and their weights that results in the lowest possible tracking error. The number of security holdings is not the only possible constraint. Other common constraints include limiting portfolio membership to stocks that have a market capitalization above a certain specified level, style characteristics that mimic those of the benchmark, restricting trades to round lots, and using only stocks that will keep rebalancing costs low.

Roll (1992) and Jorion (2003) demonstrate that running an optimization to minimize tracking error can lead to portfolios that are mean–variance inefficient versus the benchmark. That is, the optimized portfolio may exhibit higher risk than the benchmark it is being optimized against. They show that a useful way to address this problem is to add a constraint on total portfolio volatility. Accordingly, the manager of an optimized passive fund would aim to make its total volatility equal to that of the benchmark index.

Fabozzi, Focardi, and Kolm (2010) note that in practice, passive portfolio managers often conduct a mean–variance optimization using all the index constituents, the output from which shows highly diverse weightings for the stocks. Given that investing in the lowest-weight stocks may involve marginal transaction costs that exceed marginal diversification benefits, in a second, post-optimization stage, the managers may then delete the lowest-weighted stocks.

Optimization can be conducted in conjunction with stratified sampling or alone. Optimization programs, when run without constraints, do not consider country or industry affiliation but rather use security level data. Optimization requires an analyst who has a high level of technical sophistication, including familiarity with computerized optimization software or algorithms, and a good understanding of the output.

Advantages of optimization involve a lower amount of tracking error than stratified sampling. Also, the optimization process accounts explicitly for the covariances among the portfolio constituents. Although two securities from different industry sectors may be included in a passive portfolio under stratified sampling, if their returns move strongly together, one will likely be excluded from an optimized portfolio.

Usually the constituents and weights of an optimized portfolio are determined based on past market data; however, returns, variances, and correlations between securities tend to vary over time. Thus, the output from an optimization program may apply only to the period from which the data are drawn and not to a future period. Even if current results apply to the future, they might not be applicable for long. This means that optimization would need to be run frequently and adjustments made to the portfolio, which can be costly.

4.4 Blended Approach

For indexes that have few constituent securities or for which the constituents are homogeneous, full replication is typically advisable. When the reverse is true, sampling or optimization are likely to be the preferred methods. But such indexes as the Russell 3000, the S&P 1500, and the Wilshire 5000 span the capitalization spectrum from large to small. For these indexes, the 1,000 or so largest constituents are quite liquid, which means that brokerage fees, bid–ask spreads, and trading costs are low. For the largest-cap portion of an indexed portfolio, full replication is a sensible and desirable approach. For the index constituents that have smaller market capitalizations or less liquidity, however, a stratified sampling or optimization approach can be useful for all the reasons mentioned previously in this section. Thus, an indexed portfolio can actually be managed using a blended approach consisting of full replication for more-liquid issues and one of the other methods for less-liquid issues.

TRACKING ERROR MANAGEMENT

5

As discussed previously, managers of passive strategies use a variety of approaches to track indexes in cost-efficient ways. To the extent the portfolio manager's skills are ineffective, tracking error results. This section discusses the measurement and management of tracking error.

5.1 Tracking Error and Excess Return

Tracking error and excess return are two measures that enable investors to differentiate performance among passive portfolio managers. Tracking error indicates how closely the portfolio behaves like its benchmark and measures a manager's ability to replicate the benchmark return. Tracking error is calculated as the standard deviation of the difference between the portfolio return and its benchmark index return. Excess return measures the difference between the portfolio returns and benchmark returns. Tracking error for portfolio p then can be expressed by Equation 3.

$$\text{Tracking error}_p = \sqrt{\text{Variance}_{(R_p - R_b)}} \quad (3)$$

where R_p is the return on the portfolio and R_b is the return on the benchmark index. Excess return for portfolio p is calculated as in Equation 4.

$$\text{Excess return}_p = R_p - R_b \quad (4)$$

Tracking error and excess return are distinct measures; the terms should not be used interchangeably. Tracking error measures the manager's ability to closely track the benchmark over time. In principle, a manager whose return is identical to that of the index could have arrived at that point by lagging and subsequently leading the index, producing a net difference of zero. But being a standard deviation, tracking error cannot be zero in cases such as the one described. Excess returns can be positive or negative and tell the investor how the manager performed relative to the benchmark. Tracking error, which is a standard deviation, is always presented as a non-negative number.

Index fund managers endeavor to have low tracking error and excess returns that are not negative. Low tracking error is important in measuring the skill of the index fund manager because the investor's goal is to mimic the return stream of the index. Avoiding negative excess returns versus the benchmark is also important because the manager will want to avoid underperforming the stated index.

Tracking error varies according to the manager's approach to tracking the index. An index that contains a large number of constituents will tend to create higher tracking error than those with fewer constituents. This is because a large number of constituents may prevent the manager from fully replicating the index.

For an index fund, the degree of tracking error fluctuates over time. Also, the value will differ depending on whether the data frequency is daily or less frequent.

EXAMPLE 3

Tracking Error and Excess Return

Exhibit 12 illustrates key portfolio metrics for three of the older and larger conventional open-end funds in the Australian and South Korean markets. Based on the levels of tracking error and excess return figures provided in the exhibit, explain whether the funds are likely replicating or sampling.

Exhibit 12 Major Conventional Index Mutual Funds in Australia and South Korea

Fund Name (Holdings)	Holdings	Annual Management Fee (bps)	3-Year Annualized Tracking Error	3-Year Annualized Excess Return
Australian market benchmark for the following funds is the S&P/ASX 300 Index. Number of securities in the index: 300.				
BlackRock Indexed Australian Equity Fund	296	20	0.0347%	–0.1684%
Macquarie True Index Australian Shares	259	0	0.0167%	0.0111%
Vanguard Australian Shares Index	293	18	0.1084%	–0.1814%
South Korean market benchmark for the funds below is the KRX KOSPI 200 Korea Index. Number of securities in the index: 200.				
KB Star Korea Index Equity CE	190	36	1.2671%	0.3356%
KIM Cruise Index F2.8 Equity-Deriv A	178	9	1.5019%	1.7381%
Samsung Index Premium Equity-Deriv A	204	40	1.3325%	1.1097%

Solution:

Based on the number of stocks in the fund compared to the index constituent number, it appears most funds are attempting to replicate. Two of the funds (Macquarie True Index and KIM Cruise Index) have 80% to 90% of the stocks in the index, which indicates they are more likely to be using sampling. One fund (Samsung Index Premium) actually holds more than the index, which can happen if buffering is used. No fund contains the same number of stocks as constituents in the index. Thus, it is not surprising that the funds failed to track their respective indexes perfectly. On an annualized basis, tracking error for the Australian funds is less than one-tenth the level of the Korean funds. However, the Korean funds' excess return—which is fund return less the benchmark index return—is positive in all three cases. The negative excess returns for two of the Australian funds are relatively close and possibly attributable to their management fees of 18–20 basis points.

5.2 Potential Causes of Tracking Error and Excess Return

Tracking error in an indexed equity fund can arise for several reasons. A major reason involves the fees charged. Although tracking error is expressed as an absolute value, fees are always negative because they represent a cost and drive down the excess return. Therefore, higher fees will contribute to lower excess returns and higher tracking error.

A second issue to consider is the number of securities held by the portfolio versus the benchmark index. Stock indexes that are liquid and investable may be fully replicated, while indexes with hard-to-find securities or a great number of securities are sampled. Sampled portfolios typically report greater tracking error than those that are fully replicated.

The intra-day trading of the constituent stocks of an indexed portfolio also presents an important issue to consider when attributing tracking error. The effect of intra-day trading can be positive or negative for a portfolio's returns compared to its benchmark index. The price levels used to report index returns are struck at the close of the trading day, so any securities that are bought or sold at a different price than that of the index will contribute to portfolio tracking error. Index fund managers can minimize this type of tracking error by transacting at the market-on-close price or as near to the closing time as feasible.

A secondary component of trading costs that contributes to tracking error is the trading commission paid to brokers. Commission costs make excess returns more negative and also affect tracking error. According to Perold and Salomon (1991), the trading cost for passive portfolio managers is likely to be lower than the trading cost for active managers who are suspected by their counterparties to possess an information advantage.

Another issue to consider is the cash holding of the portfolio. Equity indexes do not have a cash allocation, so any cash balance creates tracking error for the index fund manager. Cash can be accumulated in the portfolio from a variety of sources, such as dividends received, sale proceeds, investor contributions, and other sources of income. Cash flows from investors and from the constituent companies may not be invested immediately, and investing them often entails a commission cost. Both may affect tracking error. The tracking error caused by temporarily uninvested cash is known as **cash drag**. The effect of cash drag on portfolio value is negative when the market is rising and positive when it is falling.

Hill and Cheong (1996) discuss how to equitize a portfolio that would otherwise suffer from cash drag. One method is to use futures contracts. ETFs have been used widely for this purpose. Some portfolio managers establish a futures commission merchant relationship to offset their cash positions with a futures contract that represents the replicated index. When a manager does this, she will calculate the accrued dividends as well to hedge the dividend drag, which is cash drag attributable to accrued cash dividends paid to shareholders.

5.3 Controlling Tracking Error

The process of controlling tracking error involves trade-offs between the benefits and costs of maintaining complete faithfulness to the benchmark index, as illustrated in Exhibit 10. Portfolio managers who are unconstrained would keep the number of constituent securities and their weights as closely aligned to the benchmark index as possible. Even so, trading costs and other fees cause actual investment performance to deviate from index performance. Passive investing does not mean that the fund does not trade. Managers trade to accommodate inflows and outflows of cash from investors, to reinvest dividends, and to reflect changes in constituents of the underlying index.

As discussed in Section 5.2, most passive portfolio managers attempt to minimize cash held because a cash position generally creates undesirable tracking error. To keep tracking error low, portfolio managers need to invest cash flows received at the same valuations used by the benchmark index provider. Of course, because this is not always feasible, portfolio managers aim to maintain a beta of 1.0 relative to the benchmark index, while keeping other risk factor exposures similar to those of the index.

6 SOURCES OF RETURN AND RISK IN PASSIVE EQUITY PORTFOLIOS

Indexed portfolios began as a representation of market performance, and some investors accept the returns of the indexed portfolio without judgment. However, understanding both positive and negative sources of return through attribution analysis is an important step in the passive equity investment process.

6.1 Attribution Analysis

An investor has many choices across the investable spectrum of assets. An investor must first choose between stocks, bonds, and other asset classes and then partition each asset class by its sub-categories. In partitioning stocks, the process begins with choosing what countries to invest in, what market-cap sizes and investment style to use, and whether to weight the constituents using market cap or an alternative weighting method.

The return on an indexed portfolio can come from any of the aforementioned criteria. Return analyses are conducted ex-post, which means that the returns of the portfolio are studied after they have been experienced.

The sources of return for an equity index replication portfolio are the same as for any actively managed fund and include company-specific returns, sector returns, country returns, and currency returns. Beyond the traditional methods of grouping the risk and returns of the indexed portfolio, portfolio managers can group their indexed portfolios according to the stated portfolio objective. For example, a high dividend yield indexed portfolio may be grouped against the broad market benchmark by dividend yield. A low volatility portfolio could be grouped by volatility buckets to show how the lowest volatility stocks performed in the indexed portfolio as well as the broad market.

Most portfolio managers will rely on their portfolio attribution system to help them in understanding the sources of return. Index fund managers who track a broad market index need to understand what factors are driving the returns of that portfolio and its underlying index. Index fund managers of passive factor-based strategies should understand both the sources of return for their indexed portfolios and how those returns relate to the broad market index from which the constituents were chosen. In this way, passive factor-based strategies are very similar to actively managed funds in the sense that they are actively chosen.

Exhibit 13 shows an example of a portfolio attribution analysis using annual returns. Portfolio X is an index fund that seeks to replicate the performance of its benchmark. The manager of Portfolio X confirms that the portfolio, which has a return of 5.62%, is closely replicating the performance of the benchmark, which has a return of 5.65%.

Using Exhibit 13, the manager analyzes the relative sector weights and sources of the three basis points of return difference. A portfolio that is within three basis points of its benchmark index is undoubtedly tracking the index closely. Beyond seeking the source of the tracking error, the portfolio manager will also seek to understand the source of the positive returns.

Exhibit 13 Example of Sector Attribution Analysis (All figures in %)

		Portfolio X		Benchmark for Portfolio X		Attribution Analysis
Sector	Sector Return (A)	Sector Weight (B)	Contribution to Return (C) = (A) × (B)	Sector Weight (D)	Contribution to Return (E) = (A) × (D)	Difference (F) = (C) – (E)
Total	5.62	100.00	5.62	100.00	5.65	–0.03
Telecom. Services	16.94	2.25	0.38	2.34	0.40	–0.02
Utilities	15.45	12.99	2.01	13.03	2.01	–0.01
Consumer Discretionary	12.09	3.89	0.47	3.90	0.47	0.00

Exhibit 13 (Continued)

		Portfolio X		Benchmark for Portfolio X		Attribution Analysis
Sector	Sector Return (A)	Sector Weight (B)	Contribution to Return (C) = (A) × (B)	Sector Weight (D)	Contribution to Return (E) = (A) × (D)	Difference (F) = (C) – (E)
Materials	9.61	2.08	0.20	2.08	0.20	0.00
Information Technology	7.03	2.82	0.20	2.85	0.20	0.00
Consumer Staples	6.82	15.07	1.03	15.09	1.03	0.00
Industrials	3.93	16.08	0.63	16.15	0.63	0.00
Financials	0.50	19.85	0.10	19.32	0.10	0.00
Health Care	0.31	12.70	0.04	12.77	0.04	0.00
Real Estate	0.80	5.04	0.04	5.23	0.04	0.00
Energy	7.21	7.23	0.52	7.24	0.52	0.00
[Cash]	0.00	0.00	0.00	0.00	0.00	0.00

Attribution analyses like the one in Exhibit 13 can be structured in many ways. This analysis is grouped by economic sector. Sector attribution can help an investor develop expectations about how a portfolio might perform in different market conditions. For example, during an era of low interest rates, high-dividend stocks such as utilities are likely to outperform while financial stocks such as banks are likely to underperform, other things held equal. To the extent the portfolio holds financial stocks in a lower concentration than the benchmark, the portfolio will likely outperform if interest rates stay low.

Column A in Exhibit 13 shows the total return for each sector. For example, the Telecommunications sector posted a return of 16.94% over this period.

Column B shows Portfolio's X's sector weight. The portfolio is heavily invested in Financials, because this is the largest sector in the benchmark index.

Column C shows each sector's contribution to the overall return of Portfolio X, obtained by multiplying each sector weight in Portfolio X by the sector's total return. The sum of the eleven sectors' contributions to return is equal to the total return of the portfolio.

Column D shows the benchmark's sector weights.

Column E shows the contribution to return of each sector held by the benchmark, obtained by multiplying each sector's weight in the benchmark by the sector's total return. The sum of the eleven sectors' contributions to return is equal to the total return of the benchmark.

Finally, column F shows the difference in contribution to returns between Portfolio X and the benchmark. Column F is the difference between columns C and E.

Portfolio X has 15.07% invested in Consumer Staples, which compares to the benchmark index's 15.09% weight in that sector. The negligible underweighting combined with a sector return of 6.82% enabled the portfolio to closely match the contribution to return of the portfolio to that of the index.

The Telecommunications and Utilities sectors were the best-performing sectors over the period. Telecommunications and Utilities holdings made up 15.24% of the portfolio's holdings and contributed 2.39 percentage points (or 239 basis points) of the 5.62% total return.

Companies in the Telecommunications and Utilities sectors are high-dividend payers and are positively affected by falling interest rates. Given this information, the manager could then connect the positive performance of the sectors to the prevailing interest rate environment. The manager would also note in the attribution analysis that the same interest rate environment, in part, caused the Financials sector to underperform the market. These opposing forces act as a good hedge against interest rate movements in either direction and are part of a robust portfolio structure.

The portfolio manager of the strategy may use the attribution analysis to determine the sources of tracking error. In this case, the analysis confirmed that the portfolio is meeting its goal of closely tracking the composition and performance of its benchmark. Further, the portfolio manager is able to determine the sources of return, which in this case are in large part from the high-dividend-yielding Telecommunications and Utilities sectors.

6.2 Securities Lending

Investors who hold long equity positions usually keep the shares in their brokerage accounts, so they are ready to sell when the time arises. But there is a demand for those shares independent of fellow investors who may wish to buy them. Investors who want to sell short may need to borrow the shares, and they are willing to pay for the right to borrow. The securities-lending income received by long portfolio managers can be a valuable addition to portfolio returns. At the very least, the proceeds can help offset the other costs of managing the portfolio. In the case of low-cost indexed portfolios, securities lending income can actually make net expenses negative—meaning that in addition to tracking the benchmark index, the portfolio earns a return in excess of the index.

An investor who wants to lend securities often uses a lending agent. In the case of institutional investors (e.g., mutual funds, pension funds, and hedge funds), the custodian (i.e., custody bank) is frequently used. Occasionally, the asset management firm will offer securities lending services. Two legal documents are usually put in place, including a securities lending authorization agreement between the lender and the agent and a master securities lending agreement between the agent and borrowers.

The lending agent identifies a borrower who posts collateral (typically 102–105% of the value of the securities). When the collateral is in securities rather than cash, the lending agent holds them as a guarantee. The lending agent evaluates the collateral daily to ensure that it is sufficient. When the collateral is in the form of cash, the lending agent invests it in money market instruments and receives interest income. In this case, the borrower sometimes receives a rebate that partially defrays its lost interest income. Regardless, the borrower pays a fee to the lender when borrowing the securities, and the lender typically splits part of this fee with the lending agent.

According to the International Securities Lending Association (2016), the 30 June 2016 global value of securities made available for lending by institutional investors was EUR 14 trillion. Of this, EUR 1.9 trillion in value was actually loaned, 53% of which was in equity securities. Of global securities on loan, US and Canadian lenders represented 67% of value. Mutual funds and pension funds accounted for 66% of the total value of equity securities loaned. In North America, cash represents approximately 70% of all collateral; in Europe, noncash collateral is more than 80% of the total. ISLA reports that over 60 countries have issued formal legal opinions on the responsibilities of securities lending counterparties.

Securities lending carries risks that can offset the benefits. The main risks are the credit quality of the borrower (credit risk) and the value of the posted collateral (market risk), although liquidity risk and operational risk are additional considerations. Lenders are permitted to sell loaned securities at any time under the normal course of the portfolio management mandate, and the borrowed shares must be returned in time for normal settlement of that sale. However, there is no guarantee that the borrower can deliver on a timely basis.

An additional risk is that lenders can invest cash held as collateral; and if a lender elects to invest the cash in long-term or risky securities, the collateral value is at risk of erosion. As long as the cash is invested in low-risk securities, risk is kept low. Typically, an agreed return on the invested cash is rebated by the lender to the borrower. Similarly, borrowers must pay cash to lenders in lieu of any cash dividends received because the dividends paid by the issuers of the shares will go to the holders. According to Duffie, Gârleanu, and Pedersen (2002), institutional investors such as index mutual funds and pension funds are viewed as preferred lenders because they are long-term holders of shares and unlikely to claim their shares back abruptly from borrowers.

The example of Sigma Finance Company illustrates collateral investment risk. Sigma Finance was a structured investment vehicle that primarily held long-term debt financed by short-term borrowings, and profit came from the interest differential. During the credit 2008–2009 global financial crisis, Sigma was downgraded by the rating agencies and lost its ability to borrow in the short-term markets, which led to default. Investors in Sigma's credit offerings, many of them security lenders, suffered substantial losses because of the default.

Borrowers take formal legal title to the securities, receive all cash flows and voting rights, and pay an annualized cost of borrowing (typically 2–10%). The borrowing cost depends on the borrower's credit quality and how difficult it is to borrow the security in question. Some securities are widely recognized as "easy to borrow" (ETB).

A popular exchange-traded fund (ETF) represents a good example of how securities lending revenue can provide a benefit to investment beneficiaries. As of 31 March 2016, the USD 25.344 billion iShares Russell 2000 ETF had loaned out USD 4.273 billion in securities to 19 counterparties. This amount was 100% collateralized with cash. An affiliated party, BlackRock Institutional Trust Company, served as the securities lending agent in exchange for 4 basis points of collateral investment fees annually, totaling USD 29 million for the year ending 31 March 2016. IWM's net securities lending income for the year was slightly above USD 10 million, which nearly offset the approximately USD 14 million in investment advisory fees charged by the portfolio managers.

6.3 Investor Activism and Engagement by Passive Managers

Institutional investors, especially index fund managers, are among the largest shareholders of many companies. The shares that they vote can have a large influence on corporate elections and outcomes of the proxy process. Their status as large shareholders often gives such investors access to private meetings with corporate management to discuss their concerns and preferences regarding corporate policies on board structure and composition, management compensation, operational risk management, the integrity of accounting statements, and other matters. Goldstein (2014) reports that in a survey, about two-thirds of public companies indicate investor engagement in 2014 was higher than it had been three years earlier. The typical points of contact were investor relations specialists, general counsel/corporate secretary, the board chair, and the CEO or CFO of the company. The respondents also reported that engagement is now covering more topics, but the subject matter is not principally financial. Governance policies, executive compensation, and social, environmental, and strategy issues are dominant.

Ferguson (2010) argues that institutional investors—who are themselves required to act in a fiduciary capacity—have a key responsibility to carry out their duties as voting shareholders. Lambiotte, Gibney, and Hartley (2014) assert that if done in an enlightened way, voting and engagement with company management by passive investors can be a return-enhancing activity. Many hedge funds and other large investors even specialize in activism to align governance in their invested companies with shareholder interests.

Activist investors are usually associated with active portfolio management. If their activism efforts do not produce the desired result, they can express their dissatisfaction by selling their shares. In contrast, passive investors hold index-constituent stocks directly or indirectly. If they are attempting to match an index's performance, they do not have the flexibility to sell. Yet both types of investors usually have the opportunity to vote their shares and participate in governance improvements.

Why should governance matter for passive investors in broadly diversified portfolios? Across such portfolios, governance quality is broadly diversified; moreover, by definition, passive investors do not try to select the best-performing companies or avoid the worst. However, corporate governance improvements are aimed at improving the effectiveness of the operations, management, and board oversight of the business. If the resulting efficiency improvements are evidenced in higher returns to index-constituent stocks, the index performance rises and so does the performance of an index-tracking portfolio. Thus, a goal of activism is to increase returns.

Passive investors may even have a higher duty than more-transient active managers to use their influence to improve governance. As long as a stock has membership in the benchmark index, passive managers can be considered permanent shareholders. Such investors might benefit from engaging with company management and boards, even outside the usual proxy season. Reinforcing the concept of permanence, some companies even give greater voting rights to long-term shareholders. Dallas and Barry (2016) examine 12 US companies with voting rights that increase to four, five, or even ten votes per share if the holding period is greater than three and sometimes four years.

Most passive managers have a fiduciary duty to their clients that includes the obligation to vote proxy ballots on behalf of investors. Although shareholder return can be enhanced by engagement, the costs of these measures must also be considered. Among the more significant costs are staff resources required to become familiar with key issues and to engage management, regulators, and other investors. Researching and voting thousands of proxy ballots becomes problematic for many managers. They frequently hire a proxy voting service, such as Institutional Shareholder Services or Broadridge Financial Services, to achieve their goal of voting the proxy ballots in their clients' favor.

Although a strong argument can be made in favor of even passive managers voting their shares in an informed way and pursuing governance changes when warranted, potential conflicts of interest may limit investors' propensity to challenge company management. Consider the hypothetical case of a large financial firm that earns substantial fees from its business of administering corporate retirement plans, including the pension plan of Millheim Corp. Let us say that the financial firm also manages index funds, and Millheim's stock is one of many index constituents. If Millheim becomes the target of shareholder activism, the financial firm's incentives are structured to support Millheim's management on any controversial issue.

Some may question the probable effectiveness of activist efforts by passive investors. Management of the company targeted by activist investors is likely to see active portfolio managers as skillful and willing users of the proxy process to effect changes and accordingly will respond seriously. In contrast, passive investors are required to hold the company's shares to fulfill their tracking mandate (without the flexibility to sell or take a short position), and management may be aware of this constrained position and thus take passive investors' activist activities less seriously.

SUMMARY

This reading explains the rationale for passive investing as well as the construction of equity market indexes and the various methods by which investors can track the indexes. Passive portfolio managers must understand benchmark index construction and the advantages and disadvantages of the various methods used to track index performance.

Among the key points made in this reading are the following:

- Active equity portfolio managers who focus on individual security selection have long been unsuccessful at beating benchmarks and have charged high management fees to their end investors. Consequently, passive investing has increased in popularity.
- Passive equity investors seek to track the return of benchmark indexes and construct their portfolios to reflect the characteristics of the chosen benchmarks.
- Selection of a benchmark is driven by the equity investor's objectives and constraints as presented in the investment policy statement. The benchmark index must be rules-based, transparent, and investable. Specific important characteristics include the domestic or foreign market covered, the market capitalization of the constituent stocks, where the index falls in the value–growth spectrum, and other risk factors.
- The equity benchmark index weighting scheme is another important consideration for investors. Weighting methods include market-cap weighting, price weighting, equal weighting, and fundamental weighting. Market cap-weighting has several advantages, including the fact that weights adjust automatically.
- Index rebalancing and reconstitution policies are important features. Rebalancing involves adjusting the portfolio's constituent weights after price changes, mergers, or other corporate events have caused those weights to deviate from the benchmark index. Reconstitution involves deleting names that are no longer in the index and adding names that have been approved as new index members.
- Increasingly, passive investors use index-based strategies to gain exposure to individual risk factors. Examples of known equity risk factors include Capitalization, Style, Yield, Momentum, Volatility, and Quality.
- For passive investors, portfolio tracking error is the standard deviation of the portfolio return net of the benchmark return.
- Indexing involves the goal of minimizing tracking error subject to realistic portfolio constraints.
- Methods of pursuing passive investing include the use of such pooled investments as mutual funds and exchange-traded funds (ETFs), a do-it-yourself approach of building the portfolio stock-by-stock, and using derivatives to obtain exposure.
- Conventional open-end index mutual funds generally maintain low fees. Their expense ratios are slightly higher than for ETFs, but a brokerage fee is usually required for investor purchases and sales of ETF shares.
- Index exposure can also be obtained through the use of derivatives, such as futures and swaps.
- Building a passive portfolio by full replication, meaning to hold all the index constituents, requires a large-scale portfolio and high-quality information about the constituent characteristics. Most equity index portfolios are managed using

either a full replication strategy to keep tracking error low, are sampled to keep trading costs low, or use optimization techniques to match as closely as possible the characteristics and performance of the underlying index.

- The principal sources of passive portfolio tracking error are fees, trading costs, and cash drag. Cash drag refers to the dilution of the return on the equity assets because of cash held. Cash drag can be exacerbated by the receipt of dividends from constituent stocks and the delay in getting them converted into shares.
- Portfolio managers control tracking error by minimizing trading costs, netting investor cash inflows and redemptions, and using equitization tools like derivatives to compensate for cash drag.
- Many index fund managers offer the constituent securities held in their portfolios for lending to short sellers and other market participants. The income earned from lending those securities helps offset portfolio management costs, often resulting in lower net fees to investors.
- Investor activism is engagement with portfolio companies and recognizing the primacy of end investors. Forms of activism can include expressing views to company boards or management on executive compensation, operational risk, board governance, and other value-relevant matters.
- Successful passive equity investment requires an understanding of the investor's needs, benchmark index construction, and methods available to track the index.

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PRACTICE PROBLEMS

The following information relates to questions 1–8

Evan Winthrop, a senior officer of a US-based corporation, meets with Rebecca Tong, a portfolio manager at Cobalt Wealth Management. Winthrop recently moved his investments to Cobalt in response to his previous manager's benchmark-relative underperformance and high expenses.

Winthrop resides in Canada and plans to retire there. His annual salary covers his current spending needs, and his vested defined benefit pension plan is sufficient to meet retirement income goals. Winthrop prefers passive exposure to global equity markets with a focus on low management costs and minimal tracking error to any index benchmarks. The fixed-income portion of the portfolio may consist of laddered maturities with a home-country bias.

Tong proposes using an equity index as a basis for an investment strategy and reviews the most important requirements for an appropriate benchmark. With regard to investable indexes, Tong tells Winthrop the following:

Statement 1 A free-float adjustment to a market-capitalization weighted index lowers its liquidity.

Statement 2 An index provider that incorporates a buffering policy makes the index more investable.

Winthrop asks Tong to select a benchmark for the domestic stock allocation that holds all sectors of the Canadian equity market and to focus the portfolio on highly liquid, well-known companies. In addition, Winthrop specifies that any stock purchased should have a relatively low beta, a high dividend yield, a low P/E, and a low price-to-book ratio (P/B).

Winthrop and Tong agree that only the existing equity investments need to be liquidated. Tong suggests that, as an alternative to direct equity investments, the new equity portfolio be composed of the exchange-traded funds (ETFs) shown in Exhibit 1.

Exhibit 1 Available Equity ETFs

Equity Benchmark	ETF Ticker	Number of Constituents	P/B	P/E	Fund Expense Ratio
S&P/TSX 60	XIU	60	2.02	17.44	0.18%
S&P 500	SPY	506	1.88	15.65	0.10%
MSCI EAFE	EFA	933	2.13	18.12	0.33%

Winthrop asks Tong about the techniques wealth managers and fund companies use to create index-tracking equity portfolios that minimize tracking error and costs. In response, Tong outlines two frequently used methods:

Method 1	One process requires that all index constituents are available for trading and liquid, but significant brokerage commissions can occur when the index is large.
Method 2	When tracking an index with a large number of constituents and/or managing a relatively low level of assets, a relatively straightforward and technically unsophisticated method can be used to build a passive portfolio that requires fewer individual securities than the index and reduces brokerage commission costs.

Tong adds that portfolio stocks may be used to generate incremental revenue, thereby partially offsetting administrative costs but potentially creating undesirable counterparty and collateral risks.

After determining Winthrop's objectives and constraints, the CAD147 million portfolio's new strategic policy is to target long-term market returns while being fully invested at all times. Tong recommends quarterly rebalancing, currency hedging, and a composite benchmark composed of equity and fixed-income indexes. Currently the USD is worth CAD1.2930, and this exchange rate is expected to remain stable during the next month. Exhibit 2 presents the strategic asset allocation and benchmark weights.

Exhibit 2 Composite Benchmark and Policy Weights

Asset Class	Benchmark Index	Policy Weight
Canadian equity	S&P/TSX 60	40.0%
US equity	S&P 500	15.0%
International developed markets equity	MSCI EAFE	15.0%
Canadian bonds	DEX Universe	30.0%
Total portfolio		100.0%

In one month, Winthrop will receive a performance bonus of USD5,750,000. He believes that the US equity market is likely to increase during this timeframe. To take advantage of Winthrop's market outlook, he instructs Tong to immediately initiate an equity transaction using the S&P 500 futures contract with a current price of 2,464.29 while respecting the policy weights in Exhibit 2. The S&P 500 futures contract multiplier is 250, and the S&P 500 E-mini multiplier is 50.

Tong cautions Winthrop that there is a potential pitfall with the proposed request when it comes time to analyze performance. She discloses to Winthrop that equity index futures returns can differ from the underlying index, primarily because of corporate actions such as the declaration of dividends and stock splits.

1 Which of Tong's statements regarding equity index benchmarks is (are) correct?

A Only Statement 1

B Only Statement 2

C Both Statement 1 and Statement 2

2 To satisfy Winthrop's benchmark and security selection specifications, the Canadian equity index benchmark Tong selects should be:

A small-capitalization with a core tilt.

B large-capitalization with a value tilt.

C mid-capitalization with a growth tilt.

3 Based on Exhibit 1 and assuming a full-replication indexing approach, the tracking error is expected to be highest for:
   A XIU.
   B SPY.
   C EFA.

4 Method 1's portfolio construction process is *most likely*:
   A optimization.
   B full replication.
   C stratified sampling.

5 Method 2's portfolio construction process is *most likely*:
   A optimization.
   B full replication.
   C stratified sampling.

6 The method that Tong suggests to add incremental revenue is:
   A program trading.
   B securities lending.
   C attribution analysis.

7 In preparation for receipt of the performance bonus, Tong should immediately:
   A buy two US E-mini equity futures contracts.
   B sell nine US E-mini equity futures contracts.
   C buy seven US E-mini equity futures contracts.

8 The risk that Tong discloses regarding the equity futures strategy is *most likely*:
   A basis risk.
   B currency risk.
   C counterparty risk.

The following information relates to questions 9–14

The Mackenzie Education Foundation funds educational projects in a four-state region of the United States. Because of the investment portfolio's poor benchmark-relative returns, the foundation's board of directors hired a consultant, Stacy McMahon, to analyze performance and provide recommendations.

McMahon meets with Autumn Laubach, the foundation's executive director, to review the existing asset allocation strategy. Laubach believes the portfolio's underperformance is attributable to the equity holdings, which are allocated 55% to a US large-capitalization index fund, 30% to an actively managed US small-cap fund, and 15% to an actively managed developed international fund.

Laubach states that that the board is interested in following a passive approach for some or all of the equity allocation. In addition, the board is open to approaches that could generate returns in excess of the benchmark for part of the equity allocation. McMahon suggests that the board consider following a passive factor-based momentum strategy for the allocation to international stocks.

McMahon observes that the benchmark used for the US large-cap equity component is a price-weighted index containing 150 stocks. The benchmark's Herfindahl–Hirschman Index (HHI) is 0.0286.

McMahon performs a sector attribution analysis based on Exhibit 1 to explain the large-cap portfolio's underperformance relative to the benchmark.

Exhibit 1 Trailing 12-Month US Large-Cap Returns and Foundation/Benchmark Weights

Sector	Sector Returns	Foundation Sector Weights	Benchmark Sector Weights
Information technology	10.75%	18.71%	19.06%
Consumer staples	12.31%	16.52%	16.10%
Energy	8.63%	9.38%	9.53%
Utilities	–3.92%	8.76%	8.25%
Financials	7.05%	6.89%	6.62%

The board decides to consider adding a mid-cap manager. McMahon presents candidates for the mid-cap portfolio. Exhibit 2 provides fees and cash holdings for three portfolios and an index fund.

Exhibit 2 Characteristics of US Mid-Cap Portfolios and Index Fund

	Portfolio 1	Portfolio 2	Portfolio 3	Index Fund
Fees	0.10%	0.09%	0.07%	0.03%
Cash holdings	6.95%	3.42%	2.13%	0.51%

9 Compared with broad-market-cap weighting, the international equity strategy suggested by McMahon is *most likely* to:

A concentrate risk exposure.

B be based on the efficient market hypothesis.

C overweight stocks that recently experienced large price decreases.

10 The international strategy suggested by McMahon is *most likely* characterized as:

A risk based.

B return oriented.

C diversification oriented.

11 The initial benchmark used for the US large-cap allocation:

A is unaffected by stocks splits.

B is essentially a liquidity-weighted index.

C holds the same number of shares in each component stock.

12 Based on its HHI, the initial US large-cap benchmark *most likely* has:

A a concentration level of 4.29.

B an effective number of stocks of approximately 35.

C individual stocks held in approximately equal weights.

13 Using a sector attribution analysis based on Exhibit 1, which US large-cap sector is the primary contributor to the portfolio's underperformance relative to the benchmark?

A Utilities

B Consumer staples

C Information technology

14 Based on Exhibit 2, which portfolio will *most likely* have the lowest tracking error?

A Portfolio 1

B Portfolio 2

C Portfolio 3

SOLUTIONS

1 B is correct. The three requirements for an index to become the basis for an equity investment strategy are that the index be (a) rules based, (b) transparent, and (c) investable. Buffering makes index benchmarks more investable (Statement 2) by making index transitions a more gradual and orderly process.

A is incorrect because basing the index weight of an individual security solely on the total number of shares outstanding without using a free-float adjustment may make the index less investable. If a stock market cap excludes shares held by founders, governments, or other companies, then the remaining shares more accurately reflect the stock's true liquidity. Thus a free-float adjustment (Statement 1) to a market index more accurately reflects its actual liquidity (it does not lower its liquidity). Many indexes require that individual stocks have float and average shares traded above a certain percentage of shares outstanding.

2 B is correct. To address Winthrop's concerns (sector diversification, liquidity, risk, dividend yield, P/E, and P/B), the Canadian equity index benchmark should consist of large-capitalization stocks with a value tilt. A large-capitalization index contains the largest-cap stocks, which tend to have the highest liquidity. Value stocks tend to exhibit high dividend yields and low P/E and P/B ratios.

A is incorrect because small-capitalization stocks tend to be riskier than large-capitalization stocks. Winthrop has a preference for low-beta (risk) stocks.

C is incorrect because a growth index will not address Winthrop's preference for a low P/E. Growth stocks exhibit characteristics such as high price momentum, high P/Es, and high EPS growth.

3 C is correct. An index that contains a large number of constituents will tend to create higher tracking error than one with fewer constituents. Based on the number of constituents in the three indexes (S&P/TSX 60 has 60, S&P 500 has 506, and MSCI EAFE has 933), EFA (the MSCI EAFE ETF) is expected to have the highest tracking error. Higher expense ratios (XIU: 0.18%; SPY: 0.10%; and EFA: 0.33%) also contribute to lower excess returns and higher tracking error, which implies that EFA has the highest expected tracking error.

4 B is correct. Full replication occurs when a manager holds all securities represented by the index in weightings that closely match the actual index weightings. Thus it requires that all index constituents are liquid and available for trading, and the asset size of the mandate must also be sufficient. Significant brokerage commissions can occur, however, when the index is large.

5 C is correct. Stratified sampling methods are most frequently used when a portfolio manager is tracking an index that has a large number of constituents, or when managing a relatively low level of assets. Brokerage fees can become excessive when the number of constituents in the index is large.

A is incorrect because optimization does not involve simple techniques. Optimization requires a high level of technical sophistication, including familiarity with computerized optimization software or algorithms, and a good understanding of the output.

B is incorrect because full replication occurs when a manager holds all (not fewer) securities represented by the index in weightings that closely match actual index weightings. Full replication techniques require that the mandate's asset size is sufficient and that the index constituents are available for trading. Full replication can create significant brokerage commissions when the index is large.

6 B is correct. Securities lending is typically used to offset the costs associated with portfolio management. By lending stocks, however, the investor is exposed to the credit quality of the stocks' borrower (counterparty or credit risk) and to risks involved with the posted collateral (market risk).

A is incorrect because program trading is a strategy of buying or selling many stocks simultaneously. It is used primarily by institutional investors, typically for large-volume trades. Orders from the trader's computer are entered directly into the market's computer system and executed automatically.

C is incorrect because attribution analysis is not a method of generating incremental revenue. Attribution analysis is a method that helps the manager understand the sources of return.

7 C is correct. The amount of the performance bonus that will be received in one month (USD5,750,000) needs to be invested passively based upon the strategic allocation recommended by Tong. Using the strategic allocation of the portfolio, 15% (USD862,500.00) should be allocated to US equity exposure using the S&P 500 E-mini contract, which trades in US dollars. Because the futures price is 2,464.29 and the S&P 500 E-mini multiplier is 50, the contract unit value is USD123,214.50 (2,464.29 × 50).

The correct number of futures contracts is (5,750,000.00 × 0.15)/123,214.50 = 7.00.

Therefore, Tong will buy seven S&P 500 E-mini futures contracts.

8 A is correct. Basis risk results from using a hedging instrument that is imperfectly matched to the investment being hedged. Basis risk can arise when the underlying securities pay dividends, because the futures contract tracks only the price of the underlying index. Stock splits do not affect investment performance comparisons.

9 A is correct. Compared with broad-market-cap weighting, passive factor-based strategies tend to concentrate risk exposure, leaving investors vulnerable during periods when the risk factor (e.g., momentum) is out of favor.

10 B is correct. McMahon suggests that the foundation follow a passive factor-based momentum strategy, which is generally defined by the amount of a stock's excess price return relative to the market during a specified period. Factor-based momentum strategies are classified as return oriented.

11 C is correct. The initial benchmark used for the US large-cap allocation is a price-weighted index. In a price-weighted index, the weight of each stock is its price per share divided by the sum of all the share prices in the index. As a result, a price-weighted index can be interpreted as a portfolio composed of one share of each constituent security.

12 B is correct. The HHI measures stock concentration risk in a portfolio, calculated as the sum of the constituent weightings squared:

$$\text{HHI} = \sum_{i=1}^{n} w_i^2$$

Using the HHI, one can estimate the effective number of stocks, held in equal weights, that would mimic the concentration level of the respective index. The effective number of stocks for a portfolio is calculated as the reciprocal of the

HHI. The HHI is 0.0286; the reciprocal (1/0.0286) is 34.97. Therefore, the effective number of stocks to mimic the US large-cap benchmark is approximately 35.

13 C is correct. Below is the attribution analysis for selected sectors of the US large-cap portfolio.

		US Large-Cap Core Portfolio		Large-Cap Benchmark		Attribution Analysis
Sector	**Sector Return (A)**	**Sector Weight (B)**	**Contribution to Return (C) = (A) × (B)**	**Sector Weight (D)**	**Contribution to Return (E) = (A) × (D)**	**Difference (F) = (C) – (E)**
Information technology	10.75%	18.71%	2.01%	19.06%	2.05%	–0.04%
Consumer staples	12.31%	16.52%	2.03%	16.10%	1.98%	0.05%
Energy	8.63%	9.38%	0.81%	9.53%	0.82%	–0.01%
Utilities	–3.92%	8.76%	–0.34%	8.25%	–0.32%	–0.02%
Financials	7.05%	6.89%	0.49%	6.62%	0.47%	0.02%

Based on this analysis, the US large-cap portfolio's information technology sector is the primary contributor to the portfolio's disappointing equity returns because it provided the largest negative differential relative to the benchmark, with a differential of –0.04%. Although the information technology sector had a positive return, this sector was underweighted relative to the benchmark, resulting in a negative contribution to the portfolio's returns.

14 C is correct. Of the three portfolios, Portfolio 3 has the lowest cash holding and the lowest fees. As a result, Portfolio 3 has the potential for the lowest tracking error compared with the other proposed portfolios.

PORTFOLIO MANAGEMENT

STUDY SESSION 10

Equity Portfolio Management (2)

This study session takes an in-depth look at active equity portfolio management. It begins with a discussion of quantitative and fundamental equity strategies, including the underlying rationale for the investment approach and how they are created, whether top-down or bottom-up. Factor-based investing, as well as key specialized equity strategies such as activist investing and statistical arbitrage, are explored. The study session concludes with a discussion of issues important in active equity portfolio construction, including active share, active risk, risk budgeting, and constraints on portfolio construction.

READING ASSIGNMENT

Reading 24	Active Equity Investing: Strategies by Bing Li, PhD, CFA, Yin Luo, CPA, PStat, CFA, and Pranay Gupta, CFA
Reading 25	Active Equity Investing: Portfolio Construction by Jacques Lussier, PhD, CFA, and Marc R. Reinganum, PhD

READING

24

Active Equity Investing: Strategies

by Bing Li, PhD, CFA, Yin Luo, CPA, PStat, CFA, and Pranay Gupta, CFA

Bing Li, PhD, CFA, is at Yuanyin Asset Management (Hong Kong SAR). Yin Luo, CPA, PStat, CFA, is at Wolfe Research LLC (USA). Pranay Gupta, CFA, is at Allocationmetrics Limited (USA).

LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	**a.** compare fundamental and quantitative approaches to active management;
☐	**b.** analyze bottom-up active strategies, including their rationale and associated processes;
☐	**c.** analyze top-down active strategies, including their rationale and associated processes;
☐	**d.** analyze factor-based active strategies, including their rationale and associated processes;
☐	**e.** analyze activist strategies, including their rationale and associated processes;
☐	**f.** describe active strategies based on statistical arbitrage and market microstructure;
☐	**g.** describe how fundamental active investment strategies are created;
☐	**h.** describe how quantitative active investment strategies are created;
☐	**i.** discuss equity investment style classifications.

INTRODUCTION

1

This reading provides an overview of active equity investing and the major types of active equity strategies. The reading is organized around a classification of active equity strategies into two broad approaches: fundamental and quantitative. Both approaches aim at outperforming a passive benchmark (for example, a broad equity market index), but they tend to make investment decisions differently. Fundamental approaches stress the use of human judgment in processing information and making investment decisions, whereas quantitative approaches tend to rely more heavily on rules-based quantitative models. As a result, some practitioners and academics refer to the fundamental, judgment-based approaches as "discretionary" and to the rules-based, quantitative approaches as "systematic."

This reading is organized as follows. Section 2 introduces fundamental and quantitative approaches to active management. Section 3 discusses bottom-up, top-down, factor-based, and activist investing strategies. Section 4 describes the process of creating fundamental active investment strategies, including the parameters to consider as well as some of the pitfalls. Section 5 describes the steps required to create quantitative active investment strategies, as well as the pitfalls in a quantitative investment process. Section 6 discusses style classifications of active strategies and the uses and limitations of such classifications. A summary of key points completes the reading.

2 APPROACHES TO ACTIVE MANAGEMENT

Active equity investing may reflect a variety of ideas about profitable investment opportunities. However, with regard to how these investment ideas are implemented—for example, how securities are selected—active strategies can be divided into two broad categories: fundamental and quantitative. Fundamental approaches are based on research into companies, sectors, or markets and involve the application of analyst discretion and judgment. In contrast, quantitative approaches are based on quantitative models of security returns that are applied systematically with limited involvement of human judgment or discretion. The labels *fundamental* and *quantitative* in this context are an imperfect shorthand that should not be misunderstood. The contrast with quantitative approaches does not mean that fundamental approaches do not use quantitative tools. Fundamental approaches often make use of valuation models (such as the free cash flow model), quantitative screening tools, and statistical techniques (e.g., regression analysis). Furthermore, quantitative approaches often make use of variables that relate to company fundamentals. Some investment disciplines may be viewed as hybrids in that they combine elements of both fundamental and quantitative disciplines. In the next sections, we examine these two approaches more closely.

Fundamental research forms the basis of the fundamental approach to investing. Although it can be organized in many ways, fundamental research consistently involves and often begins with the analysis of a company's financial statements. Through such an analysis, this approach seeks to obtain a detailed understanding of the company's current and past profitability, financial position, and cash flows. Along with insights into a company's business model, management team, product lines, and economic outlook, this analysis provides a view on the company's future business prospects and includes a valuation of its shares. Estimates are typically made of the stock's intrinsic value and/or its relative value compared to the shares of a peer group or the stock's own history of market valuations. Based on this valuation and other factors (including overall portfolio considerations), the portfolio manager may conclude that the stock should be bought (or a position increased) or sold (or a position reduced). The decision can also be stated in terms of overweighting, market weighting, or underweighting relative to the portfolio's benchmark.

In the search for investment opportunities, fundamental strategies may have various starting points. Some strategies start at a top or macro level—with analyses of markets, economies, or industries—to narrow the search for likely areas for profitable active investment. These are called top-down strategies. Other strategies, often referred to as bottom-up strategies, make little or no use of macro analysis and instead rely on individual stock analysis to identify areas of opportunity. Research distributed by investment banks and reports produced by internal analysts, organized by industry or economic sector, are also potential sources of investment ideas. The vetting of such ideas may be done by portfolio managers, who may themselves be involved in fundamental research, or by an investment committee.

Quantitative strategies, on the other hand, involve analyst judgment at the design stage, but they largely replace the ongoing reliance on human judgment and discretion with systematic processes that are often dependent on computer programming for execution. These systematic processes search for security and market characteristics and patterns that have predictive power in order to identify securities or trades that will earn superior investment returns. ("Superior" in the sense of expected added value relative to risk or expected return relative to a benchmark—for example, an index benchmark or peer benchmark). Variables that might be considered include valuation metrics (e.g., earnings yield), size (e.g., market capitalization), profitability metrics (e.g., return on equity), financial strength metrics (e.g., debt-to-equity ratio), market sentiment (e.g., analyst consensus on companies' long-term earnings growth), industry membership (e.g., stocks' GICS classification), and price-related attributes (e.g., price momentum).

Once a pattern or relationship between a given variable (or set of variables) and security prices has been established by analysis of past data, a quantitative model is used to predict future expected returns of securities or baskets of securities. Security selection then flows from expected returns, which reflect securities' exposures to the selected variables with predictive power.[1] From a quantitative perspective, investment success depends not on individual company insights but on model quality.

Exhibit 1 presents typical differences between the main characteristics of fundamental and quantitative methodologies.

Exhibit 1 Differences between Fundamental and Quantitative Approaches

	Fundamental	Quantitative
Style	Subjective	Objective
Decision-making process	Discretionary	Systematic, non-discretionary
Primary resources	Human skill, experience, judgment	Expertise in statistical modeling
Information used	Research (company/industry/economy)	Data and statistics
Analysis focus	Conviction (high depth) in stock-, sector-, or region-based selection	A selection of variables, subsequently applied broadly over a large number of securities
Orientation to data	Forecast future corporate parameters and establish views on companies	Attempt to draw conclusions from a variety of historical data
Portfolio construction	Use judgment and conviction within permissible risk parameters	Use optimizers

In the following section, we take a closer look at some of the distinguishing characteristics listed in Exhibit 1 and how they are evolving with the advent of new technologies available to investors.

1 A wide range of security characteristics have been used to define "factors." Some factors (most commonly, size, value, momentum, and quality) have been shown to be positively associated with a long-term return premium. These we call *rewarded* factors. Many other factors are used in portfolio construction but have not been empirically proven to offer a persistent return premium. Some call these *unrewarded* factors. The average investor doesn't typically distinguish between rewarded and unrewarded factors, but it is important to draw that distinction for the sake of clarity across curriculum readings.

2.1 Differences in the Nature of the Information Used

To contrast the information used in fundamental and quantitative strategies, we can start by describing typical activities for fundamental investors with a bottom-up investment discipline. Bottom-up fundamental analysts research and analyze a company, using data from company financial statements and disclosures to assess attributes such as profitability, leverage, and absolute or peer-relative valuation. They typically also assess how those metrics compare to their historical values to identify trends and scrutinize such characteristics as the company's management competence, its future prospects, and the competitive position of its product lines. Such analysts usually focus on the more recent financial statements (which include current and previous years' accounting data), notes to the financial statements and assumptions in the accounts, and management discussion and analysis disclosures. Corporate governance is often taken into consideration as well as wider environmental, social, and governance (ESG) characteristics.

Top-down fundamental investors' research focuses first on region, country, or sector information (e.g., economic growth, money supply, and market valuations). Some of the data used by fundamental managers can be measured or expressed numerically and therefore "quantified." Other items, such as management quality and reputation, cannot.

Quantitative approaches often use large amounts of historical data from companies' financial reports (in addition to other information, such as return data) but process those data in a systematic rather than a judgmental way. Judgment is used in model building, particularly in deciding which variables and signals are relevant. Typically, quantitative approaches use historical stock data and statistical techniques to identify variables that may have a statistically significant relationship with stock returns; then these relationships are used to predict individual security returns. In contrast to the fundamental approach, the quantitative approach does not normally consider information or characteristics that cannot be quantified. In order to minimize survivorship and look-ahead biases, historical data used in quantitative research should include stocks that are no longer listed, and accounting data used should be the original, unrestated numbers that were available to the market at that point in time.

Investment Process: Fundamental vs. Quantitative

The goal of the investment process is to construct a portfolio that best reflects the stated investment objective and risk tolerance, with an optimal balance between expected return and risk exposure, subject to the constraints imposed by the investment policy. The investment processes under both fundamental and quantitative approaches involve a number of considerations, such as the methodology and valuation process, which are the subject of this reading. Other considerations, such as portfolio construction and risk management, trade execution, and ongoing performance monitoring, are the subjects of subsequent curriculum readings.

	Fundamental	Quantitative
Methodology	Determine methodology to evaluate stocks (bottom-up or top-down, value or growth, income or deep value, intrinsic or relative value, etc.)	Define model to estimate expected stock returns (choose time-series macro-level factors or cross-sectional stock-level factors, identify factors that have a stable positive information coefficient IC, use a factor combination algorithm, etc.)
Valuation process	■ Prescreen to identify potential investment candidates with stringent financial and market criteria ■ Perform in-depth analysis of companies to derive their intrinsic values ■ Determine buy or sell candidates trading at a discount or premium to their intrinsic values	■ Construct factor exposures across all shares in the same industry ■ Forecast IC and/or its volatility for each factor by using algorithms (such as artificial intelligence or time-series analysis) or fundamental research ■ Combine factor exposures to estimate expected returns
Portfolio construction and rebalancing	■ Allocate assets by determining industry and country/region exposures ■ Set limits on maximum sector, country, and individual stock positions ■ Determine buy-and-sell list ■ Monitor portfolio holdings continuously	■ Determine which factors to underweight or overweight ■ Use risk model to measure *ex ante* active risk ■ Run portfolio optimization with risk model, investment, and risk constraints, as well as the structure of transaction costs ■ Rebalance at regular intervals

2.2 Differences in the Focus of the Analysis

Fundamental investors usually focus their attention on a relatively small group of stocks and perform in-depth analysis on each one of them. This practice has characteristically given fundamental (or "discretionary") investors an edge of depth in understanding individual companies' businesses over quantitative (or "systematic") investors, who do not focus on individual stocks. Quantitative investors instead usually focus on factors across a potentially very large group of stocks. Therefore, fundamental investors tend to take larger positions in their selected stocks, while quantitative investors tend to focus their analysis on a selection of factors but spread their selected factor bets across a substantially larger group of holdings.[2]

2.3 Difference in Orientation to the Data: Forecasting the Future vs. Analyzing the Past

Fundamental analysis places an emphasis on forecasting future prospects, including the future earnings and cash flows of a company. Fundamental investors use judgment and in-depth analysis to formulate a view of the company's outlook and to identify the catalysts that will generate future growth. They rely on knowledge, experience, and their ability to predict future conditions in a company to make investment decisions. Conceptually, the fundamental approach aims at forecasting forward parameters in order to make investment decisions.

2 The implications for portfolio risk of using individual stocks or factors will be considered in the reading on portfolio construction.

In contrast, quantitative analysis uses a company's history to arrive at investment decisions. Quantitative investors construct models by back-testing past data, using what is known about or has been reported by a company, including future earnings estimates that have been published by analysts, to search for the best company characteristics for purposes of stock selection. Once a model based on historical data has been finalized, it is applied to the latest available data to determine investment decisions. Conceptually, the quantitative approach aims to predict future returns using conclusions derived from analyzing historical data.

Forestalling Look-Ahead Bias

Satyam Computers is an India-based company that provides IT consulting and solutions to its global customers. In the eight years preceding 2009, Satyam overstated its revenues and profits and reported a cash holdings total of approximately $1.04 billion that did not exist. The falsification of the accounts came to light in early 2009, and Satyam was removed from the S&P CNX Nifty 50 index on 12 January.

If a quantitative analyst runs a simulation benchmarked against the S&P CNX Nifty 50 index on 31 December 2008, he or she should include the 50 stocks that were in the index on 31 December 2008 and use only the data for the included stocks that were available to investors as of that date. The analyst should therefore include Satyam as an index constituent and use the original accounting data that were published by the company at that time. While it was subsequently proved that these accounting data were fraudulent, this fact was not known to analysts and investors on 31 December 2008. As a result, it would not have been possible for any analyst to incorporate the true accounting data for Satyam on that date.

2.4 Differences in Portfolio Construction: Judgment vs. Optimization

Fundamental investors typically select stocks by performing extensive research on individual companies, which results in a list of high-conviction stocks. Thus, fundamental investors see risk at the company level. There is a risk that the assessment of the company's fair value is inaccurate, that the business's performance will differ from the analyst's expectations, or that the market will fail to recognize the identified reason for under- or overvaluation. Construction of a fundamental portfolio therefore often depends on judgment, whereby the absolute or index-relative sizes of positions in stocks, sectors, or countries are based on the manager's conviction of his or her forecasts. The portfolio must, of course, still comply with the risk parameters set out in the investment agreements with clients or in the fund prospectus.

In quantitative analysis, on the other hand, the risk is that factor returns will not perform as expected. Because the quantitative approach invests in baskets of stocks, the risks lie at the portfolio level rather than at the level of specific stocks. Construction of a quantitative portfolio is therefore generally done using a portfolio optimizer, which controls for risk at the portfolio level in arriving at individual stock weights.

The two approaches also differ in the way that portfolio changes or rebalancings are performed. Managers using a fundamental approach usually monitor the portfolio's holdings continuously and may increase, decrease, or eliminate positions at any time. Portfolios managed using a quantitative approach are usually rebalanced at regular intervals, such as monthly or quarterly. At each interval, the program or algorithm, using pre-determined rules, automatically selects positions to be sold, reduced, added, or increased.

EXAMPLE 1

Fundamental vs. Quantitative Approach

Consider two equity portfolios with the same benchmark index, the MSCI Asia ex Japan. The index contains 627 stocks as of December 2016. One portfolio is managed using a fundamental approach, while the other is managed using a quantitative approach. The fundamental approach–based portfolio is made up of 50 individually selected stocks, which are reviewed for potential sale or trimming on an ongoing basis. In the fundamental approach, the investment universe is first pre-screened by valuation and by the fundamental metrics of earnings yield, dividend yield, earnings growth, and financial leverage. The quantitative approach–based portfolio makes active bets on 400 stocks with monthly rebalancing. The particular approach used is based on a five-factor model of equity returns.

Contrast fundamental and quantitative investment processes with respect to the following:

1 Constructing the portfolio

2 Rebalancing the portfolio

Solution to 1:

Fundamental: Construct the portfolio by overweighting stocks that are expected to outperform their peers or the market as a whole. Where necessary for risk reduction, underweight some benchmark stocks that are expected to underperform. The stocks that fell out in the pre-screening process do not have explicit forecasts and will not be included in the portfolio.

Quantitative: Construct the portfolio by maximizing the objective function (such as portfolio alpha or information ratio) with risk models.

Solution to 2:

Fundamental: The manager monitors each stock continuously and sells stocks when their market prices surpass the target prices (either through appreciation of the stock price or through reduction of the target price due to changes in expectations).

Quantitative: Portfolios are usually rebalanced at regular intervals, such as monthly.

3 TYPES OF ACTIVE MANAGEMENT STRATEGIES

Equity investors have developed many different techniques for processing all the information necessary to arrive at an investment decision. Multiple approaches may be taken into account in formulating an overall opinion of a stock; however, each analyst will have his or her own set of favorite techniques based on his or her experience and judgment. Depending on the specifics of the investment discipline, most fundamental and quantitative strategies can be characterized as either bottom-up or top-down.

3.1 Bottom-Up Strategies

Bottom-up strategies begin the asset selection process with data at the individual asset and company level, such as price momentum and profitability. Bottom-up quantitative investors harness computer power to apply their models to this asset- and company-level information (with the added requirement that the information be quantifiable). The balance of this section illustrates the bottom-up process as used by fundamental investors. These investors typically begin their analysis at the company level before forming an opinion on the wider sector or market. The ability to identify companies with strong or weak fundamentals depends on the analyst's in-depth knowledge of each company's industry, product lines, business plan, management abilities, and financial strength. After identifying individual companies, the bottom-up approach uses economic and financial analysis to assess the intrinsic value of a company and compares that value with the current market price to determine which stocks are undervalued or overvalued. The analyst may also find companies operating efficiently with good prospects even though the industry they belong to is deteriorating. Similarly, companies with poor prospects may be found in otherwise healthy and prosperous industries.

Fundamental investors often focus on one or more of the following parameters for a company, either individually or in relation to its peers:

- business model and branding
- competitive advantages
- company management and corporate governance

Valuation is based on either a discounted cash flow model or a preferred market multiple, often earnings-related. We address each of these parameters and valuation approaches in turn.

Business Model and Branding. The business model of a company refers to its overall strategy for running the business and generating profit. The business model details how a company converts its resources into products or services and how it delivers those products or services to customers. Companies with a superior business model compete successfully, have scalability, and generate significant earnings. Further, companies with a robust and adaptive business model tend to outperform their peers in terms of return on shareholder equity. The business model gives investors insight into a company's value proposition, its operational flow, the structure of its value chain, its branding strategy, its market segment, and the resulting revenue generation and profit margins. This insight helps investors evaluate the sustainability of the company's competitive advantages and make informed investment decisions.

Corporate branding is a way of defining the company's business for the market in general and retail customers in particular and can be understood as the company's identity as well as its promise to its customers. Strong brand names convey product quality and can give the company an edge over its competitors in both market share and profit margin. It is widely recognized that brand equity plays an important role in the determination of product price, allowing companies to command price premiums after controlling for observed product differentiation. Apple in consumer technology and BMW in motor vehicles, for example, charge more for their products, but customers are willing to pay the premium because of brand loyalty.

Competitive Advantages. A competitive advantage typically allows a company to outperform its peers in terms of the return it generates on its capital. There are many types of competitive advantage, such as access to natural resources, superior technology, innovation, skilled personnel, corporate reputation, brand strength, high entry barriers, exclusive distribution rights, and superior product or customer support.

For value investors, who search for companies that appear to be trading below their intrinsic value (often following earnings disappointments), it is important to understand the sustainability of the company's competitive position when assessing the prospects for recovery.

Company Management. A good management team is crucial to a company's success. Management's role is to allocate resources and capital to maximize the growth of enterprise value for the company's shareholders. A management team that has a long-term rather than a short-term focus is more likely to add value to an enterprise over the long term.

To evaluate management effectiveness, one can begin with the financial statements. Return on assets, equity, or invested capital (compared either to industry peers or to historical rates achieved by the company) and earnings growth over a reasonable time period are examples of indicators used to gauge the value added by management.

Qualitative analysis of the company's management and governance structures requires attention to (1) the alignment of management's interests with those of shareholders to minimize agency problems; (2) the competence of management in achieving the company's objectives (as described in the mission statement) and long-term plans; (3) the stability of the management team and the company's ability to attract and retain high-performing executives; and (4) increasingly, risk considerations and opportunities related to a company's ESG attributes. Analysts also monitor management insider purchases and sales of the company's shares for potential indications of the confidence of management in the company's future.

The above qualitative considerations and financial statement analysis will help in making earnings estimates, cash flow estimates, and evaluations of risk, providing inputs to company valuation. Fundamental strategies within the bottom-up category may use a combination of approaches to stock valuation. Some investors rely on discounted cash flow or dividend models. Others focus on relative valuation, often based on earnings-related valuation metrics such as a P/E, price to book (P/B), and enterprise value (EV)/EBITDA. A conclusion that a security's intrinsic value is different from its current market price means the valuation is using estimates that are different from those reflected in current market prices. Conviction that the analyst's forecasts are, over a particular time period, more accurate than the market's is therefore important, as is the belief that the market will reflect the more accurate estimates within a time frame that is consistent with the strategy's investment horizon.

Bottom-up strategies are often broadly categorized as either value-based (or value-oriented) or growth-based (or growth-oriented), as the following section explains.

3.1.1 *Value-Based Approaches*

Benjamin Graham is regarded as the father of value investing. Along with David Dodd, he wrote the book *Security Analysis* (1934), which laid the basic framework for value investing. Graham posited that buying earnings and assets relatively inexpensively afforded a "margin of safety" necessary for prudent investing. Consistent with that idea, value-based approaches aim to buy stocks that are trading at a significant discount to their estimated intrinsic value. Value investors typically focus on companies with attractive valuation metrics, reflected in low earnings (or asset) multiples. In their view, investors' sometimes irrational behavior can make stocks trade below the intrinsic value based on company fundamentals. Such opportunities may arise due to a variety of behavioral biases and often reflect investors' overreaction to negative news. Various styles of value-based investing are sometimes distinguished; for example, "relative value" investors purchase stocks on valuation multiples that are high relative to historical levels but that compare favorably to those of the peer group.

3.1.1.1 Relative Value Investors who pursue a relative value strategy evaluate companies by comparing their value indicators (e.g., P/E or P/B multiples) to the average valuation of companies in the same industry sector with the aim of identifying stocks that offer value relative to their sector peers. As different sectors face different market structures and different competitive and regulatory conditions, average sector multiples vary.

Exhibit 2 lists the key financial ratios for sectors in the Hang Seng Index on the last trading day of 2016. The average P/E for companies in the energy sector is almost five times the average P/E for those in real estate. A consumer staples company trading on a P/E of 12 would appear undervalued relative to its sector, while a real estate company trading on the same P/E multiple of 12 would appear overvalued relative to its sector.

Exhibit 2 Key Financial Ratios of Hang Seng Index (30 December 2016)

	Weight	Dividend Yield	Price-to-Earnings Ratio (P/E)	Price-to-Cash-Flow Ratio (P/CF)	Price-to-Book Ratio (P/B)	Total Debt to Common Equity (%)	Current Ratio
Hang Seng Index	**100.0**	**3.5**	**12.2**	**6.1**	**1.1**	**128.4**	**1.3**
Consumer discretionary	2.9	4.1	21.3	12.5	3.0	26.3	1.4
Consumer staples	1.6	2.6	16.8	14.3	3.3	62.1	1.4
Energy	7.0	2.6	39.5	3.7	0.9	38.5	1.0
Financials	47.5	4.3	10.1	5.0	1.1	199.8	1.1
Industrials	5.5	3.8	11.8	6.0	0.9	158.7	1.2
Information technology	11.4	0.6	32.7	19.9	8.2	60.2	1.0
Real estate	10.6	3.9	8.3	8.0	0.7	30.3	2.5
Telecommunication services	7.8	3.2	13.3	4.6	1.4	11.5	0.7
Utilities	5.6	3.7	14.2	10.8	1.7	47.0	1.3

Source: Bloomberg.

Investors usually recognize that in addition to the simple comparison of a company's multiple to that of the sector, one needs a good understanding of why the valuation is what it is. A premium or discount to the industry may well be justified by the company's fundamentals.

3.1.1.2 Contrarian Investing Contrarian investors purchase and sell shares against prevailing market sentiment. Their investment strategy is to go against the crowd by buying poorly performing stocks at valuations they find attractive and then selling them at a later time, following what they expect to be a recovery in the share price. Companies in which contrarian managers invest are frequently depressed cyclical stocks with low or even negative earnings or low dividend payments. Contrarians expect these stocks to rebound once the company's earnings have turned around, resulting in substantial price appreciation.

Contrarian investors often point to research in behavioral finance suggesting that investors tend to overweight recent trends and to follow the crowd in making investment decisions. A contrarian investor attempts to determine whether the valuation of an individual company, industry, or entire market is irrational—that is, undervalued or overvalued at any time—and whether that irrationality represents an exploitable mispricing of shares. Accordingly, contrarian investors tend to go against the crowd.

Both contrarian investors and value investors who do not describe their style as contrarian aim to buy shares at a discount to their intrinsic value. The primary difference between the two is that non-contrarian value investors rely on fundamental metrics to make their assessments, while contrarian investors rely more on market sentiment and sharp price movements (such as 52-week high and low prices as sell and buy prices) to make their decisions.

3.1.1.3 High-Quality Value Some value-based strategies give valuation close attention but place at least equal emphasis on financial strength and demonstrated profitability. For example, one such investment discipline requires a record of consistent earnings power, above-average return on equity, financial strength, and exemplary management. There is no widely accepted label for this value style, the refinement of which is often associated with investor Warren Buffett.[3]

3.1.1.4 Income Investing The income investing approach focuses on shares that offer relatively high dividend yields and positive dividend growth rates. Several rationales for this approach have been offered. One argument is that a secure, high dividend yield tends to put a floor under the share price in the case of companies that are expected to maintain such a dividend. Another argument points to empirical studies that demonstrate the higher returns to equities with these characteristics and their greater ability to withstand market declines.

3.1.1.5 Deep-Value Investing A value investor with a deep-value orientation focuses on undervalued companies that are available at extremely low valuation relative to their assets (e.g., low P/B). Such companies are often those in financial distress. The rationale is that market interest in such securities may be limited, increasing the chance of informational inefficiencies. The deep-value investor's special area of expertise may lie in reorganizations or related legislation, providing a better position from which to assess the likelihood of company recovery.

3.1.1.6 Restructuring and Distressed Investing While the restructuring and distressed investment strategies are more commonly observed in the distressed-debt space, some equity investors specialize in these disciplines. Opportunities in restructuring and distressed investing are generally counter cyclical relative to the overall economy or to the business cycle of a particular sector. A weak economy generates increased incidence of companies facing financial distress. When a company is having difficulty meeting its short-term liabilities, it will often propose to restructure its financial obligations or change its capital structure.

Restructuring investors seek to purchase the debt or equity of companies in distress. A distressed company that goes through restructuring may still have valuable assets, distribution channels, or patents that make it an attractive acquisition target. Restructuring investing is often done before an expected bankruptcy or during the bankruptcy process. The goal of restructuring investing is to gain control or substantial influence over a company in distress at a large discount and then restructure it to restore a large part of its intrinsic value.

Effective investment in a distressed company depends on skill and expertise in identifying companies whose situation is better than the market believes it to be. Distressed investors assume that either the company will survive or there will be sufficient assets remaining upon liquidation to generate an appropriate return on investment.

3.1.1.7 Special Situations The "special situations" investment style focuses on the identification and exploitation of mispricings that may arise as a result of corporate events such as divestitures or spinoffs of assets or divisions or mergers with other entities. In the opinion of many investors such situations represent short-term opportunities to exploit mispricing that result from such special situations. According to

3 See Greenwald, Kahn, Sonkin, and Biema (2001).

Greenblatt (2010), investors often overlook companies that are in such special situations as restructuring (involving asset disposals or spinoffs) and mergers, which may create opportunities to add value through active investing. To take advantage of such opportunities, this type of investing requires specific knowledge of the industry and the company, as well as legal expertise.

3.1.2 *Growth-Based Approaches*

Growth-based investment approaches focus on companies that are expected to grow faster than their industry or faster than the overall market, as measured by revenues, earnings, or cash flow. Growth investors usually look for high-quality companies with consistent growth or companies with strong earnings momentum. Characteristics usually examined by growth investors include historical and estimated future growth of earnings or cash flows, underpinned by attributes such as a solid business model, cost control, and exemplary management able to execute long-term plans to achieve higher growth. Such companies typically feature above-average return on equity, a large part of which they retain and reinvest in funding future growth. Because growth companies may also have volatile earnings and cash flows going forward, the intrinsic values calculated by discounting expected future cash flows are subject to relatively high uncertainty. Compared to value-focused investors, growth-focused investors have a higher tolerance for above-average valuation multiples.

GARP (growth at a reasonable price) is a sub-discipline within growth investing. This approach is used by investors who seek out companies with above-average growth that trade at reasonable valuation multiples, and is often referred to as a hybrid of growth and value investing. Many investors who use GARP rely on the P/E-to-growth (PEG) ratio—calculated as the stock's P/E divided by the expected earnings growth rate (in percentage terms)—while also paying attention to variations in risk and duration of growth.

EXAMPLE 2

Characteristic Securities for Bottom-Up Investment Disciplines

The following table provides information on four stocks.

Company	Price	12-Month Forward EPS	3-Year EPS Growth Forecast	Dividend Yield	Industry Sector	Sector Average P/E
A	50	5	20%	1%	Industrial	10
B	56	2	2%	0%	Information technology	35
C	22	10	–5%	2%	Consumer staples	15
D	32	2	2%	8%	Utilities	16

Using only the information given in the table above, for each stock, determine which fundamental investment discipline would most likely select it.

Solution:

- Company A's forward P/E is 50/5 = 10, and its P/E-to-growth ratio (PEG) is 10/20 = 0.5, which is lower than the PEGs for the other companies (28/2 = 14 for Company B, negative for Company C, and 16/2 = 8 for Company D). Given the favorable valuation relative to growth, the company is a good candidate for investors who use GARP.
- Company B's forward P/E is 56/2 = 28, which is lower than the average P/E of 35 for its sector peers. The company is a good candidate for the relative value approach.
- Company C's forward P/E is 22/10 = 2.2, which is considered very low in both absolute and relative terms. Assuming the investor pays attention to company circumstances, the stock could be a good candidate for the deep-value approach.
- Company D's forward P/E is 32/2 = 16, which is the same as its industry average. Company D's earnings are growing slowly at 2%, but the dividend yield of 8% appears high. This combination makes the company a good candidate for income investing.

EXAMPLE 3

Growth vs. Value

Tencent Holdings Limited is a leading provider of value-added internet services in China. The company's services include social networks, web portals, e-commerce, and multiplayer online games.

Exhibit 3 shows an excerpt from an analyst report on Tencent published following the release of the company's Q3 2016 results on 16 November 2016.

Exhibit 3 Financial Summary and Valuation for Tencent Holdings Limited

Market Data: 16 November 2016			2014	2015	2016E	2017E	2018E
Closing price	196.9	Revenue (RMB millions)	78,932	102,863	150,996	212,471	276,538
Price target	251.5	YOY (%)	30.60	30.32	46.79	40.71	30.15
HSCEI	9,380	Net income (RMB millions)	23,810	28,806	42,292	56,533	68,994
HSCCI	3,669	YOY (%)	53.49	21.85	46.76	32.87	22.04
52-Week high/low	132.10/220.8	EPS (RMB)	2.58	3.10	4.56	6.05	7.39
Market cap (USD millions)	240,311	Diluted EPS (RMB)	2.55	3.06	4.51	5.99	7.31
Market cap (HKD millions)	1,864,045	ROE (%)	29.09	23.84	26.11	26.18	24.71
Shares outstanding (millions)	9,467	Debt/Assets (%)	52.02	60.20	61.33	61.26	60.37
Exchange rate (RMB/HKD)	0.8857	Dividend yield (%)	0.20	0.20	0.28	0.38	0.46
		P/E	54.78	55.17	38.27	28.80	23.60

(continued)

Exhibit 3 (Continued)

Market Data: 16 November 2016		2014	2015	2016E	2017E	2018E
	P/B	22.31	19.35	13.39	9.99	7.54
	EV/EBITDA	40.79	35.88	28.06	20.09	15.39

Notes: Market data are quoted in HKD; the company's filing is in RMB. Diluted EPS is calculated as if all outstanding convertible securities (such as convertible preferred shares, convertible debentures, stock options, and warrants) were exercised. P/E is calculated as closing price divided by each year's EPS.
Source: SWS Research.

From the perspective of the date of Exhibit 3:

1 Which metrics would support a decision to invest by a growth investor?

2 Which characteristics would a growth investor tend to weigh less heavily than a high-quality value investor?

Solution to 1:

A growth investor would focus on the following:

- The year-over-year change in revenue exceeded 30% in 2014 and 2015 and is expected to accelerate over 2016–2018.
- Past and expected net income growth rates are also high.

Solution to 2:

A growth investor would tend to be less concerned about the relatively high valuation levels (high P/E, P/B, and EV/EBITDA) and low dividend yield.

3.2 Top-Down Strategies

As the name suggests, in contrast to bottom-up strategies, top-down strategies use an investment process that begins at a top or macro level. Instead of focusing on individual company- and asset-level variables in making investment decisions, top-down portfolio managers study variables affecting many companies, such as the macroeconomic environment, demographic trends, and government policies. These managers often use instruments such as futures contracts, ETFs, swaps, and custom baskets of individual stocks to capture macro dynamics and generate portfolio return. Some bottom-up stock pickers also incorporate top-down analysis as part of their process for arriving at investment decisions. A typical method of incorporating both top-down macroeconomic and bottom-up fundamental processes is to have the portfolio strategist set the target country and sector weights. Portfolio managers then construct stock portfolios that are consistent with these preset weights.

3.2.1 *Country and Geographic Allocation to Equities*

Investors using country allocation strategies form their portfolios by investing in different geographic regions depending on their assessment of the regions' prospects. For example, the manager may have a preference for a particular region and may establish a position in that region while limiting exposure to others. Managers of global equity funds may, for example, make a decision based on a tradeoff between the US equity market and the European equity market, or they may allocate among all investable country equity markets using futures or ETFs. Such strategies may also seek to track the overall supply and demand for equities in regions or countries by analyzing the aggregate volumes of share buybacks, investment fund flows, the volumes of initial public offerings, and secondary share issuance.

The country or geographic allocation decision itself can be based on both top-down macroeconomic and bottom-up fundamental analysis. For example, just as economic data for a given country are available, the market valuation of a country can be calculated by aggregating all company earnings and market capitalization.

3.2.2 *Sector and Industry Rotation*

Just as one can formulate a strategy that allocates to different countries or regions in an investment universe, one can also have a view on the expected returns of various sectors and industries across borders. Industries that are more integrated on a global basis—and therefore subject to global supply and demand dynamics—are more suitable to global sector allocation decisions. Examples of such industries include information technology and energy. On the other hand, sectors and industries that are more local in nature to individual countries are more suitable to sector allocation within a country. Examples of these industries are real estate and consumer staples. The availability of sector and industry ETFs greatly facilitates the implementation of sector and industry rotation strategies for those portfolio managers who cannot or do not wish to implement such strategies by investing in individual stocks.

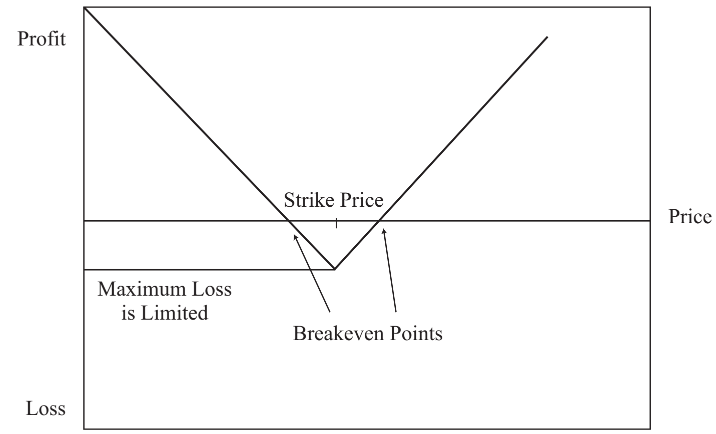
As with country and geographic allocation, both top-down macroeconomic and bottom-up fundamental variables can be used to predict sector/industry returns. Many bottom-up portfolio managers also add a top-down sector overlay to their portfolios.

3.2.3 *Volatility-Based Strategies*

Another category of top-down equity strategies is based on investors' view on volatility and is usually implemented using derivative instruments. Those managers who believe they have the skill to predict future market volatility better than option-implied volatility (reflected, for example, in the VIX Index) can trade the VIX futures listed on the CBOE Futures Exchange (CFE), trade instruments such as index options, or enter into volatility swaps (or variance swaps).

Let's assume that an investor predicts a major market move, not anticipated by others, in the near term. The investor does not have an opinion on the direction of the move and only expects the index volatility to be high. The investor can use an index straddle strategy to capitalize on his or her view. Entering into an index straddle position involves the purchase of call and put options (on the same underlying index) with the same strike price and expiry date. The success of this long straddle strategy depends on whether or not volatility turns out to be higher than anticipated by the market; the strategy incurs losses when the market stays broadly flat. Exhibit 4 shows the payoff of such an index straddle strategy. The maximum loss of the long straddle is limited to the total call and put premiums paid.

Exhibit 4 Payoff Pattern of a Classic Long Straddle Strategy



3.2.4 *Thematic Investment Strategies*

Thematic investing is another broad category of strategies. Thematic strategies can use broad macroeconomic, demographic, or political drivers, or bottom-up ideas on industries and sectors, to identify investment opportunities. Disruptive technologies, processes, and regulations; innovations; and economic cycles present investment opportunities and also pose challenges to existing companies. Investors constantly search for new and promising ideas or themes that will drive the market in the future.

It is also important to determine whether any new trend is structural (and hence long-term) or short-term in nature. Structural changes can have long-lasting impacts on the way people behave or a market operates. For example, the development of smartphones and tablets and the move towards cloud computing are probably structural changes. On the other hand, a manager might attempt to identify companies with significant sales exposure to foreign countries as a way to benefit from short-term views on currency movements. The success of a structural thematic investment depends equally on the ability to take advantage of future trends and the ability to avoid what will turn out to be merely fashionable for a limited time, unless the strategy specifically focuses on short-term trends. Further examples of thematic investment drivers include new technologies, mobile communication and computing devices, clean energy, fintech, and advances in medicine.

Implementation of Top-Down Investment Strategies

A global equity portfolio manager with special insights into particular countries or regions can tactically choose to overweight or underweight those countries or regions on a short-term basis. Once the country or region weights are determined by a top-down process, the portfolio can be constructed by selecting stocks in the relevant countries or regions.

A portfolio manager with expertise in identifying drivers of sector or industry returns will establish a view on those drivers and will set weights for those sectors in a portfolio. For example, the performance of the energy sector is typically driven by the price of crude oil. The returns of the materials sector rest on forecasts for commodity prices. The consumer and industrials sectors require in-depth knowledge of the customer–supplier chains and a range of other dynamics. Once a view is established on the return and risk of each sector, a manager can then decide which industries to invest in and what weightings to assign to those industries relative to the benchmark.

The significant growth of passive factor investing—sometimes marketed as "smart beta" products—has given portfolio managers more tools and flexibility for investing in different equity styles. One can exploit the fact, for example, that high-quality stocks tend to perform well in recessions, or that cyclical deep-value companies are more likely to deliver superior returns in a more "risk-on" environment, in which the market becomes less risk-averse. For example, where the investment mandate permits, top-down managers can choose among different equity style ETFs and structured products to obtain risk exposures that are consistent with their views on different stages of the economic cycle or their views on market sentiment.

Portfolio Overlays

Bottom-up fundamental strategies often lead to unintended macro (e.g., sector or country) risk exposures. However, bottom-up fundamental investors can incorporate some of the risk control benefits of top-down investment strategies via portfolio overlays. (A **portfolio overlay** is an array of derivative positions managed separately from the securities portfolio to achieve overall portfolio characteristics that are desired by the portfolio manager.) The fundamental investor's sector weights, for example, may vary from the benchmark's weights as a result of the stock selection process even though the investor did not intend to make sector bets. In that case, the investor may be able to adjust the sector weights to align with the benchmark's weights via long and short positions in derivatives. In this way, top-down strategies can be effective in controlling risk exposures. Overlays can also be used to attempt to add active returns that are not correlated with those generated by the underlying portfolio strategy.

3.3 Factor-Based Strategies

A factor is a variable or characteristic with which individual asset returns are correlated. It can be broadly defined as any variable that is believed to be valuable in ranking stocks for investment and in predicting future returns or risks. A wide range of security characteristics have been used to define "factors." Some factors (most commonly, size, value, momentum, and quality) have been shown to be positively associated with a long-term return premium and are often referred to as *rewarded* factors. In fact, hundreds of factors have been identified and used in portfolio construction, but a large number have not been empirically proven to offer a persistent return premium (some call these *unrewarded* factors).

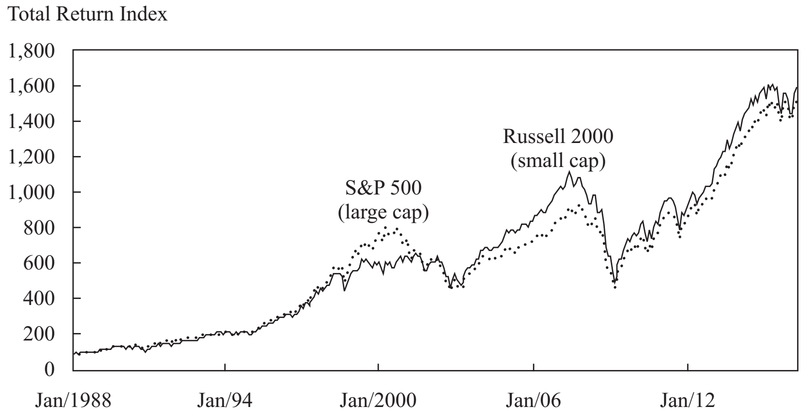
Broadly defined, a factor-based strategy aims to identify significant factors that can predict future stock returns and to construct a portfolio that tilts towards such factors. Some strategies rely on a single factor, are transparent, and maintain a relatively stable exposure to that factor with regular rebalancing (as is explained in the curriculum reading on passive equity investing). Other strategies rely on a selection of factors. Yet other strategies may attempt to time the exposure to factors, recognizing that factor performance varies over time.

For new factor ideas, analysts and managers of portfolios that use factor strategies often rely on academic research, working papers, in-house research, and external research performed by entities such as investment banks. The following exhibits illustrate how some of the traditional style factors performed in recent decades, showing the varying nature of returns. Exhibit 5 shows the cumulative performance of large-cap versus small-cap US equities, using the S&P 500 and Russell 2000 total return indexes. Exhibit 6 presents the total returns of value (Russell 1000 Value Index) versus growth (Russell 1000 Growth Index) styles. Over the 28 years from January 1988 to

April 2016, small-cap stocks earned marginally higher returns than large-cap stocks, but with significantly higher risk. Value and growth styles produce about the same return, but growth equities seem to be slightly more volatile (see Exhibit 7).

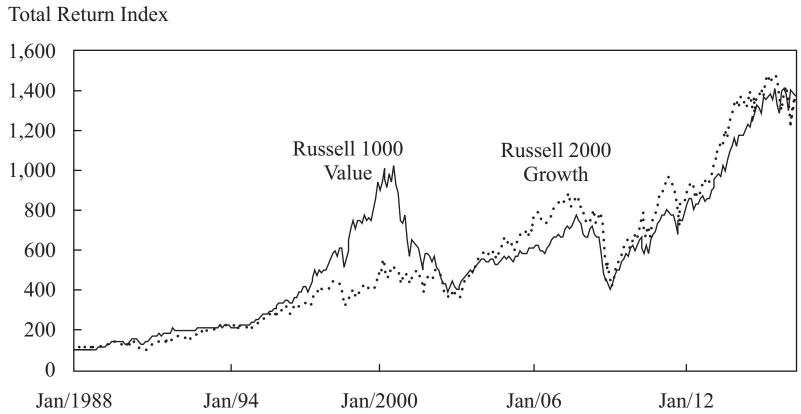
Equity style rotation strategies, a subcategory of factor investing, are based on the belief that different factors—such as size, value, momentum, and quality—work well during some time periods but less well during other time periods. These strategies use an investment process that allocates to stock baskets representing each of these styles when a particular style is expected to offer a positive excess return compared to the benchmark. While style rotation as a strategy can be used in both fundamental and quantitative investment processes, it is generally more in the domain of quantitative investing. Unlike sector or country allocation, discussed earlier, the classification of securities into style categories is less standardized.

Exhibit 5 Large-Cap vs. Small-Cap Equities



Sources: S&P, FTSE Russell.

Exhibit 6 Value vs. Growth Equities



Sources: S&P, FTSE Russell.

Exhibit 7 Summary Statistics

	S&P 500	Russell 2000	Russell 1000 Value	Russell 1000 Growth
Annual return (%)	10.7	11.1	10.9	10.7
Annual volatility (%)	14.4	18.7	14.2	16.4
Sharpe Ratio	0.74	0.59	0.77	0.65

Sources: S&P, FTSE Russell.

The most important test, however, is the "smell" test: Does the factor make intuitive sense? A factor can often pass statistical backtesting, but if it does not make common sense—if justification for the factor's efficacy is lacking—then the manager may be data-mining. Investors should always remember that impressive performance in backtesting does not necessarily imply that the factor will continue to add value in the future.

An important step is choosing the appropriate investment universe. Practitioners mostly define their investment universe in terms of well-known broad market indexes—for the United States, for example, the S&P 500, Russell 3000, and MSCI World Index. Using a well-defined index has several benefits: Such indexes are free from look-ahead and survivorship biases, the stocks in the indexes are investable with sufficient liquidity, and the indexes are also generally free from foreign ownership restrictions.

The most traditional and widely used method for implementing factor-based portfolios is the hedged portfolio approach, pioneered and formulated by Fama and French (1993). In this approach, after choosing the factor to be scrutinized and ranking the investable stock universe by that factor, investors divide the universe into groups referred to as *quantiles* (typically quintiles or deciles) to form quantile portfolios. Stocks are either equally weighted or capitalization weighted within each quantile. A long/short hedged portfolio is typically formed by going long the best quantile and shorting the worst quantile. The performance of the hedged long/short portfolio is then tracked over time.

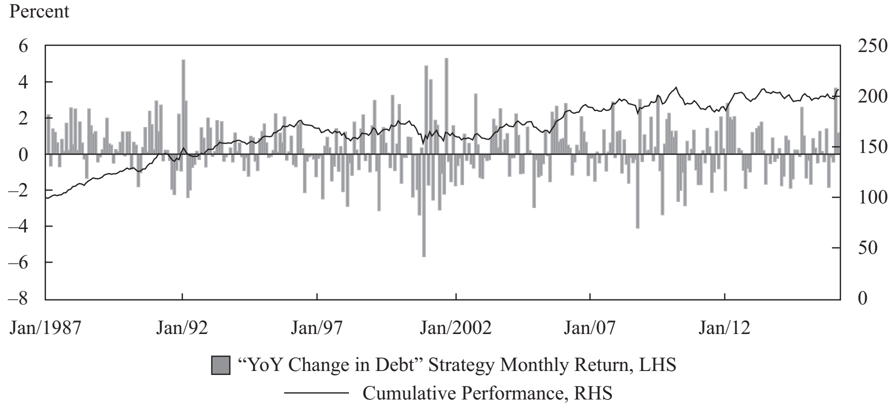
There are a few drawbacks to this "hedged portfolio" approach. First, the information contained in the middle quantiles is not utilized, as only the top and bottom quantiles are used in forming the hedged portfolio. Second, it is implicitly assumed that the relationship between the factor and future stock returns is linear (or at least monotonic), which may not be the case.[4] Third, portfolios built using this approach tend to be concentrated, and if many managers use similar factors, the resulting portfolios will be concentrated in specific stocks. Fourth, the hedged portfolio requires managers to short stocks. Shorting may not be possible in some markets and may be overly expensive in others. Fifth, and most important, the hedged portfolio is not a "pure" factor portfolio because it has significant exposures to other risk factors.

Exhibit 8 shows the performance of a factor called "year-over-year change in debt outstanding." The factor is calculated by taking the year-over-year percentage change in the per share long-term debt outstanding on the balance sheet, using all stocks

4 The payoff patterns between factor exposures and future stock returns are becoming increasingly non-linear, especially in the United States and Japan.

in the Russell 3000 universe. The portfolio is constructed by buying the top 10% of companies that reduce their debt and shorting the bottom 10% of companies that issue the most debt. Stocks in both the long and short portfolios are equally weighted.[5] The bars in the chart indicate the monthly portfolio returns. The average monthly return of the strategy is about 0.22% (or 2.7% per year), and the Sharpe ratio is 0.53 over the test period. All cumulative performance is computed on an initial investment in the factor of $100, with monthly rebalancing and excluding transaction costs.

Exhibit 8 Hedged Portfolio Return, "Year-over-Year Change in Debt Outstanding" Strategy

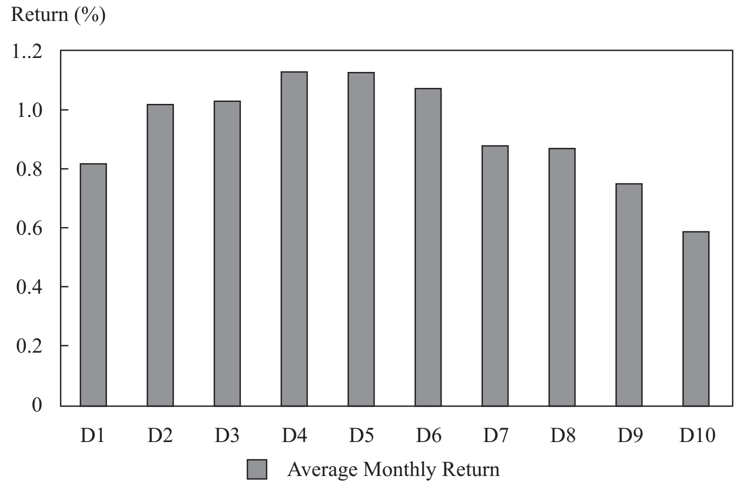


Sources: Compustat, FTSE Russell.

Exhibit 9 shows the average monthly returns of the 10 decile portfolios. It shows that companies with the highest year-over-year increase in debt financing (D10 category) marginally underperform companies with the lowest year-over-year increase in debt financing (average monthly return of 0.6% versus average monthly return of 0.8%). However, it can also be seen that the best-performing companies are the ones with reasonable financial leverage in Deciles 3 to 6. A long/short hedged portfolio approach based on the 1st and 10th deciles (as illustrated in Exhibit 9) would not take advantage of this information, as stocks in these deciles would not be used in such a portfolio. Portfolio managers observing this pattern concerning the different deciles could change the deciles used in the strategy if they believed the pattern would continue into the future.

5 Stocks can also be weighted based on their market capitalization.

Exhibit 9 Average Decile Portfolio Return Based on Year-over-Year Change in Debt Outstanding



Sources: Compustat, FTSE Russell.

For investors who desire a long-only factor portfolio, a commonly used approach is to construct a factor-tilting portfolio, where a long-only portfolio with exposures to a given factor can be built with controlled tracking error. The factor-tilting portfolio tracks a benchmark index closely but also provides exposures to the chosen factor. In this way, it is similar to an enhanced indexing strategy.

A "factor-mimicking portfolio," or FMP, is a theoretical implementation of a pure factor portfolio. An FMP is a theoretical long/short portfolio that is dollar neutral with a unit exposure to a chosen factor and no exposure to other factors. Because FMPs invest in almost every single stock, entering into long or short positions without taking into account short availability issues or transaction costs, they are very expensive to trade. Managers typically construct the pure factor portfolio by following the FMP theory but adding trading liquidity and short availability constraints.

3.3.1 *Style Factors*

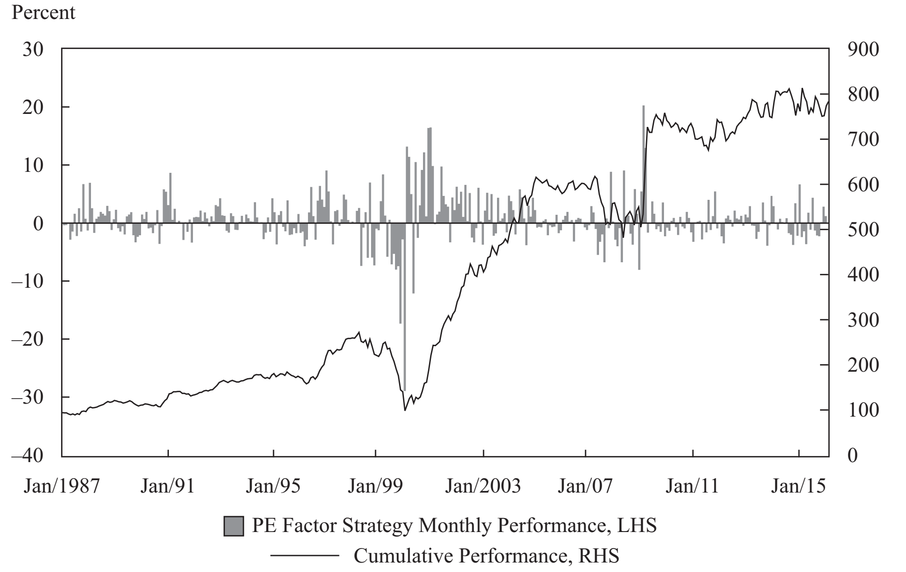
Factors are the raw ingredients of quantitative investing and are often referred to as signals. Quantitative managers spend a large amount of time studying factors. Traditionally, factors have been based on fundamental characteristics of underlying companies. However, many investors have recently shifted their attention to unconventional and unstructured data sources in an effort to gain an edge in creating strategies.

3.3.1.1 Value Value is based on Graham and Dodd's (1934) concept and can be measured in a number of ways. The academic literature has a long history of documenting the value phenomenon. Basu (1977) found that stocks with low P/E or high earnings yield tend to provide higher returns. Fama and French (1993) formally outlined value investing by proposing the book-to-market ratio as a way to measure value and growth.

Although many academics and practitioners believe that value stocks tend to deliver superior returns, there has been considerable disagreement over the explanation of this effect. Fama and French (1992, 1993, 1996) suggested that the value premium exists to compensate investors for the greater likelihood that these companies will experience financial distress. Lakonishok, Shleifer, and Vishny (1994) cited behavioral arguments, suggesting that the effect is a result of behavioral biases on the part of the typical investor rather than compensation for higher risk.

Value factors can also be based on other fundamental performance metrics of a company, such as dividends, earnings, cash flow, EBIT, EBITDA, and sales. Investors often add two more variations on most value factors by adjusting for industry (and/or country) and historical differences. Most valuation ratios can be computed using either historical (also called *trailing*) or forward metrics. Exhibit 10 shows the performance of the price-to-earnings multiple factor implemented as a long/short decile portfolio.

Exhibit 10 Performance of the P/E Factor (Long/Short Decile Portfolio)



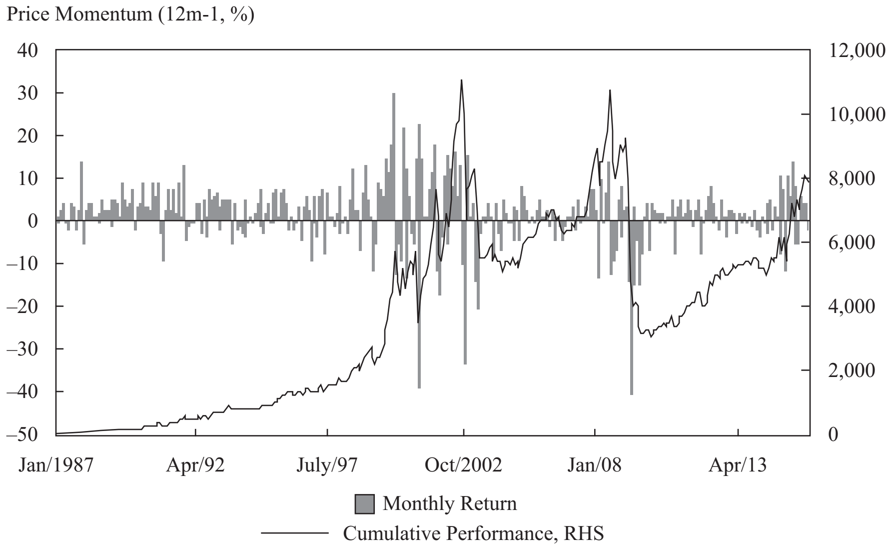
Sources: Compustat, FTSE Russell.

3.3.1.2 Price Momentum Researchers have also found a strong price momentum effect in almost all asset classes in most countries. In fact, value and price momentum have long been the two cornerstones of quantitative investing.

Jegadeesh and Titman (1993) first documented that stocks that are "winners" over the previous 12 months tend to outperform past "losers" (those that have done poorly over the previous 12 months) and that such outperformance persists over the following 2 to 12 months. The study focused on the US market during the 1965–1989 period. The authors also found a short-term reversal effect, whereby stocks that have high price momentum in the previous month tend to underperform over the next 2 to 12 months. This price momentum anomaly is commonly attributed to behavioral biases, such as overreaction to information.[6] It is interesting to note that since the academic publication of these findings, the performance of the price momentum factor has become much more volatile (see Exhibit 11). Price momentum is, however, subject to extreme tail risk. Over the three-month March–May 2009 time period, the simple price momentum strategy (as measured by the long/short decile portfolio) lost 56%. For this data period, some reduction in downside risk can be achieved by removing the effect of sector exposure from momentum factor returns: We will call this modified version the "sector-neutralized price momentum factor."[7] The results are shown in Exhibits 12 and 13 for US, European, and Japanese markets.

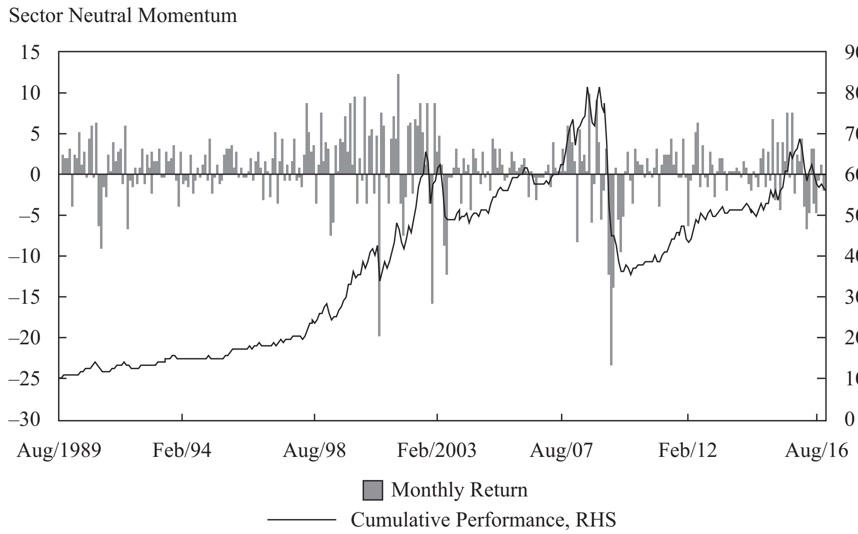
6 Behavioral biases are covered in the Level III readings on behavioral finance.
7 The methods for removing sector exposure are beyond the scope of this reading.

Exhibit 11 Performance of the Price Momentum Factor (Long/Short Decile Portfolio)



Sources: Compustat, FTSE Russell.

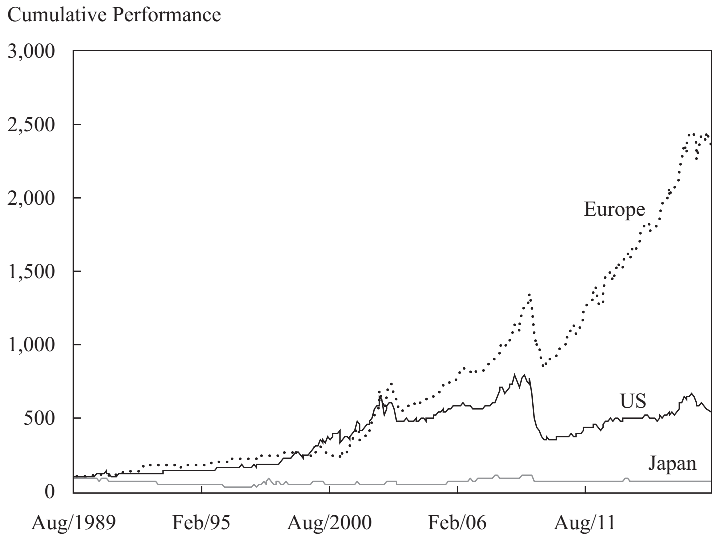
Exhibit 12 Performance of the Sector-Neutralized Price Momentum Factor (Long/Short Decile Portfolio)



Sources: Compustat, FTSE Russell.

Exhibit 13 extends the analysis to include European and Japanese markets, where a similar effect on downside risk can be shown to have been operative over the period.

Exhibit 13 Performance of the Sector-Neutralized Price Momentum Factor in US, European, and Japanese Markets (Long/Short Decile Portfolio)



Sources: Compustat, FTSE Russell.

EXAMPLE 4

Factor Investing

A quantitative manager wants to expand his current strategy from US equities into international equity markets. His current strategy uses a price momentum factor. Based on Exhibit 13:

1. State whether momentum has been a factor in European and Japanese equity returns overall in the time period examined.
2. Discuss the potential reasons why neutralizing sectors reduces downside risk.

Solution to 1:

As shown in Exhibit 13, price momentum has performed substantially better in Europe than in the United States. On the other hand, there does not appear to be any meaningful pattern of price momentum in Japan. Exhibit 13 suggests that the price momentum factor could be used for a European portfolio but not for a Japanese portfolio. However, managers need to perform rigorous backtesting before they can confidently implement a factor model in a market that they are not familiar with. Managers should be aware that what appears to be impressive performance in backtests does not necessarily imply that the factor will continue to add value in the future.

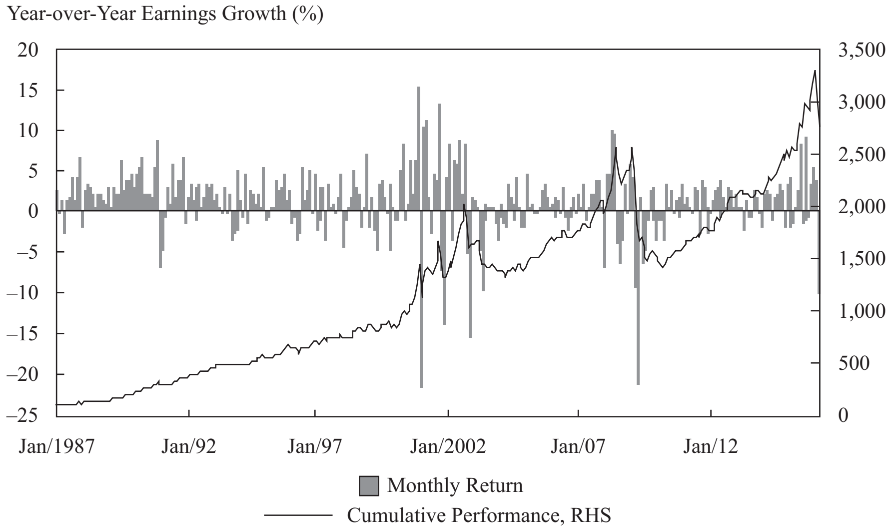
Solution to 2:

Using the simple price momentum factor means that a portfolio buys past winners and shorts past losers. The resulting portfolio could have exposure to potentially significant industry bets. Sector-neutral price momentum focuses on stock selection without such risk exposures and thus tends to reduce downside risk.

3.3.1.3 Growth Growth is another investment approach used by some style investors. Growth factors aim to measure a company's growth potential and can be calculated using the company's historical growth rates or projected forward growth rates. Growth factors can also be classified as short-term growth (last quarter's, last year's, next quarter's, or next year's growth) and long-term growth (last five years' or next five years' growth). While higher-than-market or higher-than-sector growth is generally considered to be a possible indicator for strong future stock price performance, the growth of some metrics, such as assets, results in weaker future stock price performance.

Exhibit 14 shows the performance of the year-over-year earnings growth factor. The exhibit is based on a strategy that invests in the top 10% of companies with the highest year-over-year growth in earnings per share and shorts all the stocks in the bottom 10%.

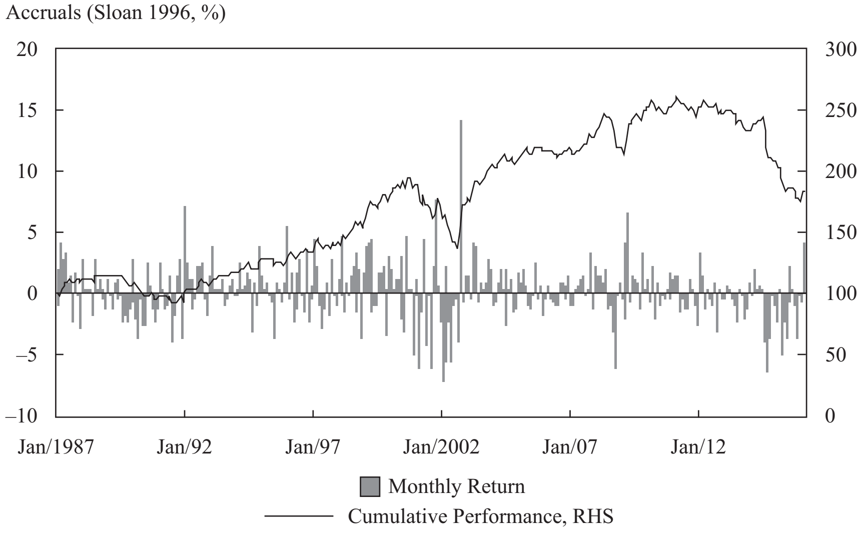
Exhibit 14 Performance of Year-over-Year Earnings Growth Factor (Long/Short Decile Portfolio)



Sources: Compustat, FTSE Russell.

3.3.1.4 Quality In addition to using accounting ratios and share price data as fundamental style factors, investors have continued to create more complex factors based on the variety of accounting information available for companies. One of the best-known examples of how in-depth accounting knowledge can impact investment performance is Richard Sloan's (1996) seminal paper on earnings quality, with its proposition of the accruals factor. Sloan suggests that stock prices fail to reflect fully the information contained in the accrual and cash flow components of current earnings.[8] The performance of the accruals anomaly factor, however, appears to be quite cyclical.

Exhibit 15 Performance of Earnings Quality Factor



Sources: Compustat, FTSE Russell.

In addition to the accruals anomaly, there are many other potential factors based on a company's fundamental data, such as profitability, balance sheet and solvency risk, earnings quality, stability, sustainability of dividend payout, capital utilization, and management efficiency measures. Yet another, analyst sentiment, refers to the phenomenon of sell-side analysts revising their forecasts of corporate earnings estimates, which is called *earnings revision*. More recently, with the availability of more data, analysts have started to include cash flow revisions, sales revisions, ROE revisions, sell-side analyst stock recommendations, and target price changes as variables in the "analyst sentiment" category.

A new and exciting area of research involves news sentiment. Rather than just relying on the output of sell-side analysts, investors could use natural language processing (NLP) algorithms to analyze the large volume of news stories and quantify the news sentiment on stocks.

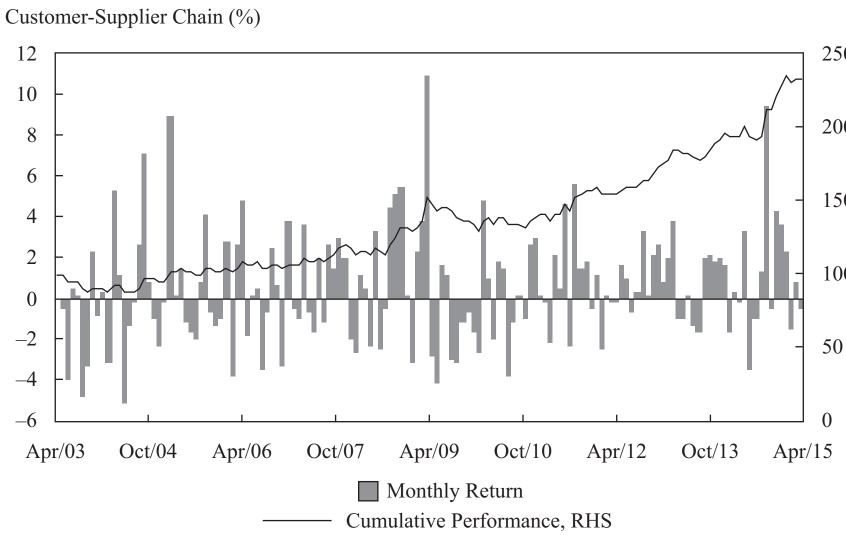
3.3.2 *Unconventional Factors Based on Unstructured Data*

With the rapid growth in technology and computational algorithms, investors have been embracing big data. "Big data" is a broad term referring to extremely large datasets that may include structured data—such as traditional financial statements and market data—as well as unstructured or "alternative" data that has previously not been widely used in the investment industry because it lacks recognizable structure. Examples of such alternative data include satellite images, textual information, credit card payment information, and the number of online mentions of a particular product or brand.

8 Sloan (1996) argues that in the long term, cash flows from operations and net income (under accruals-based accounting) should converge and be consistent. In the short term, they could diverge. Management has more discretion in accruals-based accounting; therefore, the temporary divergence between cash flows and net income reflects how conservative a company chooses to be in reporting its net income.

Exhibit 16 shows the performance (as measured by the long/short quintile portfolio) of a factor based on customer–supplier chain data.[9] The signal is based on the trailing one-month stock price return of a company's largest customer. Stocks are ranked by largest customer performance, and the portfolio goes long the top quintile and shorts the lowest quintile. The positions are held until the following month's stock ranking and rebalancing. The intuition is that the positive performance of customers is likely to benefit the supplier company in subsequent periods. Indeed, compared to many traditional factors, the supply-chain signal seems to have shown more consistent returns, especially in recent years.

Exhibit 16 Performance of Customer–Supplier-Chain Factor



Sources: Compustat, FactSet Revere, FTSE Russell.

Portfolio construction is covered in the curriculum reading titled "Active Equity Portfolio Construction."

EXAMPLE 5

Researching Factor Timing

An analyst is exploring the relationship between interest rates and style factor returns for the purpose of developing equity style rotation strategies for the US equity market. The analysis takes place in early 2017. The first problem the analyst addresses is how to model the interest rate variable. The data in Exhibit 17 show an apparent trend of declining US government bond yields over the last 30 years. Trends may or may not continue into the future. The analyst decides

9 These data can be obtained from FactSet Revere's historical point-in-time supply chain dataset.

to normalize the yield data so that they do not incorporate a prediction on continuation of the trend and makes a simple transformation by subtracting the yield's own 12-month moving average:

$$\text{Normalized yield}_t = \text{Nominal yield}_t - \frac{1}{12}\sum_{\tau=1}^{12}\text{Nominal yield}_{t-\tau+1}$$

The normalized yield data are shown in Exhibit 18. Yields calculated are as of the beginning of the month. Do the fluctuations in yield have any relationship with style factor returns? The analyst explores possible contemporaneous (current) and lagged relationships by performing two regressions (using the current month's and the next month's factor returns, respectively) against the normalized long-term bond yield:

$$f_{i,t} = \beta_{i,0} + \beta_{i,1}\text{Normalized yield}_t + \varepsilon_{i,t}$$

and

$$f_{i,t+1} = \beta_{i,0} + \beta_{i,1}\text{Normalized yield}_t + \varepsilon_{i,t}$$

where $f_{i,t}$ is the return of style factor i at time t and $f_{i,t+1}$ is the subsequent (next) month's return to style factor i. The first regression reveals the contemporaneous relationship between interest rate and factor performance—that is, how well the current interest rate relates to the current factor performance. The second equation states whether the current interest rate can predict the next month's factor return. Exhibit 19 shows the findings.

Exhibit 17 Current and Expected Bond Yield, US

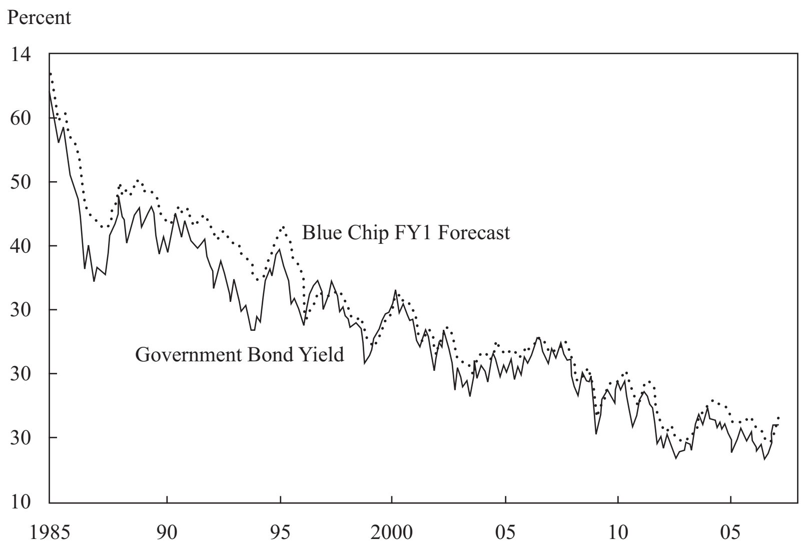
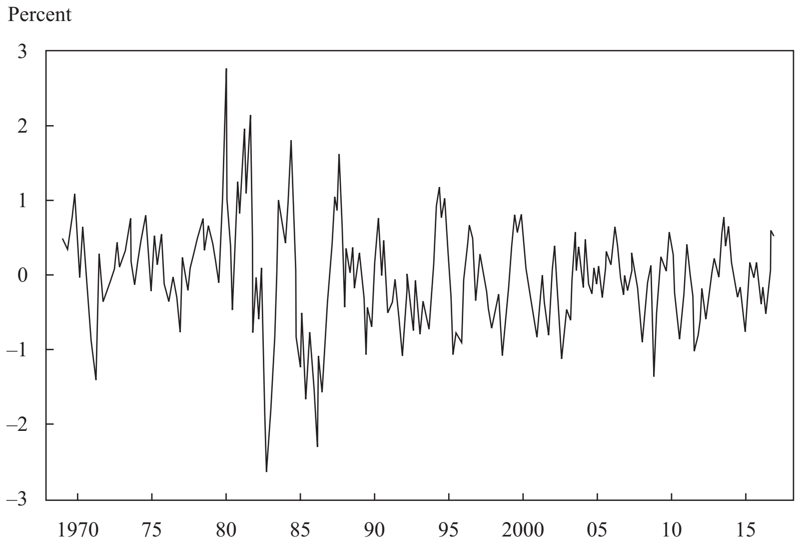
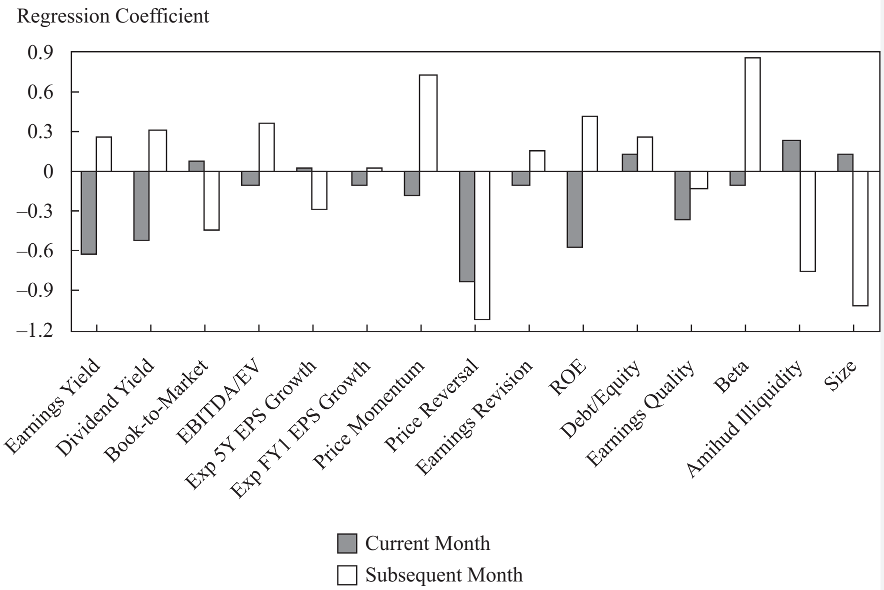


Exhibit 18 Normalized 10-Year Treasury Bond Yield, US



Source: Haver Analytics.

Exhibit 19 Normalized Bond Yield and Style Factor Returns



Source: Haver Analytics.

Using only the information given, address the following:

1 Interpret Exhibit 19.

2 Discuss the relevance of contemporaneous and forward relationships in an equity factor rotation strategy.

3 What concerns could the analyst have in relation to an equity factor rotation strategy, and what possible next steps could the analyst take to address those concerns?

Solution to 1:

Exhibit 19 suggests an inverse relationship between concurrent bond yields and returns to the dividend yield, price reversal, and ROE factors. For some factors (such as earnings quality), the relationship between bond yields and forward (next month's) factor returns is in the same direction as the contemporaneous relationship.

Solution to 2:

Attention needs to be given to the timing relationship of variables to address this question. A contemporaneous style factor return becomes known as of the end of the month. If the known value of bond yields at the beginning of the month is correlated with factor returns, the investor may be able to gain some edge relative to investors who do not use that information. The same conclusion holds concerning the forward relationship. If the contemporaneous variable were defined so that it is realized at the same time as the variable we want to predict, the forward but not the contemporaneous variable would be relevant.

Solution to 3:

The major concern is the validity of the relationships between normalized interest rates and the style variables. Among the steps the analyst can take to increase his or her conviction in the relationships' validity are the following:

- Establish whether the relationships have predictive value out of sample (that is, based on data not used to model the relationship).
- Investigate whether or not there are economic rationales for the relationships such that those relationships could be expected to persist into the future.

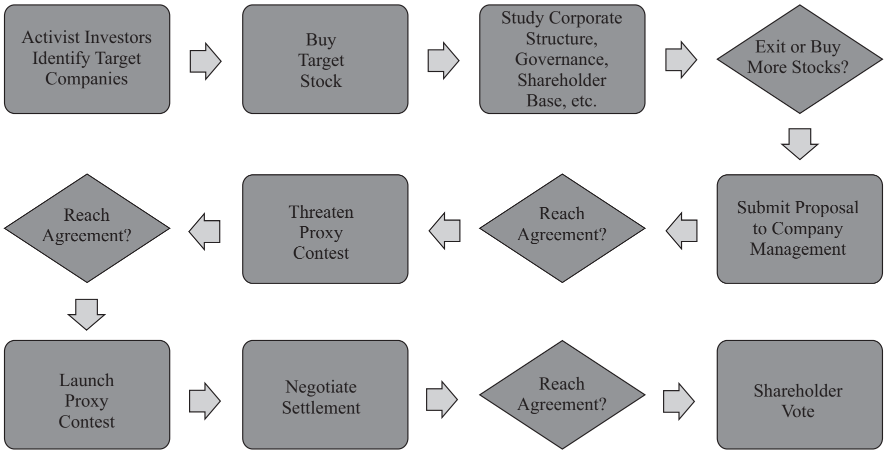
Exhibit 19 shows both weak relationships (e.g., for earnings revision) and strong relationships (e.g., for size and beta) in relation to the subsequent month's returns. This fact suggests some priorities in examining this question.

3.4 Activist Strategies

Activist investors specialize in taking stakes in listed companies and advocating changes for the purpose of producing a gain on the investment. The investor may wish to obtain representation on the company's board of directors or use other measures in an effort to initiate strategic, operational, or financial structure changes. In some cases, activist investors may support activities such as asset sales, cost-cutting measures, changes to management, changes to the capital structure, dividend increases, or share buybacks. Activists—including hedge funds, public pension funds, private investors, and others—vary greatly in their approaches, expertise, and investment horizons. They may also seek different outcomes. What they have in common is that they advocate for change in their target companies.

Shareholder activism typically follows a period of screening and analysis of opportunities in the market. The investor usually reviews a number of companies based on a range of parameters and carries out in-depth analysis of the business and the opportunities for unlocking value. Activism itself starts when an investor buys an equity stake in the company and starts advocating for change (i.e., pursuing an activist campaign). These equity stakes are generally made public. Stakes above a certain threshold must be made public in most jurisdictions. Exhibit 20 shows a typical activist investing process. The goal of activist investing could be either financial gain (increased shareholder value) or a non-financial cause (e.g., environmental, social, and governance issues). Rather than pursuing a full takeover bid, activist investors aim to achieve their goals with smaller stakes, typically of less than 10%. Activist investors' time horizon is often shorter than that of buy-and-hold investors, but the whole process can last for a number of years.

Exhibit 20 A Typical Shareholder Activist Investing Process



Source: Deutsche Bank.

3.4.1 *The Popularity of Shareholder Activism*

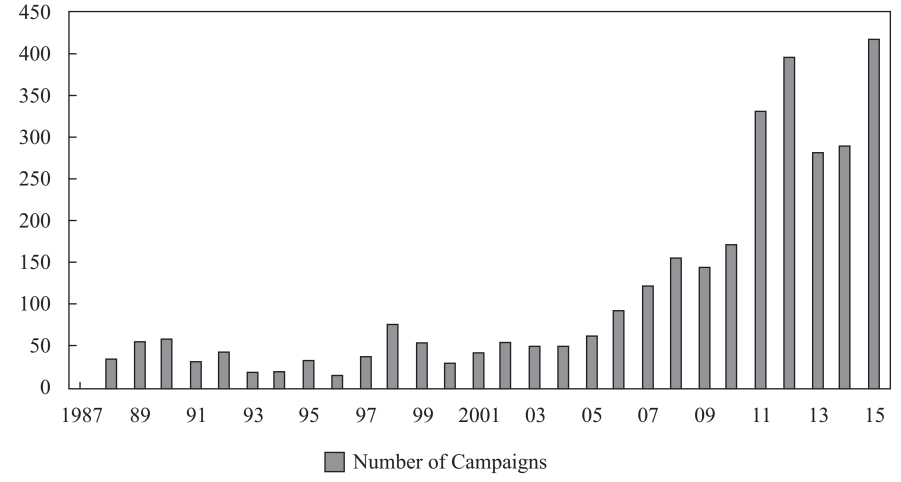
Shareholder (or investor) activism is by no means a new investment strategy. Its foundations go back to the 1970s and 1980s, when investors known as corporate raiders took substantial stakes in companies in order to influence their operations, unlock value in the target companies, and thereby raise the value of their shares. Proponents of activism argue that it is an important and necessary activity that helps monitor and discipline corporate management to the benefit of all shareholders. Opponents argue that such interventionist tactics can cause distraction and negatively impact management performance.

Activist hedge funds—among the most prominent activist investors—saw growing popularity for a number of years, with assets under management (AUM) reaching \$50 billion in 2007[10] before falling sharply during the global financial crisis. Activist hedge fund investing has since strongly recovered, with AUM close to \$120 billion in 2015.[11] The activity of such investors can be tracked by following the activists' announcements that they are launching a campaign seeking to influence companies. Exhibit 21 shows the number of activist events reported by the industry. Hedge funds that specialize in activism benefit from lighter regulation than other types of funds, and their fee structure, offering greater rewards, justifies concerted campaigns for change at the companies they hold. The popularity and viability of investor activism

10 Hedge Fund Research.
11 See "Activist Funds: An Investor Calls," *Economist* (7 February 2015).

are influenced by the legal frameworks in different jurisdictions, shareholder structures, and cultural considerations. The United States has seen the greatest amount of activist activity initiated by hedge funds, individuals, and pension funds, but there have been a number of activist events in Europe too. Other regions have so far seen more limited activity on the part of activist investors. Cultural reasons and more concentrated shareholder ownership of companies are two frequently cited explanations.

Exhibit 21 Number of Global Activist Events



Source: Thomson Reuters Activism database.

3.4.2 *Tactics Used by Activist Investors*

Activists use a range of tactics on target companies in order to boost shareholder value. These tactics include the following:

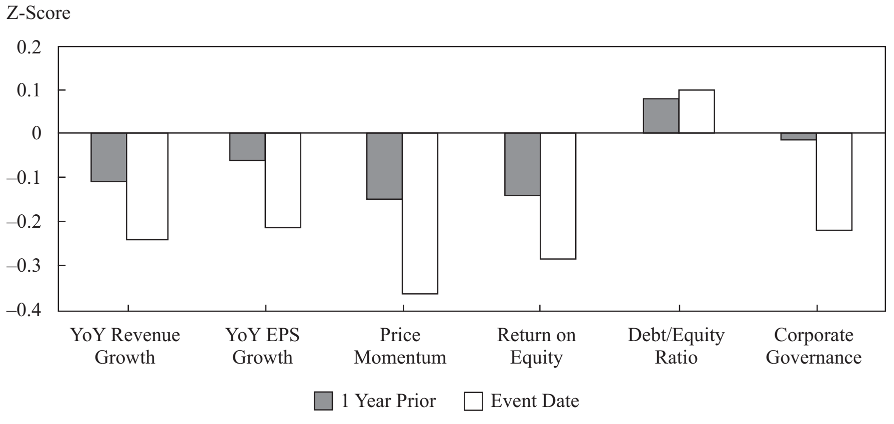
- Seeking board representation and nominations
- Engaging with management by writing letters to management calling for and explaining suggested changes, participating in management discussions with analysts or meeting the management team privately, or launching proxy contests whereby activists encourage other shareholders to use their proxy votes to effect change in the organization
- Proposing significant corporate changes during the annual general meeting (AGM)
- Proposing restructuring of the balance sheet to better utilize capital and potentially initiate share buybacks or increase dividends
- Reducing management compensation or realigning management compensation with share price performance
- Launching legal proceedings against existing management for breach of fiduciary duties
- Reaching out to other shareholders of the company to coordinate action
- Launching a media campaign against existing management practices
- Breaking up a large conglomerate to unlock value

The effectiveness of shareholder activism depends on the response of the existing management team and the tools at that team's disposal. In many countries, defense mechanisms can be employed by management or a dominant shareholder to hinder activist intervention. These techniques include multi-class share structures whereby a company founder's shares are typically entitled to multiple votes per share; "poison pill" plans allowing the issuance of shares at a deep discount, which causes significant economic and voting dilution; staggered board provisions whereby a portion of the board members are not elected at annual shareholders meetings and hence cannot all be replaced simultaneously; and charter and bylaw provisions and amendments.

3.4.3 *Typical Activist Targets*

Activist investors look for specific characteristics in deciding which companies to target. Exhibit 22 shows the characteristics of target companies relative to the market as a whole. The exhibit provides a measure of these characteristics on the event day as well as a year before the announcement, giving a flavor of the dynamics of these attributes. It shows that, on average,[12] target companies feature slower revenue and earnings growth than the market, suffer negative share price momentum, and have weaker-than-average corporate governance.[13] By building stakes and initiating change in underperforming companies, activists hope to unlock value. In addition, by targeting such companies, activist investors are more likely to win support for their actions from other shareholders and the wider public. Traditionally, the target companies have been small and medium-sized listed stocks. This has changed as a number of larger companies have become subject to activism.[14]

Exhibit 22 Fundamental Characteristics of Target Companies



Sources: Capital IQ, Compustat, FTSE Russell, MSCI, S&P.

12 The fundamental characteristics of all companies in the investment universe (i.e., the Russell 3000) are standardized using z-scores (by subtracting the mean and dividing by the standard deviation) every month from 1988 until 2015. Thus, we can compare the average exposure to each fundamental characteristic over time.

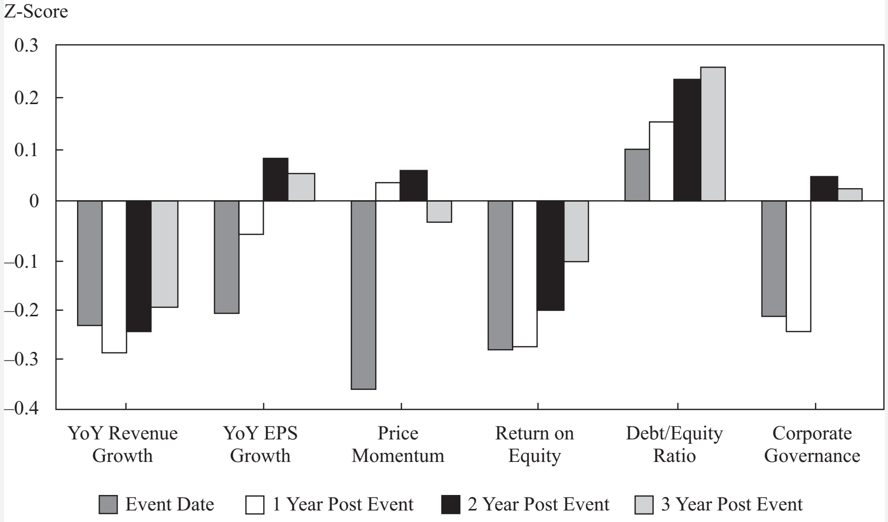
13 We normalize all target and non-target companies' factor exposures using z-scores (i.e., subtracting the sample mean and dividing by the sample standard deviation).

14 Trian Fund Management proposed splitting PepsiCo into standalone public companies; Third Point called for leadership change at Yahoo!.

Do Activists Really Improve Company Performance?

Exhibit 23 shows that, on average, fundamental characteristics of targeted companies do improve in subsequent years following activists' efforts, with evidence that revenue and earnings growth increase, profitability improves, and corporate governance indicators become more robust. There is evidence, however, that the financial leverage of such companies increases significantly.

Exhibit 23 Fundamentals of Target Companies Improve

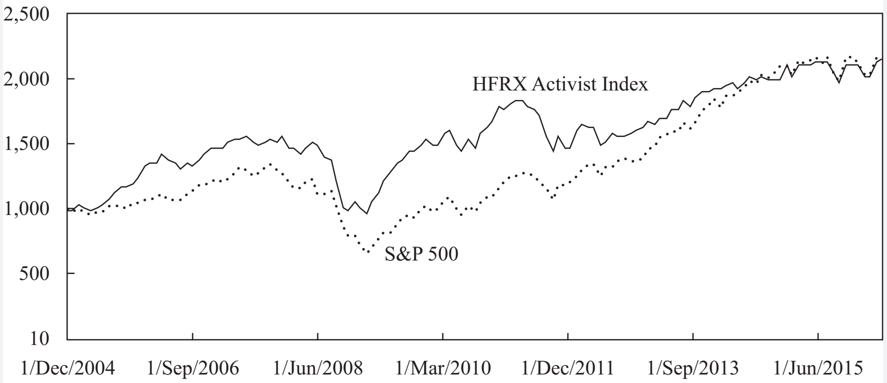


Note: Data are for US companies, 1988–2015.
Sources: Capital IQ, Compustat, FTSE Russell, MSCI, S&P.

Do Activist Investors Generate Alpha?

Activist hedge funds are among the major activist investors. Based on the HFRX Activist Index, in the aggregate, activist hedge funds have delivered an average annual return of 7.7% with annual volatility of 13.7% and therefore a Sharpe ratio of 0.56—slightly higher than the Sharpe ratio of the S&P 500 Index of 0.54 (see Exhibit 24). However, it is difficult to conclude how much value activist investors add because the HFRX index does not include a large enough number of managers. Furthermore, managers themselves vary in their approaches and the risks they take.

Exhibit 24 Performance of HFRX Activist Index vs. S&P 500



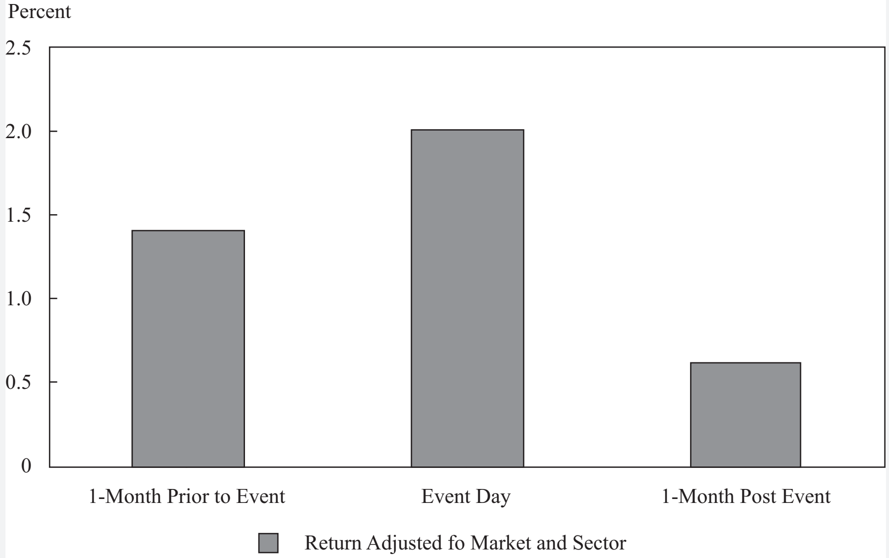
Sources: Hedge Fund Research, S&P.

How Does the Market React to Activist Events?

Investors have generally reacted positively to activism announcements: On average, target company stocks go up by 2% on the announcement day (based on all activist events in the Thomson Reuters Corporate Governance Intelligence database from 1987 to 2016).[15] Interestingly, the positive reaction comes on top of stock appreciation prior to activism announcements (see Exhibit 25). According to the model of Maug (1998), activist investors trade in a stock prior to the announcement to build up a stake, assert control, and profit from the value creation. It may also be argued that there must be information leakage about the activists' involvement, driving the stock higher even before the first public announcement. There is a modest post-announcement drift: In the month after the activist announcement date, target share prices move up by 0.6%, on average, relative to the market.

15 All returns are excess returns, adjusted for the market and sector. For details, see Jussa, Webster, Zhao, and Luo (2016).

Exhibit 25 Market Reactions to Activist Events



Sources: Capital IQ, Compustat, FTSE Russell, S&P.

EXAMPLE 6

Activist Investing

Kendra Cho is an analyst at an investment firm that specializes in activist investing and manages a concentrated portfolio of stocks invested in listed European companies. Cho and her colleagues hope to identify and buy stakes in companies with the potential to increase their value through strategic, operational, or financial change. Cho is considering the following three companies:

- Company A is a well-established, medium-sized food producer. Its profitability, measured by operating margins and return on assets, is ahead of industry peers. The company is recognised for its high corporate governance standards and effective communication with existing and potential investors. Cho's firm has invested in companies in this sector in the past and made gains on those positions.
- Company B is a medium-sized engineering business that has experienced a significant deterioration in profitability in recent years. More recently, the company has been unable to pay interest on its debt, and its new management team has recognized the need to restructure the business and negotiate with its creditors. Due to the company's losses, Cho cannot use earnings-based price multiples to assess upside potential, but based on sales and asset multiples, she believes there is significant upside potential in the stock if the company's current difficulties can be overcome and the debt can be restructured.
- Company C is also a medium-sized engineering business, but its operating performance, particularly when measured by the return on assets, is below that of the rest of the industry. Cho has identified a number of

company assets that are underutilised. She believes that the management has significant potential to reduce fixed-asset investments, concentrate production in fewer facilities, and dispose of assets, in line with what the company's peers have been doing. Such steps could improve asset turnover and make it possible to return capital to shareholders through special dividends.

Identify the company that is most appropriate for Cho to recommend to the fund managers:

Solution:

Company C is the most appropriate choice. The company offers upside potential because of its ability to improve operating performance and cash payout using asset disposals, a strategy being implemented by other companies in its sector. Neither Company A nor Company B offers an attractive opportunity for activist investing: Company A is already operating efficiently, while Company B is more suitable for investors that focus on restructuring and distressed investing.

3.5 Other Strategies

There are many other strategies that active portfolio managers employ in an attempt to beat the market benchmark. In this section, we explain two other categories of active strategies that do not fit neatly into our previous categorizations—namely, statistical arbitrage and event-driven strategies. Both rely on extensive use of quantitative data and are usually implemented in a systematic, rules-based way but can also incorporate the fund manager's judgment in making investment decisions.

3.5.1 *Strategies Based on Statistical Arbitrage and Market Microstructure*

Statistical arbitrage (or "stat arb") strategies use statistical and technical analysis to exploit pricing anomalies. Statistical arbitrage makes extensive use of data such as stock price, dividend, trading volume, and the limit order book for this purpose. The analytical tools used include (1) traditional technical analysis, (2) sophisticated time-series analysis and econometric models, and (3) machine-learning techniques. Portfolio managers typically take advantage of either mean reversion in share prices or opportunities created by market microstructure issues.

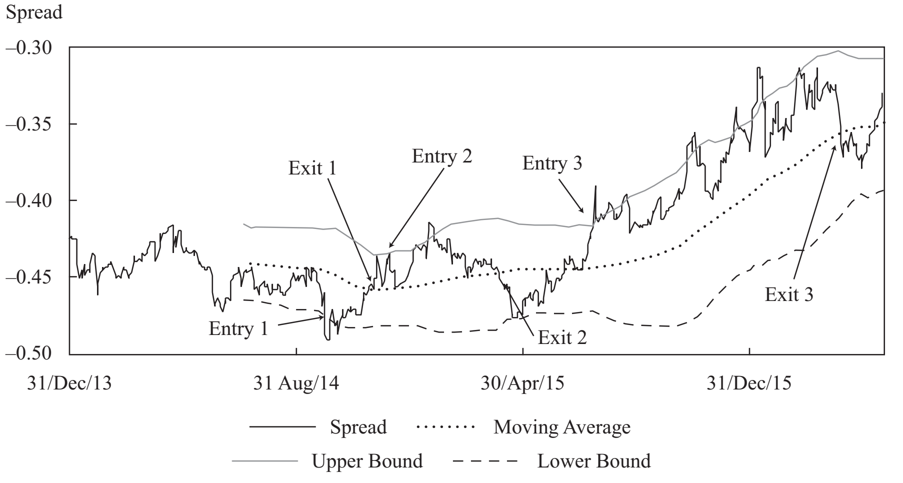
Pairs trading is an example of a popular and simple statistical arbitrage strategy. Pairs trading uses statistical techniques to identify two securities that are historically highly correlated with each other. When the price relationship of these two securities deviates from its long-term average, managers that expect the deviation to be temporary go long the underperforming stock and simultaneously short the outperforming stock. If the prices do converge to the long-term average as forecast, the investors close the trade and realize a profit. This kind of pairs trading therefore bets on a mean-reversion pattern in stock prices. The biggest risk in pairs trading and most other mean-reversion strategies is that the observed price divergence is not temporary; rather, it might be due to structural reasons.[16] Because risk management is critical for the success of such strategies, investors often employ stop-loss rules to exit trades when a loss limit is reached.

16 For example, the outperformance of one stock might be due to the fact that the company has developed a new technology or product that cannot be easily replicated by competitors.

The most difficult aspect of a pairs-trading strategy is the identification of the pairs of stocks. This can be done either by using a quantitative approach and creating models of stock prices or by using a fundamental approach to judge the two stocks whose prices should move together for qualitative reasons.

Consider Canadian National Railway (CNR) and Canadian Pacific Railway (CP). These are the two dominant railways in Canada. Their business models are fairly similar, as both operate railway networks and transport goods throughout the country. Exhibit 26 shows that the prices of the two stocks have been highly correlated.[17] The y-axis shows the log price differential, referred to as the spread.[18] The exhibit also shows the moving average of the spread computed on a rolling 130-day window and bands at two standard deviations above and two standard deviations below the moving average. A simple pairs-trading strategy would be to enter into a trade when the spread is more than (or less than) two standard deviations from the moving average. The trade would be closed when the spread reaches the moving average again. Exhibit 26 shows the three trades based on our decision rules. The first trade was opened on 2 October 2014, when the spread between CNR and CP crossed the –2 standard deviation mark.[19] This trade was closed on 18 November 2014, when the spread reached the moving average. The first trade was profitable, and the position was maintained for slightly more than a month. The second trade was also profitable but lasted much longer. After the third trade was entered on 21 July 2015, however, there was a structural break, in that CP's decline further intensified while CNR stayed relatively flat; therefore, the spread continued to widen. The loss on the third trade could have been significantly greater than the profits made from the first two transactions if the positions had been closed prior to mean reversion in the spring of 2016. This example highlights the risk inherent in mean-reversion strategies.

Exhibit 26 Pairs Trade between CNR and CP



Sources: Bloomberg, Wolfe Research

17 The correlation coefficient between the two stocks was 69% based on daily returns from 2 January 2014 to 26 May 2016.

18 ln(Price of CNR/Price of CP).

19 The position is long CNR and short CP.

In the United States, many market microstructure–based arbitrage strategies take advantage of the NYSE Trade and Quote (TAQ) database and often involve extensive analysis of the limit order book to identify very short-term mispricing opportunities. For example, a temporary imbalance between buy and sell orders may trigger a spike in share price that lasts for only a few milliseconds. Only those investors with the analytical tools and trading capabilities for high-frequency trading are in a position to capture such opportunities, usually within a portfolio of many stocks designed to take advantage of very short-term discrepancies.

EXAMPLE 7

An analyst is asked to recommend a pair of stocks to be added to a statistical arbitrage fund. She considers the following three pairs of stocks:

- Pair 1 consists of two food-producing companies. Both are mature companies with comparable future earnings prospects. Both typically trade on similar valuation multiples. The ratio of their share prices shows mean reversion over the last two decades. The ratio is currently more than one standard deviation above its moving average.
- Pair 2 consists of two consumer stocks: One is a food retailer, and the other is a car manufacturer. Although the two companies operate in different markets and have different business models, statistical analysis performed by the analyst shows strong correlation between their share prices that has persisted for more than a decade. The stock prices have moved significantly in opposite directions in recent days. The analyst, expecting mean reversion, believes this discrepancy represents an investment opportunity.
- Pair 3 consists of two well-established financial services companies with a traditional focus on retail banking. One of the companies recently saw the arrival of a new management team and an increase in acquisition activity in corporate and investment banking—both new business areas for the company. The share price fell sharply on news of these changes. The price ratio of the two banks now deviates significantly from the moving average.

Based on the information provided, select the pair that would be most suitable for the fund.

Solution:

Pair 1 is the most suitable for the fund. The companies' share prices have been correlated in the past, with the share price ratio reverting to the moving average. They have similar businesses, and there is no indication of a change in either company's strategies, as there is for Pair 3. By contrast with the price ratio for Pair 1, the past correlation of share prices for Pair 2 may have been spurious and is not described as exhibiting mean reversion.

3.5.2 *Event-Driven Strategies*

Event-driven strategies exploit market inefficiencies that may occur around corporate events such as mergers and acquisitions, earnings or restructuring announcements, share buybacks, special dividends, and spinoffs.

Risk arbitrage associated with merger and acquisition (M&A) activity is one of the most common examples of an event-driven strategy.

In a cash-only transaction, the acquirer proposes to purchase the shares of the target company for a given price. The stock price of the target company typically remains below the offered price until the transaction is completed. Therefore, an arbitrageur could buy the stock of the target company and earn a profit if and when the acquisition closes.

In a share-for-share exchange transaction, the acquirer uses its own shares to purchase the target company at a given exchange ratio. A risk arbitrage trader normally purchases the target share and simultaneously short-sells the acquirer's stock at the same exchange ratio. Once the acquisition is closed, the arbitrageur uses his or her long positions in the target company to exchange for the acquirer's stocks, which are further used to cover the arbitrageur's short positions.

The first challenge in managing risk arbitrage positions is to accurately estimate the risk of the deal failing. An M&A transaction, for example, may not go through for numerous reasons. A regulator may block the deal because of antitrust concerns, or the acquirer may not be able to secure the approval from the target company's shareholders. If a deal fails, the price of the target stock typically falls sharply, generating significant loss for the arbitrageur. Hence, this strategy has the label "risk arbitrage."

Another important consideration that an arbitrageur has to take into account is the deal duration. At any given point in time, there are many M&A transactions outstanding, and the arbitrageur has to decide which ones to participate in and how to weight each position, based on the predicted premium and risk. The predicted premium has to be annualized to enable the arbitrageur to compare different opportunities. Therefore, estimating deal duration is important for accurately estimating the deal premium.

4 CREATING A FUNDAMENTAL ACTIVE INVESTMENT STRATEGY

Fundamental (or discretionary) investing remains one of the prevailing philosophies of active management. In the following sections, we discuss how fundamental investors organize their investment processes.

4.1 The Fundamental Active Investment Process

The broad goal of active management is to outperform a selected benchmark on a risk-adjusted basis, net of fees and transaction costs. Value can be added at different stages of the investment process. For example, added value may come from the use of proprietary data, from special skill in security analysis and valuation, or from insight into industry/sector allocation.

Many fundamental investors use processes that include the following steps:

1. Define the investment universe and the market opportunity—the perceived opportunity to earn a positive risk-adjusted return to active investing, net of costs—in accordance with the investment mandate. The market opportunity is also known as the investment thesis.
2. Prescreen the investment universe to obtain a manageable set of securities for further, more detailed analysis.
3. Understand the industry and business for this screened set by performing:
   - industry and competitive analysis and
   - analysis of financial reports.

4 Forecast company performance, most commonly in terms of cash flows or earnings.

5 Convert forecasts to valuations and identify *ex ante* profitable investments.

6 Construct a portfolio of these investments with the desired risk profile.

7 Rebalance the portfolio with buy and sell disciplines.

The investment universe is mainly determined by the mandate agreed on by the fund manager and the client. The mandate defines the market segments, regions, and/or countries in which the manager will seek to add value. For example, if an investment mandate specifies Hong Kong's Hang Seng Index as the performance benchmark, the manager's investment universe will be primarily restricted to the 50 stocks in that index. However, an active manager may also include non-index stocks that trade on the same exchange or whose business activities significantly relate to this region. It is important for investors who seek to hold a diversified and well-constructed portfolio to understand the markets in which components of the portfolio will be invested. In addition, a clear picture of the market opportunity to earn positive active returns is important for active equity investment. The basic question is, what is the opportunity and why is it there? The answer to this two-part question can be called the investment thesis. The "why" part involves understanding the economic, financial, behavioral, or other rationale for a strategy's profitability in the future.

Practically, the investment thesis will suggest a set of characteristics that tend to be associated with potentially profitable investments. The investor may prescreen the investment universe with quantitative and/or qualitative criteria to obtain a manageable subset that will be analyzed in greater detail. Prescreening criteria can often be associated with a particular investment style. A value style manager, for example, may first exclude those stocks with high P/E multiples and high debt-to-equity ratios. Growth style managers may first rule out stocks that do not have high enough historical or forecast EPS growth. Steps 3 to 5 cover processes of in-depth analysis described in the Level II CFA Program readings on industry and company analysis and equity valuation. Finally, a portfolio is constructed in which stocks that have high upside potential are overweighted relative to the benchmark and stocks that are expected to underperform the benchmark are underweighted, not held at all, or (where relevant) shorted.[20]

As part of the portfolio construction process (step 6), the portfolio manager needs to decide whether to take active exposures to particular industry groups or economic sectors or to remain sector neutral relative to the benchmark. Portfolio managers may have top-down views on the business trends in some industries. For example, innovations in medical technology may cause an increase in earnings in the health care sector as a whole, while a potential central bank interest rate hike may increase the profitability of the banking sector. With these views, assuming the changed circumstances are not already priced in by the market, a manager could add extra value to the portfolio by overweighting the health care and financial services sectors. If the manager doesn't have views on individual sectors, he or she should, in theory, establish a neutral industry position relative to the benchmark in constructing the portfolio. However, a manager who has very strong convictions on the individual names in a specific industry may still want to overweight the industry that those names belong to. The potential high excess return from overweighting individual stocks can justify the risk the portfolio takes on the active exposure to that industry.

20 A portfolio that is benchmarked against an index that contains hundreds or thousands of constituents will most likely have zero weighting in most of them.

In addition to the regular portfolio rebalancing that ensures that the investment mandate and the desired risk exposures are maintained, a stock sell discipline needs to be incorporated into the investment process. The stock sell discipline will enable the portfolio to take profit from a successful investment and to exit from an unsuccessful investment at a prudent time.

In fundamental analysis, each stock is typically assigned a target price that the analyst believes to be the fair market value of the stock. The stock will be reclassified from undervalued to overvalued if the stock price surpasses this target price. Once this happens, the upside of the stock is expected to be limited, and holding that stock may not be justified, given the potential downside risk. The sell discipline embedded within an investment process requires the portfolio manager to sell the stock at this point. In practice, recognizing that valuation is an imprecise exercise, managers may continue to hold the stock or may simply reduce the size of the position rather than sell outright. This flexibility is particularly relevant when, in relative valuation frameworks where the company is being valued against a peer group, the valuations of industry peers are also changing. The target price of a stock need not be a constant but can be updated by the analyst with the arrival of new information. Adjusting the target price downward until it is lower than the current market price would also trigger a sale or a reduction in the position size.

Other situations could arise in which a stock's price has fallen and continues to fall for what the analyst considers to be poorly understood reasons. If the analyst remains positive on the stock, he or she should carefully consider the rationale for maintaining the position; if the company fundamentals indeed worsened, the analyst must also consider his or her own possible behavioral biases. The portfolio manager needs to have the discipline to take a loss by selling the stock if, for example, the price touches some pre-defined stop-loss trigger point. The stop-loss point is intended to set the maximum loss for each asset, under any conditions, and limit such behavioral biases.

EXAMPLE 8

Fundamental Investing

A portfolio manager uses the following criteria to prescreen his investment universe:

1. The year-over-year growth rate in earnings per share from continuing operations has increased over each of the last four fiscal years.
2. Growth in earnings per share from continuing operations over the last 12 months has been positive.
3. The percentage difference between the actual announced earnings and the consensus earnings estimate for the most recent quarter is greater than or equal to 10%.
4. The percentage change in stock price over the last four weeks is positive.
5. The 26-week relative price strength is greater than or equal to the industry's 26-week relative price strength.
6. The average daily volume for the last 10 days is in the top 50% of the market.

Describe the manager's investment mandate.

Solution:

The portfolio manager has a growth orientation with a focus on companies that have delivered EPS growth in recent years and that have maintained their earnings and price growth momentum. Criterion 1 specifies accelerating EPS growth rates over recent fiscal years, while criterion 2 discards companies for which recent earnings growth has been negative. Criterion 3 further screens for companies that have beaten consensus earnings expectations—have had a positive earnings surprise—in the most recent quarter. A positive earnings surprise suggests that past earnings growth is continuing. Criteria 4 and 5 screen for positive recent stock price momentum. Criterion 6 retains only stocks with at least average market liquidity. Note the absence of any valuation multiples among the screening criteria: A value investor's screening criteria would typically include a rule to screen out issues that are expensively valued relative to earnings or assets.

4.2 Pitfalls in Fundamental Investing

Pitfalls in fundamental investing include behavioral biases, the value trap, and the growth trap.

4.2.1 *Behavioral Bias*

Fundamental, discretionary investing in general and stock selection in particular depend on subjective judgments by portfolio managers based on their research and analysis. However, human judgment, though potentially more insightful than a purely quantitative method, can be less rational and is often susceptible to human biases. The CFA Program curriculum readings on behavioral finance divide behavioral biases into two broad groups: cognitive errors and emotional biases. Cognitive errors are basic statistical, information-processing, or memory errors that cause a decision to deviate from the rational decisions of traditional finance, while emotional biases arise spontaneously as a result of attitudes and feelings that can cause a decision to deviate from the rational decisions of traditional finance. Several biases that are relevant to active fundamental equity management are discussed here.

4.2.1.1 Confirmation Bias A cognitive error, confirmation bias—sometimes referred to as "stock love bias"—is the tendency of analysts and investors to look for information that confirms their existing beliefs about their favorite companies and to ignore or undervalue any information that contradicts their existing beliefs. This behavior creates selective exposure, perception, and retention and may be thought of as a selection bias. Some of the consequences are a poorly diversified portfolio, excessive risk exposure, and holdings in poorly performing securities. Actively seeking out the opinions of other investors or team members and looking for information from a range of sources to challenge existing beliefs may reduce the risk of confirmation bias.

4.2.1.2 Illusion of Control The basic philosophy behind active equity management is that investors believe they can control or at least influence outcomes. Skilled investors have a healthy confidence in their own ability to select stocks and influence outcomes, and they expect to outperform the market. The illusion of control bias refers to the human tendency to overestimate these abilities. Langer (1983) defines the illusion of control bias as "an expectancy of a personal success probability inappropriately higher than the objective probability would warrant." The illusion of control is a cognitive error.

Having an illusion of control could lead to excessive trading and/or heavy weighting on a few stocks. Investors should seek contrary viewpoints and set and enforce proper trading and portfolio diversification rules to try to avoid this problem.

4.2.1.3 Availability Bias Availability bias is an information-processing bias whereby individuals take a mental shortcut in estimating the probability of an outcome based on the availability of the information and how easily the outcome comes to mind. Easily recalled outcomes are often perceived as being more likely than those that are harder to recall or understand. Availability bias falls in the cognitive error category. In fundamental equity investing, this bias may reduce the investment opportunity set and result in insufficient diversification as the portfolio manager relies on familiar stocks that reflect a narrow range of experience. Setting an appropriate investment strategy in line with the investment horizon, as well as conducting a disciplined portfolio analysis with a long-term focus, will help eliminate any short-term over-emphasis caused by this bias.

4.2.1.4 Loss Aversion Loss aversion is an emotional bias whereby investors tend to prefer avoiding losses over achieving gains. A number of studies on loss aversion suggest that, psychologically, losses are significantly more powerful than gains. In absolute value terms, the utility derived from a gain is much lower than the utility given up in an equivalent loss.

Loss aversion can cause investors to hold unbalanced portfolios in which poorly performing positions are maintained in the hope of potential recovery and successful investments are sold (and the gains realized) prematurely in order to avoid further risk. A disciplined trading strategy with firmly established stop-loss rules is essential to prevent fundamental investors from falling into this trap.

4.2.1.5 Overconfidence Bias Overconfidence bias is an emotional bias whereby investors demonstrate unwarranted faith in their own intuitive reasoning, judgment, and/or cognitive abilities. This overconfidence may be the result of overestimating knowledge levels, abilities, and access to information. Unlike the illusion of control bias, which is a cognitive error, overconfidence bias is an illusion of exaggerated knowledge and abilities. Investors may, for example, attribute success to their own ability rather than to luck. Such bias means that the portfolio manager underestimates risks and overestimates expected returns. Regularly reviewing actual investment records and seeking constructive feedback from other professionals can help investors gain awareness of such self-attribution bias.

4.2.1.6 Regret Aversion Bias An emotional bias, regret aversion bias causes investors to avoid making decisions that they fear will turn out poorly. Simply put, investors try to avoid the pain of regret associated with bad decisions. This bias may actually prevent investors from making decisions. They may instead hold on to positions for too long and, in the meantime, lose out on profitable investment opportunities.

A carefully defined portfolio review process can help mitigate the effects of regret aversion bias. Such a process might, for example, require investors to periodically review and justify existing positions or to substantiate the decision not to have exposure to other stocks in the universe.

4.2.2 *Value and Growth Traps*

Value- and growth-oriented investors face certain distinctive risks, often described as "traps."

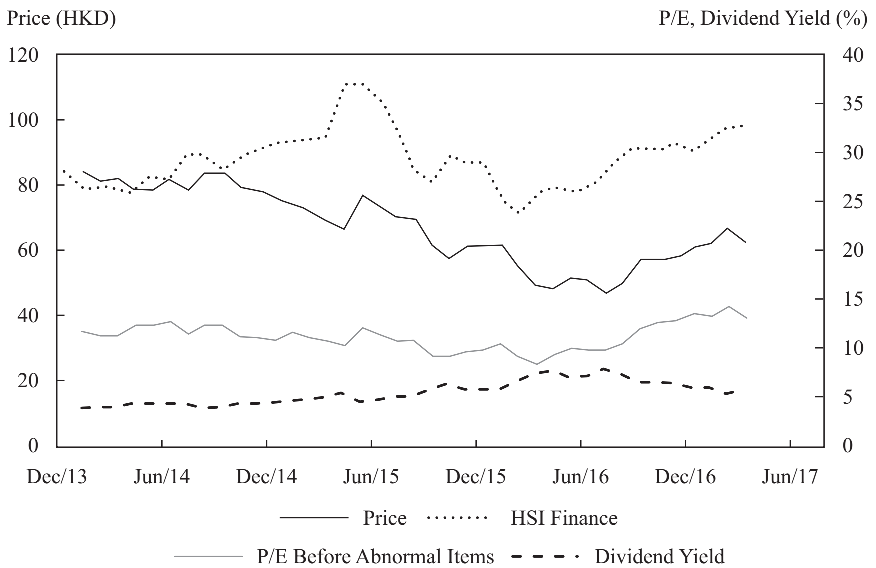
4.2.2.1 The Value Trap A value trap is a stock that appears to be attractively valued—with a low P/E multiple (and/or low price-to-book-value or price-to-cash-flow multiples)—because of a significant price fall but that may still be overpriced given its worsening future prospects. For example, the fact that a company is trading at a low price relative to earnings or book value might indicate that the company or the entire sector is facing deteriorating future prospects and that stock prices may stay low for an extended period of time or decline even further. Often, a value trap appears to be such an attractive investment that investors struggle to understand why the stock fails to perform. Value investors should conduct thorough research before investing in any company that appears to be cheap so that they fully understand the reasons for what appears to be an attractive valuation. Stock prices generally need catalysts or a change in perceptions in order to advance. If a company doesn't have any catalysts to trigger a reevaluation of its prospects, there is less of a chance that the stock price will adjust to reflect its fair value. In such a case, although the stock may appear to be an attractive investment because of a low multiple, it could lead the investor into a value trap.

HSBC Holdings is a multinational banking and financial services holding company headquartered in London. It has a dual primary listing on the Hong Kong Stock Exchange (HKSE) and the London Stock Exchange (LSE) and is a constituent of both the Hang Seng Index (HSI) and the FTSE 100 Index (UKX).

The stock traded on the HKSE at a price of over $80 at the end of 2013 and dropped below $50 in mid-June 2016. It declined by 43.7% in two and a half years, while the industry index (the Hang Seng Financial Index) lost only 5.4% over the same period. At the start of the period, HSBC Holdings looked cheap compared to peers and its own history, with average P/E and P/B multiples of 10.9x and 0.9x, respectively. Despite appearing undervalued, the stock performed poorly over the subsequent two-and-a-half-year period (see Exhibit 27) for reasons that included the need for extensive cost cutting. The above scenario is an illustration of a value trap.

Exhibit 27 Performance of HSBC vs. Its Value Indicators

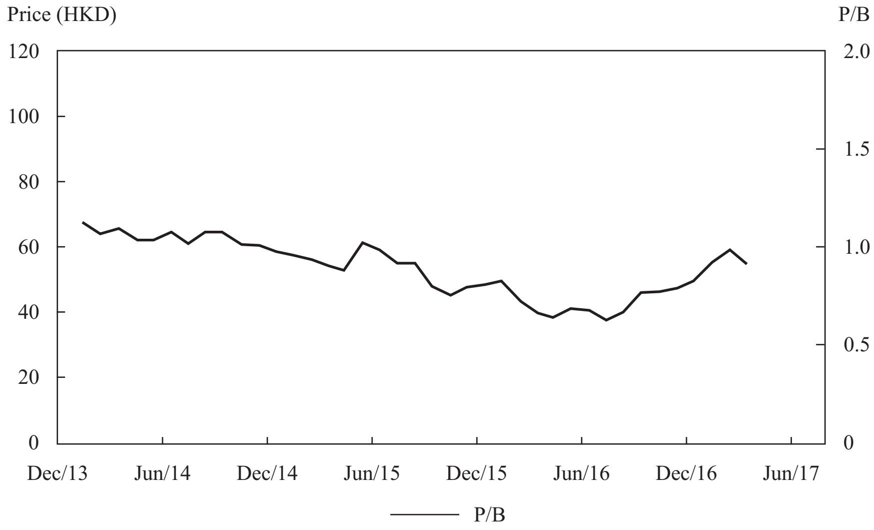
Panel A



Panel B

(continued)

Exhibit 27 (Continued)



Source: Bloomberg.

4.2.2.2 The Growth Trap Investors in growth stocks do so with the expectation that the share price will appreciate when the company experiences above-average earnings (or cash flow) growth in the future. However, if the company's results fall short of these expectations, stock performance is affected negatively. The stock may also turn out to have been overpriced at the time of the purchase. The company may deliver above-average earnings or cash flow growth, in line with expectations, but the share price may not move any higher due to its already high starting level. The above circumstances are known as a growth trap. As with the value trap in the case of value stocks, the possibility of a growth trap should be considered when investing in what are perceived to be growth stocks.

Investors are often willing to justify paying high multiples for growth stocks in the belief that the current earnings are sustainable and that earnings are likely to grow fast in the future. However, neither of these assumptions may turn out to be true: The company's superior market position may be unsustainable and may last only until its competitors respond. Industry-specific variables often determine the pace at which new entrants or existing competitors respond and compete away any supernormal profits. It is also not uncommon to see earnings grow quickly from a very low base only to undergo a marked slowdown after that initial expansion.

5 CREATING A QUANTITATIVE ACTIVE INVESTMENT STRATEGY

Quantitative active equity investing began in the 1970s and became a mainstream investment approach in the subsequent decades. Many quantitative equity funds suffered significant losses in August 2007, an event that became known as the "quant meltdown." The subsequent global financial crisis contributed to growing suspicions about the sustainability of quantitative investing. However, both the performance and the perception of quantitative investing have recovered significantly since 2012 as this approach has regained popularity.

5.1 Creating a Quantitative Investment Process

Quantitative (systematic, or rules-based) investing generally has a structured and well-defined investment process. It starts with a belief or hypothesis. Investors collect data from a wide range of sources. Data science and management are also critical for dealing with missing values and outliers. Investors then create quantitative models to test their hypothesis. Once they are comfortable with their models' investment value, quantitative investors combine their return-predicting models with risk controls to construct their portfolios.

5.1.1 *Defining the Market Opportunity (Investment Thesis)*

Like fundamental active investing, quantitative active investing is based on a belief that the market is competitive but not necessarily efficient. Fund managers use publicly available information to predict future returns of stocks, using factors to build their return-forecasting models.

5.1.2 *Acquiring and Processing Data*

Data management is probably the least glamorous part of the quantitative investing process. However, investors often spend most of their time building databases, mapping data from different sources, understanding the data availability, cleaning up the data, and reshaping the data into a usable format. The most commonly used data in quantitative investing typically fall into the following categories:

- **Company mapping** is used to track many companies over time and across data vendors. Each company may also have multiple classes of shares. New companies go public, while some existing companies disappear due to bankruptcies, mergers, or takeovers. Company names, ticker symbols, and other identifiers can also change over time. Different data vendors have their own unique identifiers.
- **Company fundamentals** include company demographics, financial statements, and other market data (e.g., price, dividends, stock splits, trading volume). Quantitative portfolio managers almost never collect company fundamental data themselves. Instead, they rely on data vendors, such as Capital IQ, Compustat, Worldscope, Reuters, FactSet, and Bloomberg.
- **Survey data** include details of corporate earnings, forecasts and estimates by various market participants, macroeconomic variables, sentiment indicators, and information on funds flow.
- **Unconventional data,** or unstructured data, include satellite images, measures of news sentiment, customer–supplier chain metrics, and corporate events, among many other types of information.

Data are almost never in the format that is required for quantitative investment analysis. Hence, investors spend a significant amount of time checking data for consistency, cleaning up errors and outliers, and transforming the data into a usable format.

5.1.3 *Back-testing the Strategy*

Once the required data are available in the appropriate form, strategy back-testing is undertaken. Back-testing is a simulation of real-life investing. For example, in a standard monthly back-test, one can build a portfolio based on a value factor as of a given month-end—perhaps 10 years ago—and then track the return of this portfolio over the subsequent month. Investors normally repeat this process (i.e., rebalance the portfolio) according to a predefined frequency or rule for multiple years to evaluate how such a portfolio would perform and assess the effectiveness of a given strategy over time.

5.1.3.1 Information Coefficient Under the assumption that expected returns are linearly related to factor exposures, the correlation between factor exposures and their holding period returns for a cross section of securities has been used as a measure of factor performance in quantitative back-tests. This correlation for a factor is known in this context as the factor's information coefficient (IC). An advantage of the IC is that it aggregates information about factors from all securities in the investment universe, in contrast to an approach that uses only the best and worst deciles (a quantile-based approach), which captures only the top and bottom extremes.

The Pearson IC is the simple correlation coefficient between the factor scores (essentially standardized exposures) for the current period's and the next period's stock returns. As it is a correlation coefficient, its value is always between –1 and +1 (or, expressed in percentage terms, between –100% and +100%). The higher the IC, the higher the predictive power of the factor for subsequent returns. As a simple rule of thumb, in relation to US equities, any factor with an average monthly IC of 5%–6% is considered very strong. The coefficient is sensitive to outliers, as is illustrated below.

A similar but more robust measure is the Spearman rank IC, which is often preferred by practitioners. The Spearman rank IC is essentially the Pearson correlation coefficient between the ranked factor scores and ranked forward returns.

In the example shown in Exhibit 28 for earnings yield, the Pearson IC is negative at –0.8%, suggesting that the signal did not perform well and was negatively correlated with the subsequent month's returns. Looking more carefully, however, we can see that the sample factor is generally in line with the subsequent stock returns, with the exception of Stock I, for which the factor predicts the highest return but which turns out to be the worst performer. A single outlier can therefore turn what may actually be a good factor into a bad one, as the Pearson IC is sensitive to outliers. In contrast, the Spearman rank IC is at 40%, suggesting that the factor has strong predictive power for subsequent returns. If three equally weighted portfolios had been constructed, the long basket (Stocks G, H, and I) would have outperformed the short basket (Stocks A, B, and C) by 56 bps in this period.

Exhibit 28 Pearson Correlation Coefficient IC and Spearman Rank IC

Stock	Factor Score	Subsequent Month Return (%)	Rank of Factor Score	Rank of Return
A	–1.45	–3.00%	9	8
B	–1.16	–0.60%	8	7
C	–0.60	–0.50%	7	6
D	–0.40	–0.48%	6	5
E	0.00	1.20%	5	4
F	0.40	3.00%	4	3
G	0.60	3.02%	3	2
H	1.16	3.05%	2	1
I	1.45	–8.50%	1	9
Mean	0.00	–0.31%		

Exhibit 28 (Continued)

Stock	Factor Score	Subsequent Month Return (%)	Rank of Factor Score	Rank of Return
Standard deviation	1.00	3.71%		
Pearson IC		–0.80%		
Spearman rank IC				40.00%
Long/short tercile portfolio return				0.56%

Note: The portfolio is split into terciles, with each tercile containing one-third of the stocks.
Source: QES (Wolfe Research).

5.1.3.2 Creating a Multifactor Model After studying the efficacy of single factors, managers need to decide which factors to include in a multifactor model. Factor selection and weighting is a fairly complex subject. Managers can select and weight each factor using either qualitative or systematic processes. For example, Qian, Hua, and Sorensen (2007) propose treating each factor as an asset; therefore, factor weighting becomes an asset allocation decision. A standard mean–variance optimization can also be used to weight factors. Deciding on which factors to include and their weight is a critical piece of the strategy. Investors should bear in mind that factors may be effective individually but not add material value to a factor model because they are correlated with other factors.

5.1.4 *Evaluating the Strategy*

Once back-testing is complete, the performance of the strategy can be evaluated. An out-of-sample back-test, in which a different set of data is used to evaluate the model's performance, is generally done to confirm model robustness. However, even strategies with great out-of-sample performance may perform poorly in live trading. Managers generally compute various statistics—such as the t-statistic, Sharpe ratio, Sortino ratio, VaR, conditional VaR, and drawdown characteristics—to form an opinion on the outcome of their out-of-sample back-test.

5.1.5 *Portfolio Construction Issues in Quantitative Investment*

Most quantitative managers spend the bulk of their time searching for and exploring models that can predict stock returns, and may overlook the importance of portfolio construction to the quantitative investment process. While portfolio construction is covered in greater detail in other readings, the following aspects are particularly relevant to quantitative investing:

- **Risk models:** Risk models estimate the variance–covariance matrix of stock returns—that is, the risk of every stock and the correlation among stocks. Directly estimating the variance–covariance matrix using sample return data typically is infeasible and suffers from significant estimation errors.[21] Managers generally rely on commercial risk model vendors[22] for these data.

21 One problem with a sample covariance matrix is the curse of dimensionality. For a portfolio of N assets, we need to estimate $N \times (N + 1)/2$ parameters—that is, $N \times (N - 1)/2$ covariance parameters and N estimates of stock-specific risk. For a universe of 3,000 stocks, we would have to estimate about 4.5 million parameters.
22 MSCI Barra and Axioma are examples of data providers.

- **Trading costs:** There are two kinds of trading costs—explicit (e.g., commissions, fees, and taxes) and implicit (e.g., bid–ask spread and market impact). When two stocks have similar expected returns and risks, normally the one with lower execution costs is preferred.[23]

Unconventional Big Data and Machine-Learning Techniques

Rohal, Jussa, Luo, Wang, Zhao, Alvarez, Wang, and Elledge (2016) discuss the implications and applications of big data and machine-learning techniques in investment management. The rapid advancement in computing power today allows for the collection and processing of data from sources that were traditionally impossible or overly expensive to access, such as satellite images, social media, and payment-processing systems.

Investors now have access to data that go far beyond the traditional company fundamentals metrics. There are also many data vendors providing increasingly specialized or unique data content. Processing and incorporating unconventional data into existing investment frameworks, however, remains a challenge. With the improvements in computing speed and algorithms, significant successes in machine-learning techniques have been achieved. Despite concerns about data mining, machine learning has led to significant improvement in strategy performance.

5.2 Pitfalls in Quantitative Investment Processes

All active investment strategies have their pros and cons. There are many pitfalls that investors need to be aware of when they assess any quantitative strategy. Wang, Wang, Luo, Jussa, Rohal, and Alvarez (2014) discuss some of the common issues in quantitative investing in detail.

5.2.1 *Survivorship Bias, Look-Ahead Bias, Data Mining, and Overfitting*

Survivorship bias is one of the most common issues affecting quantitative decision making. While investors are generally aware of the problem, they often underestimate its significance. When back-tests use only those companies that are currently in business today, they ignore the stocks that have left the investment universe due to bankruptcy,[24] delisting, or acquisition. This approach creates a bias whereby only companies that have survived are tested and it is assumed that the strategy would never have invested in companies that have failed. Survivorship bias often leads to overly optimistic results and sometimes even causes investors to draw wrong conclusions.

The second major issue in back-testing is look-ahead bias. This bias results from using information that was unknown or unavailable at the time an investment decision was made. An example of this bias is the use of financial accounting data for a company at a point in time before the data were actually released by the company.

In computer science, data mining refers to automated computational processes for discovering patterns in large datasets, often involving sophisticated statistical techniques, computation algorithms, and large-scale database systems. In finance, data mining can refer to such a process and can introduce a bias that results in model

23 Trading costs are covered in depth in separate curriculum readings.

24 In the United States, companies may continue to trade after filing for bankruptcy as long as they continue to meet listing requirements. However, their stocks are normally removed from most equity indexes.

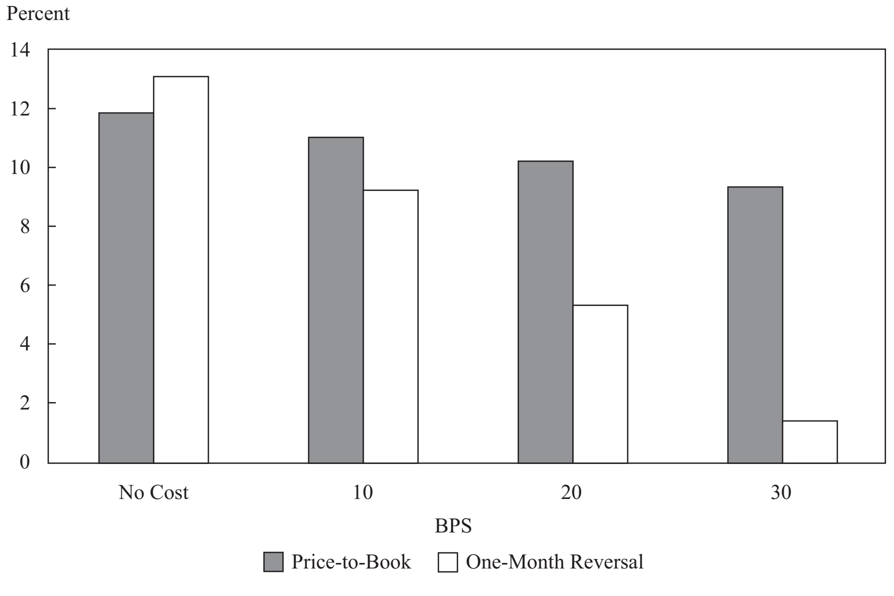
overfitting. It can be described as excessive search analysis of past financial data to uncover patterns and to conform to a pre-determined model for potential use in investing.

5.2.2 *Turnover, Transaction Costs, and Short Availability*

Back-testing is often conducted in an ideal, but unrealistic world without transaction costs, constraints on turnover, or limits on the availability of long and short positions. In reality, managers may face numerous constraints, such as limits on turnover and difficulties in establishing short positions in certain markets. Depending on how fast their signal decays, they may or may not be able to capture their model's expected excess return in a live trading process.

More importantly, trading is not free. Transaction costs can easily erode returns significantly. An example is the use of short-term reversal as a factor: Stocks that have performed well recently (say, in the last month) are more likely to revert (underperform) in the subsequent month. This reversal factor has been found to be a good stock selection signal in the Japanese equity market (before transaction costs). As shown in Exhibit 29, in a theoretical world with no transaction costs, a simple long/short strategy (buying the top 20% dividend-paying stocks in Japan with the worst performance in the previous month and shorting the bottom 20% stocks with the highest returns in the previous month) has generated an annual return of 12%, beating the classic value factor of price to book. However, if the transaction cost assumption is changed from 0 bps to 30 bps per trade, the return of the reversal strategy drops sharply, while the return of the price-to-book value strategy drops only modestly.

Exhibit 29 Annualized Returns with Different Transaction Cost Assumptions



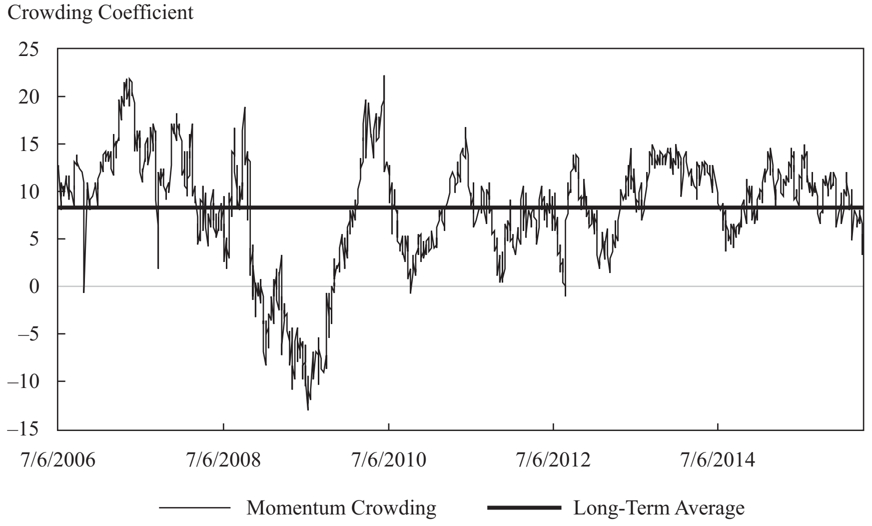
Sources: Compustat, Capital IQ, Thomson Reuters.

Quant Crowding

In the first half of 2007, despite some early signs of the US subprime crisis, the global equity market was relatively calm. Then, in August 2007, many of the standard factors used by quantitative managers suffered significant losses,[25] and quantitative equity managers' performance suffered. These losses have been attributed to crowding among quantitative managers following similar trades (see Khandani and Lo 2008). Many of these managers headed for the exit at the same time, exacerbating the losses.

How can it be concluded that the August 2007 quant crisis was due to crowding? More importantly, how can crowding be measured so that the next crowded trade can be avoided? Jussa et al (2016a) used daily short interest data from Markit's securities finance database to measure crowding. They proposed that if stocks with poor price momentum are heavily shorted[26] relative to outperforming stocks, it indicates that many investors are following a momentum style. Hence, momentum as an investment strategy might get crowded. A measure of crowding that may be called a "crowding coefficient" can be estimated by regressing short interest on price momentum. Details of such regression analysis are beyond the scope of this reading.[27] As shown in Exhibit 30, the level of crowding for momentum reached a local peak in mid-2007. In the exhibit, increasing values of the crowding coefficient indicate greater crowding in momentum strategies.

Exhibit 30 Crowding in Momentum Strategies



Sources: Compustat, FTSE Russell, Markit.

25 The average performance of many common factors was strong and relatively stable in 2003–2007. Actually, value and momentum factors suffered more severe losses in late 2002 and around March 2009.

26 Short interest can be defined as the ratio of the number of stocks shorted to the number of stocks in the available inventory for lending.

27 For more on this subject, see Jussa, Rohal, Wang, Zhao, Luo, Alvarez, Wang, and Elledge (2016) and Cahan and Luo (2013).

EXAMPLE 9

How to Start a Quantitative Investment Process

An asset management firm that traditionally follows primarily a fundamental value investing approach wants to diversify its investment process by incorporating a quantitative element. Discuss the potential benefits and hurdles involved in adding quantitative models to a fundamental investment approach.

Solution:

Quantitative investing is based on building models from attributes of thousands of stocks. The performance of quantitative strategies is generally not highly correlated with that of fundamental approaches. Therefore, in theory, adding a quantitative overlay may provide some diversification benefit to the firm.

In practice, however, because the processes behind quantitative and fundamental investing tend to be quite different, combining these two approaches is not always straightforward. Quantitative investing requires a large upfront investment in data, technology, and model development. It is generally desirable to use factors and models that are different from those used by most other investors to avoid potential crowded trades.

Managers need to be particularly careful with their back-testing so that the results do not suffer from look-ahead and survivorship biases. Transaction costs and short availability (if the fund involves shorting) should be incorporated into the back-testing.

6 EQUITY INVESTMENT STYLE CLASSIFICATION

An investment style classification process generally splits the stock universe into two or three groups, such that each group contains stocks with similar characteristics. The returns of stocks within a style group should therefore be correlated with one another, and the returns of stocks in different style groups should have less correlation. The common style characteristics used in active management include value, growth, blend (or core), size, price momentum, volatility, income (high dividend), and earnings quality. Stock membership in an industry, sector, or country group—for example, the financial sector or emerging markets—is also used to classify the investment style. Exhibit 31 lists a few mainstream categories of investment styles in use today.

Exhibit 31 Examples of Investment Styles

Characteristics based	Value, Growth or Blend/Core
	Capitalization
	Volatility
Membership based	Sector
	Country
	Market (developed or emerging)
Position based	Long/short (net long, short, or neutral)

Investment style classification is important for asset owners who seek to select active strategies. It allows active equity managers with similar styles to be compared with one another. Further, comparing the active returns or positions of a manager with those of the right style index can provide more information about the manager's active strategy and approach. A manager's portfolio may appear to have active positions when compared with the general market benchmark index; however, that manager may actually follow a style index and do so passively. Identifying the actual investment style of equity managers is important for asset owners in their decision-making process.

6.1 Different Approaches to Style Classification

Equity styles are defined by pairs of common attributes, such as value and growth, large cap and small cap, high volatility and low volatility, high dividend and low dividend, or developed markets and emerging markets. Style pairs need not be mutually exclusive. Each pair interprets the stock performance from a different perspective. A combination of several style pairs may often give a more complete picture of the sources of stock returns.

Identifying the investment styles of active managers helps to reveal the sources of added value in the portfolio. Modern portfolio theory advocates the use of efficient portfolio management of a diversified portfolio of stocks and bonds. Gupta, Skallsjö, and Li (2016) detail how the concept of diversification, when extended to different strategies and investment processes, can have a significant impact on the risk and reward of an investor's portfolio. A portfolio's risk–return profile is improved not only by including multiple asset classes but also by employing managers with different investment styles. An understanding of the investment style of a manager helps in evaluating the manager and confirming whether he or she sticks with the claimed investment style or deviates from it.

Two main approaches are often used in style analysis: a holdings-based approach and a returns-based approach. Each approach has its own strengths and weaknesses.

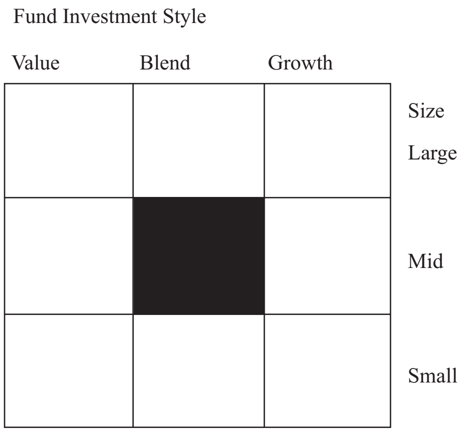
6.1.1 *Holdings-Based Approaches*

An equity investment style is actually the aggregation of attributes from individual stocks in the portfolio. Holdings-based approaches to style analysis are done bottom-up, but they are executed differently by the various commercial investment information providers. Using different criteria or different sources of underlying value and growth numbers may lead to slightly different classifications for stocks and therefore may result in different style characterizations for the same portfolio. In the style classification process followed by Morningstar and Thomson Reuters Lipper, the styles of individual stocks are clearly defined in that a stock's attribute for a specific style is 1 if it is included in that style index; otherwise, it is 0. The methodology used by MSCI and FTSE Russell, on the other hand, assumes that a stock can have characteristics of two styles, such as value and growth, at the same time. This methodology uses a multifactor approach to assign style inclusion factors to each stock. So a particular stock can belong to both value and growth styles by a pre-determined fraction. A portfolio's active exposure to a certain style equals the sum of the style attributes from all the individual stocks, weighted by their active positions.

The Morningstar Style Box

The Morningstar Style Box first appeared in 1992 to help investors and advisers determine the investment style of a fund. In a style box, each style pair splits the stock universe into two to three groups, such as value, core (or “blend”), and growth. The same universe can be split by another style definition—for example, large cap, mid cap, and small cap. The Morningstar Style Box splits the stock universe along both style dimensions, creating a grid of nine squares. It uses holdings-based style analysis and classifies about the same number of stocks in each of the value, core, and growth styles. Morningstar determines the value and growth scores by using five stock attributes (see Exhibit 33). The current Morningstar Style Box, as shown in Exhibit 32, is a nine-square grid featuring three stock investment styles for each of three size categories: large, mid, and small. Two of the three style categories are “value” and “growth,” common to both stocks and funds. However, the third, central column is labeled “core” for stocks (i.e., those stocks for which neither value nor growth characteristics dominate) and “blend” for funds (meaning that the fund holds a mixture of growth and value stocks).

Exhibit 32 Morningstar Fund Style Classification



Source: Morningstar.

6.1.1.1 Large-Cap, Mid-Cap, and Small-Cap Classifications The size classification is determined by the company’s market capitalization. There is no consensus on what the size thresholds for the different categories should be, and indeed, different data and research providers use different criteria for size classification purposes. Large-cap companies tend to be well-established companies with a strong market presence, good levels of information disclosure, and extensive scrutiny by the investor community and the media. While these attributes may not apply universally across different parts of the world, large-cap companies are recognized as being lower risk than smaller companies and offering more limited future growth potential. Small-cap companies, on the other hand, tend to be less mature companies with potentially greater room for future growth, higher risk of failure, and a lower degree of analyst and public scrutiny.

Mid-cap companies tend to rank between the two other groups on many important parameters, such as size, revenues, employee count, and client base. In general, they are in a more advanced stage of development than small-cap companies but provide greater growth potential than large-cap companies.

There is no consensus on the boundaries that separate large-, mid-, and small-cap companies. One practice is to define large-cap stocks as those that account for the top ~70% of the capitalization of all stocks in the universe, with mid-cap stocks representing the next ~20% and small-cap stocks accounting for the balance.

6.1.1.2 Measuring Growth, Value, and Core Characteristics Equity style analysis starts with assigning a style score to each individual stock. Taking the value/growth style pair as an example, each stock is assigned a value score based on the combination of several value and growth characteristics or factors of that stock. The simplest value scoring model uses one factor, price-to-book ratio, to rank the stock. The bottom half of the stocks in this ranking (smaller P/Bs) constitute the value index, while the stocks ranked in the top half (higher P/Bs) constitute the growth index. Weighting the stocks by their market capitalization thus creates both a value index and a growth index, with the condition that each style index must represent 50% of the market capitalization of all stocks in the target universe. A comprehensive value scoring model may use more factors in addition to price to book, such as price to earnings, price to sales, price to cash flow, return on equity, dividend yield, and so on. The combination of these factors through a predefined process, such as assigning a fixed weight to each selected factor, generates the value score. The value score is usually a number between 0 and 1, corresponding to 0% and 100% contribution to the value index. Depending on the methodologies employed by the vendors, the value score may be a fraction. A security with a value score of 0.6 will have 60% of its market capitalization allocated to the value index and the remaining 40% to the growth index.

Morningstar's Classification Criteria for Value Stocks

For each stock, Morningstar assigns a growth score and a value score, each based on five components that are combined with pre-determined weights, as shown in Exhibit 33.

Exhibit 33 Morningstar Value and Growth Scoring Scheme

Value Score Components and Weights		Growth Score Components and Weights	
Forward-looking measures	**50.0%**	*Forward-looking measures*	**50.0%**
*Price to projected earnings		*Long-term projected earnings growth	
Historical measures	**50.0%**	*Historical measures*	**50.0%**
*Price to book	12.5%	*Historical earnings growth	12.5%
*Price to sales	12.5%	*Sales growth	12.5%
*Price to cash flow	12.5%	*Cash flow growth	12.5%
*Dividend yield	12.5%	*Book value growth	12.5%

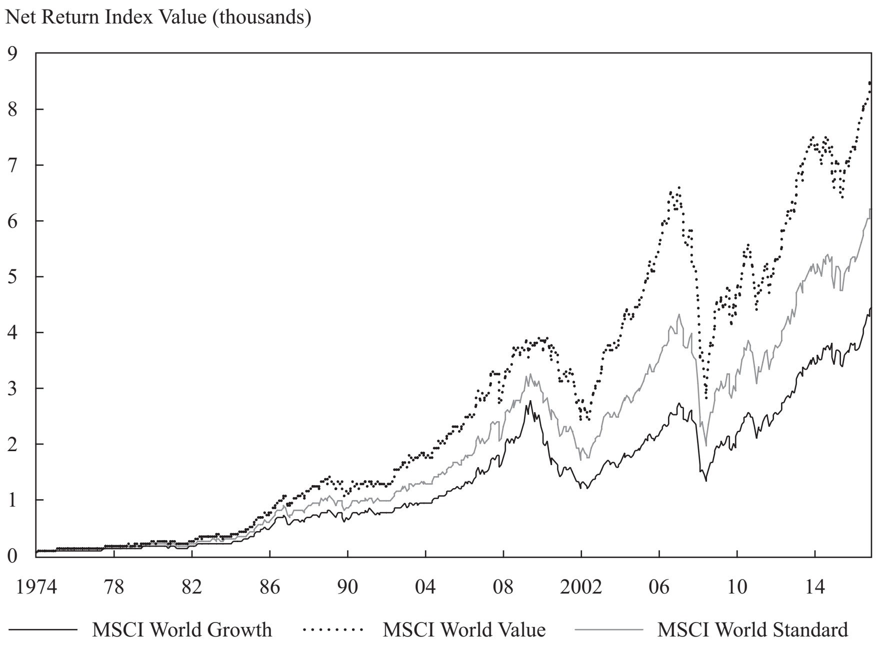
The scores are scaled to a range of 0 to 100, and the difference between the stock's growth and value scores is called the net style score. If this net style score is strongly negative, approaching –100, the stock's style is classified as value. If the result is strongly positive, the stock is classified as growth. If the scores for value and growth are similar in strength, the net style score will be close to zero and the stock will be classified as core. On average, value, core, and growth stocks each account for approximately one-third of the total capitalization in a given row of the Morningstar Style Box.

MSCI World Value and Growth Indexes

MSCI provides a range of indexes that include value and growth. In order to construct those indexes, the firm needs to establish the individual stocks' characteristics. The following (simplified) process is used to establish how much of each stock's market capitalization should be included in the respective indexes.

The value investment style characteristics for index construction are defined using three variables: book-value-to-price ratio, 12-month forward-earnings-to-price ratio, and dividend yield. The growth investment style characteristics for index construction are defined using five variables: long-term forward EPS growth rate, short-term forward EPS growth rate, current internal growth rate, long-term historical EPS growth trend, and long-term historical sales-per-share growth trend. *Z*-scores for each variable are calculated and aggregated for each security to determine the security's overall style characteristics. For example, a stock is assigned a so-called "value inclusion factor" of 0.6, which means that the stock could have both value and growth characteristics and contributes to the performance of the value and growth indexes by 60% and 40%, respectively. Exhibit 34 shows the cumulative return of the MSCI World Value and MSCI World Growth indexes since 1975.

Exhibit 34 Cumulative Return of MSCI World Value and Growth Indexes since 1975



Source: MSCI.

6.1.2 *Returns-Based Style Analysis*

Many investment managers do not disclose the full details of their portfolios, and therefore a holdings-based approach cannot be used to assess their strategies. The investment style of these portfolio managers is therefore analyzed by using a returns-based approach to compare the returns of the employed strategy to those of a set of style indexes.

The objective of a returns-based style analysis is to find the style concentration of underlying holdings by identifying the style indexes that provide significant contributions to fund returns with the help of statistical tools. Such an analysis attributes fund returns to selected investment styles by running a constrained multivariate regression:[28]

$$r_t = \alpha + \sum_{s=1}^{m} \beta^s R_t^s + \varepsilon_t$$

where

r_t = the fund return within the period ending at time t

R_t^s = the return of style index s in the same period

β^s = the fund exposure to style s (with constraints $\sum_{s=1}^{m} \beta^s = 1$ and $\beta^s > 0$ for a long-only portfolio)

α = a constant often interpreted as the value added by the fund manager

ε_t = the residual return that cannot be explained by the styles used in the analysis

The key inputs to a returns-based style analysis are the historical returns for the portfolio and the returns for the style indexes. The critical part, however, is the selection of the styles used, as stock returns can be highly correlated within the same sector, across sectors, and even across global markets. If available, the manager's own description of his or her style is a good starting point for determining the investment styles that can be used.

Commercial investment information providers, such as Thomson Reuters Lipper and Morningstar, perform the role of collecting and analyzing fund data and classifying the funds into style groups.

Data Sources

The success of a returns-based style analysis depends, to some extent, on the choice of style indexes. The component-based style indexes provided by investment information providers enable analysts to identify the style that is closest to the investment strategy employed by the fund manager.

Thomson Reuters Lipper provides mutual and hedge fund data as well as analytical and reporting tools to institutional and retail investors. All funds covered by Lipper are given a classification based on statements in the funds' prospectuses. Funds that are considered "diversified," because they invest across economic sectors and/or countries, also have a portfolio-based classification. Exhibit 35 shows the Lipper fund classifications for US-listed open-end equity funds.

28 Sharpe (1992).

Exhibit 35 Lipper's Style Classification

	OPEN-END EQUITY FUNDS		
	General Domestic Equity	**World Equity**	**Sector Equity**
Prospectus-Based Classifications	**All** prospectus-based classifications in this group are considered diversified.	**Some** prospectus-based classifications in this group are considered diversified (global and international types only).	**No** prospectus-based classifications in this group are considered diversified.
	Capital Appreciation	Gold	Health/Biotech
	Growth	European Region	Natural Resources
	Micro Cap	Pacific Region	Technology
	Mid Cap	Japan	Telecom
	Small Cap	Pacific ex-Japan	Utilities
	Growth & Income	China	Financial Services
	S&P 500	Emerging Markets	Real Estate
	Equity	Latin America	Specialty & Miscellaneous
	Income	Global	
		Global Small Cap	
		International	
		International Small Cap	

(continued)

Exhibit 35 (Continued)

	OPEN-END EQUITY FUNDS		
	General Domestic Equity	**World Equity**	**Sector Equity**
Portfolio-Based Classifications	Large-Cap Growth Large-Cap Core Large-Cap Value Multi-Cap Growth Multi-Cap Core Multi-Cap Value Mid-Cap Growth Mid-Cap Core Mid-Cap Value Small-Cap Growth Small-Cap Core Small-Cap Value S&P 500 Equity Income	Global Large-Cap Growth Global Large-Cap Core Global Large-Cap Value Global Multi-Cap Growth Global Multi-Cap Core Global Multi-Cap Value Global Small-/Mid-Cap Growth Global Small-/Mid-Cap Core Global Small-/Mid-Cap Value International Large-Cap Growth International Large-Cap Core International Large-Cap Value International Multi-Cap Growth International Multi-Cap Core International Multi-Cap Value International Small-/Mid-Cap Growth International Small-/Mid-Cap Core International Small-/Mid-Cap Value	

Source: Thomson Reuters Lipper.

6.1.3 *Manager Self-Identification*

Equity strategy investment styles result from the active equity manager's employment of a particular strategy to manage the fund. The fund's investment strategy is usually described in the fund prospectus and can be used to identify the fund's investment objective. This objective can be regarded as the manager's self-identification of the investment style.

Returns-based or holdings-based style analysis is commonly used to identify the investment style—such as value/growth or large cap/small cap—and to determine whether it corresponds to the manager's self-identified style. Some other styles, however, cannot be easily identified by such methods. For example, the styles of equity hedge funds, equity income funds, and special sector funds can be more efficiently identified using a combination of manager self-identification and holdings- or returns-based analysis.

Some equity hedge fund styles are non-standard and do not fit into any of the established style categories. Examples include long/short equity, equity market neutral, and dedicated short bias. For such funds, the investment objective is often laid out in the prospectus, which explains the fund's investment strategy. The prospectus becomes the key source of information for those assigning styles to such funds.

6.2 Strengths and Limitations of Style Analysis

Holdings-based style analysis is generally more accurate than returns-based analysis because it uses the actual portfolio holdings. Portfolio managers (and those who assess their strategies and performance) can see how each portfolio holding contributes to the portfolio's style, verify that the style is in line with the stated investment philosophy, and take action if they wish to prevent the portfolio's style from moving away from its intended target. Unlike returns-based style analysis, holdings-based style analysis is able to show the styles that any portfolio is exposed to, thus providing input for style allocation decisions.

Holdings-based style analysis requires the availability of all the portfolio constituents as well as the style attributes of each stock in the portfolio. While this information may be accessible for current portfolios, an analyst who wants to track the historical change in investment styles may face some difficulty. In this case, point-in-time databases are required for both the constituents of the fund and the stocks' style definitions.

As investment style research uses statistical and empirical methods to arrive at conclusions, it can produce inaccurate results due to limitations of the data or flaws in the application design. Kaplan (2011) argued that most returns-based style analysis models impose unnecessary constraints that limit the results within certain boundaries, making it difficult to detect more aggressive positions, such as deep value or micro cap. Furthermore, the limited availability of data on derivatives often makes holdings-based style analysis less effective for funds with substantial positions in derivatives. It is therefore important to understand the strengths and limitations of style analysis models in order to interpret the results correctly. Morningstar studies have concluded that holdings-based style analysis generally produces more accurate results than returns-based style analysis, although there may be exceptions. Ideally, practitioners should use both approaches: Returns-based models can often be more widely applied, while holdings-based models allow deeper style analysis.

Variation of Fund Characteristics within a Style Classification

Consider the Morningstar Style Box, in which funds are classified along two dimensions: value/growth and size (market capitalization). Within the same value style box, funds can be classified as large cap or small cap. To keep the classification map simple and concise, Morningstar omits other styles and characteristics, such as performance volatility and sector or market/region exposure. It is important to note that style classification provides only a reference to the key investment styles that may contribute to performance. The funds within the same style classification can be quite different in other characteristics, which may also contribute to fund returns and lead to differences in performance.

EXAMPLE 10

Equity Investment Styles

Consider an actively managed equity fund that has a five-year track record. An analyst performed both holdings-based and returns-based style analysis on the portfolio. She used the current portfolio holdings to perform the holdings-based style analysis and five-year historical monthly returns to carry out the returns-based analysis. The analyst found the following:

- Holdings-based style analysis on the current portfolio shows that the fund has value and growth exposures of 0.85 and 0.15, respectively.
- Returns-based style analysis with 60 months' historical returns shows that the value and growth exposures of the fund are equal to 0.4 and 0.6, respectively.

Explain possible reason(s) for the inconsistency between the holdings-based and returns-based style analyses.

Solution:

Some active equity managers may maintain one investment style over time in the belief that that particular style will outperform the general market. Others may rotate or switch between styles to accommodate the then-prevailing investment thesis. Returns-based style analysis regresses the portfolio's historical returns against the returns of the corresponding style indexes (over 60 months in this example). Its output indicates the average effect of investment styles employed during the period. While the holdings-based analysis suggests that the current investment style of the equity fund is value oriented, the returns-based analysis indicates that the style actually employed was likely in the growth category for a period of time within the past five years.

SUMMARY

This reading discusses the different approaches to active equity management and describes how the various strategies are created. It also addresses the style classification of active approaches.

- Active equity management approaches can be generally divided into two groups: fundamental (also referred to as discretionary) and quantitative (also known as systematic or rules-based). Fundamental approaches stress the use of human judgment in arriving at an investment decision, whereas quantitative approaches stress the use of rules-based, quantitative models to arrive at a decision.

- The main differences between fundamental and quantitative approaches include the following characteristics: approach to the decision-making process (subjective versus objective); forecast focus (stock returns versus factor returns); information used (research versus data); focus of the analysis (depth versus breadth); orientation to the data (forward looking versus backward looking); and approach to portfolio risk (emphasis on judgment versus emphasis on optimization techniques).
- The main types of active management strategies include bottom-up, top-down, factor-based, and activist.
- Bottom-up strategies begin at the company level, and use company and industry analyses to assess the intrinsic value of the company and determine whether the stock is undervalued or overvalued relative to its market price.
- Fundamental managers often focus on one or more of the following company and industry characteristics: business model and branding, competitive advantages, and management and corporate governance.
- Bottom-up strategies are often divided into value-based approaches and growth-based approaches.
- Top-down strategies focus on the macroeconomic environment, demographic trends, and government policies to arrive at investment decisions.
- Top-down strategies are used in several investment decision processes, including the following: country and geographic allocation, sector and industry rotation, equity style rotation, volatility-based strategies, and thematic investment strategies.
- Quantitative equity investment strategies often use factor-based models. A factor-based strategy aims to identify significant factors that drive stock prices and to construct a portfolio with a positive bias towards such factors.
- Factors can be grouped based on fundamental characteristics—such as value, growth, and price momentum—or on unconventional data.
- Activist investors specialize in taking meaningful stakes in listed companies and influencing those companies to make changes to their management, strategy, or capital structures for the purpose of increasing the stock's value and realizing a gain on their investment.
- Statistical arbitrage (or "stat arb") strategies use statistical and technical analysis to exploit pricing anomalies and achieve superior returns. Pairs trading is an example of a popular and simple statistical arbitrage strategy.
- Event-driven strategies exploit market inefficiencies that may occur around corporate events such as mergers and acquisitions, earnings announcements, bankruptcies, share buybacks, special dividends, and spinoffs.
- The fundamental active investment process includes the following steps: define the investment universe; prescreen the universe; understand the industry and business; forecast the company's financial performance; convert forecasts into a target price; construct the portfolio with the desired risk profile; and rebalance the portfolio according to a buy and sell discipline.
- Pitfalls in fundamental investing include behavioral biases, the value trap, and the growth trap.
- Behavioral biases can be divided into two groups: cognitive errors and emotional biases. Typical biases that are relevant to active equity management include confirmation bias, illusion of control, availability bias, loss aversion, overconfidence, and regret aversion.

- The quantitative active investment process includes the following steps: define the investment thesis; acquire, clean, and process the data; backtest the strategy; evaluate the strategy; and construct an efficient portfolio using risk and trading cost models.
- The pitfalls in quantitative investing include look-ahead and survivorship biases, overfitting, data mining, unrealistic turnover assumptions, transaction costs, and short availability.
- An investment style generally splits the stock universe into two or three groups, such that each group contains stocks with similar characteristics. The common style characteristics used in active management include value, size, price momentum, volatility, high dividend, and earnings quality. A stock's membership in an industry, sector, or country group is also used to classify the investment style.
- Two main approaches are often used in style analysis: a returns-based approach and a holdings-based approach. Holdings-based approaches aggregate the style scores of individual holdings, while returns-based approaches analyze the investment style of portfolio managers by comparing the returns of the strategy to those of a set of style indexes.

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PRACTICE PROBLEMS

The following information relates to questions 1–6

James Leonard is a fund-of-funds manager with Future Generation, a large sovereign fund. He is considering whether to pursue more in-depth due diligence processes with three large-cap long-only funds proposed by his analysts. Although the funds emphasize different financial metrics and use different implementation methodologies, they operate in the same market segment and are evaluated against the same benchmark. The analysts prepared a short description of each fund, presented in Exhibit 1.

Exhibit 1 Description of Each Candidate Fund

Fund	Description
Furlings	Furlings Investment Partners combines sector views and security selection. The firm's head manager uses several industry and economic indicators identified from his own experience during the last two decades, as well as his personal views on market flow dynamics, to determine how to position the fund on a sector basis. Sector deviations from the benchmark of 10% or more are common and are usually maintained for 12 to 24 months. At the same time, sector managers at Furlings use their expertise in dissecting financial statements and their understanding of the corporate branding and competitive landscape within sectors to build equally weighted baskets of securities within sectors. Each basket contains their 7 to 10 highest-conviction securities, favoring firms that have good governance, strong growth potential, competitive advantages such as branding, and attractive relative valuations. The Furlings master fund holds approximately 90 securities.
Asgard	Asgard Investment Partners is a very large asset manager. It believes in investing in firms that have a strong business model and governance, reasonable valuations, solid capital structures with limited financial leverage, and above-average expected earnings growth for the next three years. Although the Asgard master fund invests in fewer than 125 securities, each sector analyst builds financial models that track as many as 50 firms. To support them in their task, analysts benefit from software developed by the Asgard research and technology group that provides access to detailed market and accounting information on 5,000 global firms, allowing for the calculation of many valuation and growth metrics and precise modeling of sources of cash-flow strengths and weaknesses within each business. Asgard analysts can also use the application to back-test strategies and build their own models to rank securities' attractiveness according to their preferred characteristics. Security allocation is determined by a management team but depends heavily on a quantitative risk model developed by Asgard. Asgard has a low portfolio turnover.
Tokra	Tokra Capital uses a factor-based strategy to rank securities from most attractive to least attractive. Each security is scored based on three metrics: price to book value (P/B), 12-month increase in stock price, and return on assets. Tokra's managers have a strong risk management background. Their objective is to maximize their exposure to the most attractive securities using a total scoring approach subject to limiting single-security concentration below 2%, sector deviations below 3%, active risk below 4%, and annual turnover less than 40%, while having a market beta close to 1. The master fund holds approximately 400 positions out of a possible universe of more than 2,000 securities evaluated.

When Leonard's analysts met with Asgard, they inquired whether its managers engage in activist investing because Asgard's portfolio frequently holds significant positions, because of their large asset size, and because of their emphasis on strong governance and their ability to model sources of cash-flow strengths and weaknesses within each business. The manager indicated that Asgard engages with companies from a long-term shareholder's perspective, which is consistent with the firm's low portfolio turnover, and uses its voice, and its vote, on matters that can influence companies' long-term value.

Leonard wants to confirm that each manager's portfolios are consistent with its declared style. To this end, Exhibit 2 presents key financial information associated with each manager's portfolio and also with the index that all three managers use.

Exhibit 2 Key Financial Data

Fund	Index	Furlings	Asgard	Tokra
Dividend/price (trailing 12-month)	2.3%	2.2%	2.2%	2.6%
P/E (trailing 12-month)	26.5	24.7	26.6	27.3
Price/cash flows (12-month forward)	12.5	13.8	12.5	11.6
P/B	4.8	4.30	4.35	5.4
Average EPS growth (three to five years forward)	11.9%	11.0%	13.1%	10.8%
Net income/assets	2.8%	4.5%	4.3%	3.2%
Average price momentum (trailing 12 months)	10.5%	14.0%	10.0%	12.0%

1 Which fund manager's investing approach is most consistent with fundamental management?

A Furlings

B Asgard

C Tokra

2 Which of the following statements about the approaches and styles of either Furlings, Asgard, or Tokra is incorrect?

A Furlings is a top-down sector rotator with a value orientation within sectors.

B Asgard is a bottom-up manager with a GARP (growth at a reasonable price) style.

C Tokra is a factor-based manager using value, growth, and profitability metrics.

3 Which manager is most likely to get caught in a value trap?

A Furlings

B Asgard

C Tokra

4 Which activist investing tactic is Asgard *least likely* to use?

A Engaging with management by writing letters to management, calling for and explaining suggested changes, and participating in management discussions with analysts or meeting the management team privately

B Launching legal proceedings against existing management for breach of fiduciary duties

C Proposing restructuring of the balance sheet to better utilize capital and potentially initiate share buybacks or increase dividends

5 Based on the information provided in Exhibits 1 and 2, which manager's portfolio characteristics is most likely at odds with its declared style?

A Furlings

B Asgard

C Tokra

6 Leonard is looking at the style classification from Asgard as reported by Morningstar and Thomson Reuters Lipper. He is surprised to find that Asgard is classified as a blend fund by Morningstar and a value fund by Lipper. Which of the following statements is correct?

A Although the Morningstar methodology classifies securities as either value, growth, or core, the Lipper methodology assumes a stock can have the characteristics of many styles. This approach can result in a different classification for the same portfolio.

B The Lipper methodology can only lead to a value or growth classification. It does not offer a core/blend component.

C The Morningstar methodology classifies securities as either value, growth, or core by looking at the difference between their respective growth and value scores. It is possible that the Asgard funds hold a balanced exposure to both value and growth and/or core stocks.

The following information relates to questions 7–14

Aleksy Nowacki is a new portfolio manager at Heydon Investments. The firm currently offers a single equity fund, which uses a top-down investment strategy based on fundamentals. Vicky Knight, a junior analyst at Heydon, assists with managing the fund.

Nowacki has been hired to start a second fund, the Heydon Quant Fund, which will use quantitative active equity strategies. Nowacki and Knight meet to discuss distinct characteristics of the quantitative approach to active management, and Knight suggests three such characteristics:

Characteristic 1	The focus is on factors across a potentially large group of stocks.
Characteristic 2	The decision-making process is systematic and non-discretionary.
Characteristic 3	The approach places an emphasis on forecasting the future prospects of underlying companies.

Nowacki states that quantitative investing generally follows a structured and well-defined process. Knight asks Nowacki:

"What is the starting point for the quantitative investment process?"

The new Heydon Quant Fund will use a factor-based strategy. Nowacki assembles a large dataset with monthly standardized scores and monthly returns for the strategy to back-test a new investment strategy and calculates the information coefficient. $FS(t)$ is the factor score for the current month, and $FS(t + 1)$ is the score for the next month. $SR(t)$ is the strategy's holding period return for the current month, and $SR(t + 1)$ is the strategy's holding period return for the next month.

As an additional step in back-testing of the strategy, Nowacki computes historical price/book ratios (P/Bs) and price/earnings ratios (P/Es) using calendar year-end (31 December) stock prices and companies' financial statement data for the same calendar year. He notes that the financial statement data for a given calendar year are not typically published until weeks after the end of that year.

Because the Heydon Quant Fund occasionally performs pairs trading using statistical arbitrage, Nowacki creates three examples of pairs trading candidates, presented in Exhibit 1. Nowacki asks Knight to recommend a suitable pair trade.

Exhibit 1 Possible Pairs Trades Based on Statistical Arbitrage

Stock Pair	Current Price Ratio Compared with Long-Term Average	Historical Price Ratio Relationship	Historical Correlation between Returns
1 and 2	Not significantly different	Mean reverting	High
3 and 4	Significantly different	Mean reverting	High
5 and 6	Significantly different	Not mean reverting	Low

Knight foresees a possible scenario in which the investment universe for the Heydon Quant Fund is unchanged but a new factor is added to its multifactor model. Knight asks Nowacki whether this scenario could affect the fund's investment-style classifications using either the returns-based or holdings-based approaches.

7 Which of the following asset allocation methods would **not** likely be used by Nowacki and Knight to select investments for the existing equity fund?

A Sector and industry rotation

B Growth at a reasonable price

C Country and geographic allocation

8 Relative to Heydon's existing fund, the new fund will *most likely*:

A hold a smaller number of stocks.

B rebalance at more regular intervals.

C see risk at the company level rather than the portfolio level.

9 Which characteristic suggested by Knight to describe the quantitative approach to active management is *incorrect*?

A Characteristic 1

B Characteristic 2

C Characteristic 3

10 Nowacki's *most appropriate* response to Knight's question about the quantitative investment process is to:

A back-test the new strategy.

B define the market opportunity.

C identify the factors to include and their weights.

11 In Nowacki's back-testing of the factor-based strategy for the new fund, the calculated information coefficient should be based on:

A $FS(t)$ and $SR(t)$.

B $FS(t)$ and $SR(t + 1)$.

C $SR(t)$ and $FS(t + 1)$.

12 Nowacki's calculated price/book ratios (P/Bs) and price/earnings ratios (P/Es), in his back-testing of the new strategy, are a problem because of:

A data mining.

B look-ahead bias.

C survivorship bias.

13 Based on Exhibit 1, which stock pair should Knight recommend as the best candidate for statistical arbitrage?

A Stock 1 and Stock 2

B Stock 3 and Stock 4

C Stock 5 and Stock 6

14 The *most appropriate* response to Knight's question regarding the potential future scenario for the Heydon Quant Fund is:

A only the returns-based approach.

B only the holdings-based approach.

C both the returns-based approach and the holdings-based approach.

The following information relates to questions 15–19

Jack Dewey is managing partner of DC&H, an investment management firm, and Supriya Sardar is an equity analyst with the firm. Dewey recently took over management of the firm's Purity Fund. He is developing a fundamental active investment process for managing this fund that emphasizes financial strength and demonstrated profitability of portfolio companies. At his previous employer, Dewey managed a fund for which his investment process involved taking active exposures in sectors based on the macroeconomic environment and demographic trends.

Dewey and Sardar meet to discuss developing a fundamental active investment process for the Purity Fund. They start by defining the investment universe and market opportunity for the fund, and then they pre-screen the universe to obtain a manageable set of securities for further, more detailed analysis. Next, Dewey notes that industry and competitive analysis of the list of securities must be performed. He then asks Sardar to recommend the next step in development of the fundamental active management process.

During the next few months, Dewey rebalances the Purity Fund to reflect his fundamental active investment process. Dewey and Sardar meet again to discuss potential new investment opportunities for the fund. Sardar recommends the purchase of AZ Industrial, which she believes is trading below its intrinsic value, despite its high price-to-book value (P/B) relative to the industry average.

Dewey asks Sardar to perform a bottom-up style analysis of the Purity Fund based on the aggregation of attributes from individual stocks in the portfolio. Dewey plans to include the results of this style analysis in a profile he is preparing for the fund.

15 In managing the fund at his previous employer, Dewey's investment process can be *best* described as:

A an activist strategy.

B a top-down strategy.

C a bottom-up strategy.

16 Sardar's recommendation for the next step should be to:

A review results from back-testing the strategy.

B make recommendations for rebalancing the portfolio.

C forecast companies' performances and convert those forecasts into valuations.

17 Based upon Dewey's chosen investment process for the management of the Purity Fund, rebalancing of the fund will *most likely* occur:

A at regular intervals.

B in response to changes in company-specific information.

C in response to updated output from optimization models.

18 Which investment approach is the *most likely* basis for Sardar's buy recommendation for AZ Industrial?

A Relative value

B High-quality value

C Deep-value investing

19 The analysis performed by Sardar on the Purity Fund can be *best* described as being based on:

A a holdings-based approach.

B manager self-identification.

C a returns-based style analysis.

SOLUTIONS

1 A is correct. Furlings combines a top-down and bottom-up approach, but in both cases, the allocation process is significantly determined according to the managers' discretion and judgement. There is a strong emphasis on understanding financial reporting, and the sector managers focus on a relatively small number for firms. They also extend their analysis to other areas associated with fundamental management, such as valuation, competitive advantages, and governance. Finally, Furlings's top-down process depends largely on the views and experience of its head manager.

B is incorrect. Asgard has many of the attributes associated with a fundamental manager. It invests in a relatively small number of securities and focuses on the companies' business model, valuations, and future growth prospects. Because of the scope of the securities coverage by each manager, however, Asgard depends heavily on technology and tools to support screening and ranking of securities attractiveness. Each manager can use his judgement to build his own quantitative models. Furthermore, the allocation process, although overlaid by a management team, also depends heavily on technology. Asgard has characteristics of both fundamental and quantitative managers.

C is incorrect. Tokra exhibits the characteristics of a quantitative manager. The firm uses quantitative metrics to rank securities based on valuation, profitability, and momentum criteria and uses portfolio optimization to determine the final allocation. Tokra holds many positions typical of quantitative approaches.

2 C is an incorrect statement. Although Tokra is a factor manager, and although it uses a value proxy such as P/B and a profitability proxy such as return on assets, it does not use a growth proxy such as earnings growth over the last 12 or 36 months but rather a price momentum proxy.

A is a correct statement. Furlings is a top-down manager. It makes significant sector bets based on industry and economic indicators derived from the head manager's experience, and it does select its securities within sectors while considering relative valuation.

B is a correct statement. Asgard favors securities that have reasonable valuations and above-average growth prospects. It has a bottom-up approach and builds its portfolio starting at the security level.

3 C is the correct answer. A value trap occurs when a stock that appears to have an attractive valuation because of a low P/E and/or P/B multiple (or other relevant value proxies) appears cheap only because of its worsening growth prospects. Although a pitfall such as value trap is more common in fundamental investing, a quantitative process that relies on historical information and does not integrate future expectations about cash flows or profitability may be unable to detect a value trap.

A is an incorrect answer. Although Furlings is a top-down manager, its sector portfolios are built through investing in a small number of high-conviction securities after its analysts have dissected the financial statements and analyzed the competitive landscape and growth prospects. Managers at Furlings are more likely than managers at Tokra to be aware of the significant deteriorating prospects of a security they are considering for investment.

B is an incorrect answer. One of Asgard's investment criteria is identifying firms that have good potential cash flow growth over the next three years. The firm has access to database and support tools, allowing its analysts to evaluate many potential growth metrics. Managers at Asgard are more likely than managers at Tokra to be aware of the significant deteriorating prospects of a security they are considering for investment.

4 B is the correct answer. Asgard invests in firms that have strong business models and good governance. Also, it approaches investing as a long-term investor looking to use its voice to improve the company's asset management. Asgard is unlikely to use an aggressive posturing or to invest or stay invested in companies with weak governance or where managers may be in breach of fiduciary duties.

A is an incorrect answer. Engaging in positive conversations with management of companies with which Asgard has invested reflects a use of its voice to improve these companies' long-term value.

C is an incorrect answer. Because Asgard is strong at modeling sources of cash flows and is known for investing in companies with a strong capital structure, it would be consistent for Asgard to propose ways to optimize the capital structure and shareholders' compensation.

5 C is the correct answer. Tokra indicates that it emphasizes three metrics: P/B, 12-month price momentum, and return on assets. Although the portfolio consists of securities that have stronger momentum than those of the index on average, and although the ratio of net income to assets is also favorable, the average P/B is somehow higher than that of the index. Although this scenario could normally be explained by an emphasis on specific sectors with a higher P/B than other sectors, the low level of sector deviation tolerated within the strategy weakens that explanation. This should be explored with Tokra's managers.

A is an incorrect answer. Furlings is a top-down sector rotator with a value orientation within sectors. The lower P/B and P/E and higher net income over assets are consistent with a relative value orientation. Because Furlings can take significant positions in specific sectors, however, there could be other circumstances in which the portfolio would have a higher P/B and/or P/E and or a lower net income /assets than the index if the fund were to emphasize sectors having such characteristics. Yet, this would not necessarily imply that the firm does not favor the most attractive relative valuations within sectors.

B is an incorrect answer. Asgard invests in firms that offer reasonable valuations and above-average expected cash flow growth during the next three years. The data, such as P/B and average expected three-year profit growth, are consistent with its declared style. Again, it is not necessarily inconsistent to emphasize these aspects while investing in a portfolio that has a lower dividend yield, slightly higher P/E, and lower price momentum.

6 C is a correct answer. Morningstar calculates a score for value and growth on a scale of 0 to 100 using five proxy measures for each. The value score is subtracted from the growth score. A strongly positive net score leads to a growth classification, and a strongly negative score leads to a value classification. A score relatively close to zero indicates a core classification. To achieve a blend classification, the portfolio must have a balanced exposure to stocks classified as value and growth, a dominant exposure to stocks classified as core, or a combination of both.

A is an incorrect answer. Both Morningstar and Lipper classify individual stocks in a specific style category. Neither assumes a security can belong to several styles in specific proportion.

B is an incorrect answer. The Lipper methodology does have a core classification. It sums the Z-score of six portfolio characteristics over several years to determine an overall Z-score that determines either a value, core, or growth classification.

7 B is correct. The firm currently offers a single equity fund, which uses a top-down investment strategy. Country and geographic allocation and sector and industry rotation are both top-down strategies that begin at the top or macro level and are consistent with the fund's top-down investment strategy. Growth at a reasonable price (GARP), however—a growth-based approach—is a bottom-up asset selection strategy that begins with data at the company level. Therefore, Nowacki and Knight likely would not use the GARP approach to select investments for the existing equity fund, which uses a top-down investment strategy. A is incorrect because sector and industry rotation is a top-down strategy, consistent with the fund's top-down approach. C is incorrect because country and geography selection is a top-down strategy, consistent with the fund's top-down approach.

8 B is correct. Portfolios managed using a quantitative approach are usually rebalanced at regular intervals, such as monthly or quarterly. In contrast, portfolios managed using a fundamental approach usually monitor the portfolio's holdings continuously and may increase, decrease, or eliminate positions at any time.

Also, the focus of a quantitative approach is on factors across a potentially large group of stocks, whereas fundamental strategies focus on a relatively small group of stocks. Consequently, Heydon's new quantitative fund will likely hold a larger number of stocks than the existing equity fund.

Finally, managers following a fundamental approach typically select stocks by performing extensive research on individual companies; thus, fundamental investors see risk at the company level. In contrast, with a quantitative approach, the risk is that factor returns will not perform as expected. Because the quantitative approach invests in baskets of stocks, the risks lie at the portfolio level rather than at the level of specific stocks (company level). Consequently, Nowacki's new quantitative fund will likely see risk at the portfolio level, rather than the company level as the existing equity fund does.

9 C is correct. Quantitative analysis uses a company's history to arrive at investment decisions. The quantitative decision-making process is systematic and non-discretionary (whereas the fundamental decision-making process is more discretionary), and the focus of the quantitative approach is on factors across a potentially large group of stocks (whereas fundamental strategies focus on a relatively small group of stocks). In contrast, fundamental analysis (not quantitative analysis) emphasizes forecasting future prospects, including the future earnings and cash flows of a company.

10 B is correct. The first step in creating a quantitative, active strategy is to define the market opportunity or investment thesis. Then, relevant data is acquired, processed, and transformed into a usable format. This step is followed by back-testing the strategy, which involves identifying the factors to include as well as their weights. Finally, the strategy performance should be evaluated using an out-of-sample back-test.

11 B is correct. The purpose of back-testing is to identify correlations between the current period's factor scores, $FS(t)$, and the next period's holding period strategy returns, $SR(t + 1)$.

12 B is correct. Look-ahead bias results from using information that was unknown or unavailable at the time the investment decision was made. An example of this bias is using financial accounting data for a company at a point before the data were actually released by the company. Nowacki computed historical P/Bs and P/Es using calendar year-end (31 December) stock prices and companies' financial statement data for the same calendar year, even though the financial statement data for that calendar year were likely unavailable at year-end.

Data mining refers to automated computational procedures for discovering patterns in large datasets, which can introduce a bias known as overfitting. Survivorship bias occurs when back-testing uses companies that are in business today but ignores companies that have left the investment universe.

13 B is correct. Knight should recommend the Stock 3 and Stock 4 pair trade. Two stocks make for an ideal pairs trade if (1) the current price ratio differs from its long-term average and shows historical mean reversion and (2) the two stocks' returns are highly correlated. The relationship between Stock 3 and Stock 4 meets these conditions.

14 C is correct. Because the Heydon Quant Fund would be changing its factor model by adding a new factor, the correlations of the fund's returns with the factors would likely change and the returns-based style would change. Even though the investment universe is unchanged, the portfolio holdings would likely change and the holdings-based style classification would also will be affected.

15 B is correct. At his previous firm, Dewey managed a fund for which his investment process involved taking active exposures in sectors based on the macroeconomic environment and demographic trends. An investment process that begins at a top, or macro level, is a top-down strategy. Top-down portfolio strategies study variables affecting many companies or whole sectors, such as the macroeconomic environment, demographic trends, and government policies. This approach differs from bottom-up strategies, which focus on individual company variables in making investment decisions. It also differs from activist strategies, which take stakes in listed companies and advocate changes for the purpose of producing a gain on the investment.

16 C is correct. The steps to developing a fundamental active investment process are as follows:

1. Define the investment universe and the market opportunity—the perceived opportunity to earn a positive risk-adjusted return to active investing, net of costs—in accordance with the investment mandate. The market opportunity is also known as the investment thesis.
2. Prescreen the investment universe to obtain a manageable set of securities for further, more detailed analysis.
3. Understand the industry and business for this screened set by performing industry and competitive analysis and analyzing financial reports.
4. Forecast company performance, most commonly in terms of cash flows or earnings.
5. Convert forecasts to valuations and identify *ex ante* profitable investments.
6. Construct a portfolio of these investments with the desired risk profile.
7. Rebalance the portfolio with buy and sell disciplines.

So, Sardar should recommend that the next step in the development of the fundamental active management process be forecasting companies' performances and converting those forecasts into valuations.

17 B is correct. Managers using an active fundamental investment process, like Dewey's, usually monitor the portfolio's holdings continuously and may rebalance at any time. In contrast, portfolios using a quantitative approach are usually rebalanced at regular intervals, such as monthly or quarterly, or in response to updated output from optimization models. A is incorrect because portfolios using a quantitative (not fundamental) active approach are usually rebalanced at regular intervals, such as monthly or quarterly. C is incorrect because construction of a quantitative portfolio (not a fundamental portfolio) typically involves using a portfolio optimizer, which controls for risk at the portfolio level in arriving at individual stock weights and leads to rebalancing decisions.

18 B is correct. Dewey has developed a fundamental active investment process for the Purity Fund that emphasizes financial strength and demonstrated profitability. High-quality value investors focus on companies' intrinsic values that are supported by attractive valuation metrics, with an emphasis on financial strength and demonstrated profitability. In their view, investors sometimes behave irrationally, making stocks trade at prices very different from intrinsic value based on company fundamentals. A is incorrect because investors who pursue a relative value strategy evaluate companies by comparing their value indicators (e.g., P/E or P/B multiples) with the average valuation of companies in the same industry sector, in an effort to identify stocks that offer value relative to their sector peers. AZ Industrial is trading at a high P/B relative to the industry average, which is contrary to relative value and suggests that the relative value approach was not the basis for Sardar's buy recommendation. C is incorrect because a deep-value investing approach focuses on undervalued companies that are available at extremely low valuation relative to their assets. Such companies are often those in financial distress, which is not reflective of financial strength or demonstrated profitability. Therefore, Sardar's buy recommendation was not based on a deep-value investing orientation.

19 A is correct. Dewey asks Sardar to perform a bottom-up style analysis of the Purity Fund based on the aggregation of attributes from individual stocks in the portfolio, which describes a holdings-based approach to style analysis. The overall equity investment style is an aggregation of attributes from individual stocks in the portfolio, weighted by their positions.

READING

25

Active Equity Investing: Portfolio Construction

by Jacques Lussier, PhD, CFA, and Marc R. Reinganum, PhD

Jacques Lussier, PhD, CFA (Canada). Marc R. Reinganum, PhD (USA).

LEARNING OUTCOMES

Mastery	*The candidate should be able to:*
☐	**a.** describe elements of a manager's investment philosophy that influence the portfolio construction process;
☐	**b.** discuss approaches for constructing actively managed equity portfolios;
☐	**c.** distinguish between Active Share and active risk and discuss how each measure relates to a manager's investment strategy;
☐	**d.** discuss the application of risk budgeting concepts in portfolio construction;
☐	**e.** discuss risk measures that are incorporated in equity portfolio construction and describe how limits set on these measures affect portfolio construction;
☐	**f.** discuss how assets under management, position size, market liquidity, and portfolio turnover affect equity portfolio construction decisions;
☐	**g.** evaluate the efficiency of a portfolio structure given its investment mandate;
☐	**h.** discuss the long-only, long extension, long/short, and equitized market-neutral approaches to equity portfolio construction, including their risks, costs, and effects on potential alphas.

INTRODUCTION

1

Active equity investing is based on the concept that a skilled portfolio manager can both identify and differentiate between the most attractive securities and the least attractive securities—typically relative to a pre-specified benchmark. If this is the case, why is a portfolio—a collection of securities—even necessary? Why shouldn't the portfolio manager just identify the most attractive security and invest all assets in this one security? Or in a long/short context, why not buy the "best" security and sell the "worst" one? Although very simple, this one-stock approach is not likely to be optimal or even feasible. No manager has perfect foresight, and his predictions will likely differ from realized returns. What he predicted would be the "best security" may quite likely turn out *not* to be the best. Active equity portfolio managers, even those with great skill, cannot avoid this risk. Security analysis is the process for ranking the relative attractiveness of securities, whereas portfolio construction is about selecting the securities to be included and carefully determining what percentage of the portfolio is to be held in each security—balancing superior insights regarding predicted returns against some likelihood that these insights will be derailed by events unknown or simply prove to be inaccurate.

Active managers rely on a wide array of investment strategies and methodologies to build portfolios of securities that they expect to outperform the benchmark. The challenges faced by active managers are similar whether they manage long-only traditional strategies, systematic/quantitative strategies, or long/short opportunistic strategies. Managers may differ in their investment style, operational complexity, flexibility of investment policy, ability to use leverage and short positions, and implementation methodologies, but predictions about returns and risk are essential to most active equity management styles.

In Section 2, we introduce the "building blocks" of portfolio construction, and in Section 3, we discuss the different approaches to portfolio construction. In Sections 4 and 5, we discuss risk budgeting concepts relevant to portfolio construction and the measures used to evaluate portfolio risk. Section 6 looks at how issues of scale may affect portfolio construction. Section 7 addresses the attributes of a well-constructed portfolio. Section 8 looks at certain specialized equity strategies and how their approaches to portfolio construction may differ from a long-only equity strategy. The reading concludes with a summary.

2 BUILDING BLOCKS OF ACTIVE EQUITY PORTFOLIO CONSTRUCTION

Investors who pursue active management are looking to generate portfolio returns in excess of benchmark returns (adjusted for all costs) for an appropriate level of risk. The excess return—also called **active return** (R_A)—of an actively managed portfolio is driven by the difference in weights between the active portfolio and the benchmark. It can be mathematically expressed as

$$R_A = \sum_{i=1}^{N} \Delta W_i R_i \tag{1}$$

where

R_i = the return on security i and

ΔW_i = the difference between the portfolio weights W_{Pi} and the benchmark weights W_{Bi}. ΔW_i is also referred to as the active weight.

An active manager will generate positive active returns if:

The gains generated by		The losses generated by
■ overweighting the securities that outperform the benchmark and ■ underweighting the securities that underperform the benchmark.	are, on average, >	■ underweighting the securities that outperform the benchmark and ■ overweighting the securities that underperform the benchmark.

2.1 Fundamentals of Portfolio Construction

Conceptually, a manager can generate active returns by

- strategically adjusting the active weights of the securities to create long-term exposures to rewarded risks that are different from those of his benchmark;
- tactically adjusting the active weights of the securities using his skills/expertise in identifying mispricing in securities, sectors, rewarded risks, and so on, to generate alpha that cannot be explained by long-term exposure to rewarded risks; and
- assuming excessive idiosyncratic risk that may result in lucky or unlucky returns.

Historically, any excess return over the benchmark was often termed "alpha." More sophisticated investors then moved to evaluating managers on the basis of excess *risk-adjusted* returns, where risk was assessed relative to a cap-weighted index. The information ratio became an important measure of the manager's value-added. Today, research supports the argument that much of what was historically viewed as alpha is, in fact, "alternative beta"—exposure to rewarded risks (often referred to as "priced factors" or "rewarded factors") that can be obtained at much lower cost.[1] In this reading, we use "rewarded factors" as a generic term that refers specifically to investment risks for which investors expect to be compensated through a long-run return premium, such as exposure to market risk and liquidity risk. The existence of numerous rewarded factors is well documented in the literature and supported by strong empirical evidence. The recognition of this phenomenon is fundamentally altering the investment management industry, with large asset owners negotiating fee structures that compensate active managers for returns above and beyond those that can be generated by simple exposure to rewarded factors.[2]

These three sources of active return remain the same whether a manager follows a fundamental/discretionary or quantitative/systematic approach, a bottom-up or top-down strategy, or a style such as value or growth at a reasonable price. Of course, the proportion of return sourced from exposure to rewarded factors, alpha, and luck will vary among managers and portfolio management approaches. Equation 2 expresses the decomposition of *ex post* active returns in terms of these components:

$$R_A = \sum\left(\beta_{pk} - \beta_{bk}\right) \times F_k + \left(\alpha + \varepsilon\right) \quad (2)$$

1 Kahn and Lemmon (2016); Bender, Hammond, and Mok (2014).

2 Rewarded factors were discussed in the Level II reading "An Introduction to Multifactor Models." For example, Fama and French (1992) introduced a three-factor model that includes Market, Size, and Value, which was complemented with Momentum by Carhart (1997). However, there are potentially many more factors, such as liquidity, low beta, and credit. There are also factors related to surprises in macroeconomic variables, such as interest rates, inflation, and business cycles, although academicians have had much more difficulty identifying reliable return premiums to these types of macroeconomic factors.

where

β_{pk} = the sensitivity of the portfolio (p) to each rewarded factor (k)

β_{bk} = the sensitivity of the benchmark to each rewarded factor[3]

F_k = the return of each rewarded factor

$(\alpha + \varepsilon)$ = the part of the return that cannot be explained by exposure to rewarded factors. The volatility of this component is very much dependent on how a manager sizes individual positions in his portfolio. The alpha (α) is the active return of the portfolio that can be attributed to the specific skills/strategies of the manager—skills such as security selection and factor timing. ε is the idiosyncratic return, often resulting from a random shock, such as a company announcing unexpected earnings. It could also be called noise or luck (good or bad). Although managers generate returns above or below those that can be explained by the exposure to rewarded factors, it is very difficult to isolate how much of this return differential can be attributed to alpha/skill or to noise/luck.[4]

Although not all active managers expressly employ a factor methodology in creating active returns, the growth of exchange-traded funds, coupled with the disappointing after-fee performance of many active managers, is expanding the factor-based view of the investment landscape. It is important to understand the components of active returns (exposure to rewarded risks, alpha, and luck) and how Equation 2 explicitly or implicitly relates to various management styles and approaches.

To illustrate, let's consider two hypothetical managers: a systematic manager (Quanto) and a discretionary manager (Evolo). Each claims to have a "Value" orientation.

Quanto estimates the "Value" characteristics of each security in his investment universe using such proxies as the ratios of price to book and forward earnings to price. He then uses a systematic allocation methodology that determines the specific active weights that can be expected to deliver the desired exposure to the Value factor. Quanto holds a large number of securities to limit the impact of idiosyncratic risks on performance. Quanto attempts to outperform the benchmark by choosing factor exposures that differ from those of the benchmark.

Evolo has developed a comprehensive measure of value using a forward-looking free cash flow model. This allows Evolo to compare her own estimates of security valuation to the current market price for each security covered by the firm. The manager uses her judgment to determine the appropriate active weights based on her own level of confidence in each estimate. She runs a concentrated portfolio because she believes she has an edge in setting the appropriate active weights.

Although Evolo is not using a systematic approach to determine the active security weights and the overall portfolio exposure to the Value factor, she is driven by a Value philosophy and is exposed to the Value factor. Her returns will be driven in part by this factor exposure, even if she has never seen Equation 2. Indeed, if her portfolio is not exposed to the Value factor, clients and consultants may question her claim to run a value-oriented portfolio. If Evolo has developed a better Value proxy than her competitors and if she is skilled at identifying the best and worst securities and setting

3 Because the investable universe as a whole (the market) is usually much larger than the investment universe defined by any single benchmark, most benchmarks have an inherent exposure to the Market factor different from one and some net exposure (different from zero) to other rewarded factors.

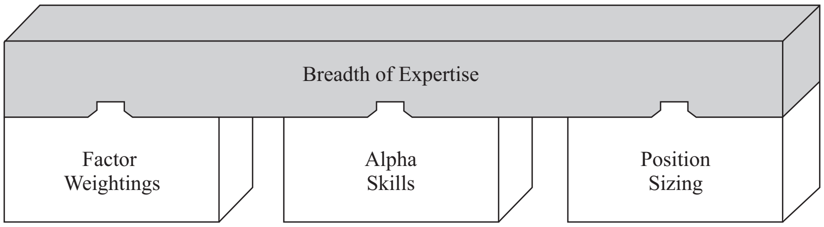
4 If one observes only a small number of active returns, it may be difficult to infer whether the active return is zero or significantly different from zero given the likely volatility of realized active returns.

appropriate active weights, part of her active return will be attributed to her alpha skills. Because Evolo runs a more concentrated portfolio, the portion of her active performance attributed to idiosyncratic risk will likely be greater.

2.2 Building Blocks Used in Portfolio Construction

This section introduces the three main building blocks of portfolio construction—*rewarded factor weightings*, *alpha skills*, and *position sizing* (shown in Exhibit 1)—and explains how each relates to the three broad sources of active returns. A fourth critical component of portfolio construction, *breadth of expertise*, is necessary to assemble these three building blocks into a successful portfolio construction process.

Exhibit 1 Building Blocks Used in Portfolio Construction



2.2.1 *First Building Block: Overweight or Underweight Rewarded Factors*

Let's begin by considering the market portfolio as our benchmark. The market portfolio encompasses all securities, and the weight of each security is proportional to its market capitalization. Our benchmark would have an exposure (or beta, β) of 1 to the Market factor and no net exposure to other rewarded factors, such as Size, Value, and Momentum.[5]

However, most individual securities have a β less than or greater than 1 to the Market factor and most will also have a non-zero exposure to the other factors. Indeed, one way an active manager can try to add value over and above the market portfolio is to choose, explicitly or implicitly, exposures to rewarded risks that differ from those of the market.

Practically speaking, most investors use narrower market proxies as a benchmark: the S&P 500 Index for a US mandate, the FTSE 100 Index for a UK mandate, or the MSCI All Country World Index (ACWI)[6] for a global mandate, for example. These indexes, although quite broad, do not include all securities that are publicly traded. Thus, these well-known indexes may not have a β of exactly 1 to the Market factor and could very well have a net exposure to other rewarded factors. For example, although most large-cap indexes usually have a β close to 1 to the Market factor, they usually have a negative sensitivity to the Size factor, indicating their large-cap tilt. When a manager is creating an exposure to a rewarded risk, the exposure must be established relative to that of his benchmark to achieve an expected excess return.

5 Market is a long-only factor, whereas other factors, such as Size and Value, are defined as long/short factors. Hence, the exposure of the market portfolio to the Market factor should be 1, whereas the exposure of the market portfolio to other factors should be 0.

6 The MSCI ACWI is a cap-weighted index that represents sources of equity returns from 23 developed and 24 emerging markets.

The growing understanding of rewarded factors is profoundly changing the view of active and passive investing. There are many investment products that allow investors to directly access such factors as Value, Size, Momentum, and Quality, and the bar for active managers is rising: An active value manager not only needs to outperform a passive value benchmark but may also need to outperform a rules-based value-tilted product. In the following discussion, we illustrate the concept of returns to factors and the application of this concept to portfolio management.

Exhibit 2 illustrates the factor exposures of the Russell 1000 Index, the Russell 1000 Value Index, and a discretionary mid-cap value fund (using the four Fama–French and Carhart factors). The performance of the actively managed fund is presented before the deduction of fees to make the comparison with benchmark returns fair.

The average monthly performance of each factor from February 1990 to December 2016 is specified in the last column.[7] All four factors showed positive returns over the period. Most regression coefficients are statistically significant at the 5% level (not shown); the momentum coefficients of the Russell 1000 and the Russell 1000 Value are the exceptions.

Exhibit 2 Risk Factor Exposure (February 1990–December 2016)

	Russell 1000 Index	Russell 1000 Value Index	Value Fund	Factor Performance US Market
Monthly performance in excess of the risk-free rate	0.64%	0.66%	0.40%	—
	β to specified factor:			
Market*	0.99	0.92	0.90	0.64%
Size	–0.16	–0.23	0.13	0.16%
Value	0.02	0.41	0.59	0.18%
Momentum	–0.01	0.13	0.09	0.61%
“Alpha” (monthly)	0.05%	–0.05%	–0.35%	—
R^2	0.99	0.95	0.74	

* As mentioned in footnote 3, the Market factor is built from a much larger universe of securities than are traditional benchmarks, such as the Russell 1000. Therefore, we should not expect the β of indexes to the Market factor to be necessarily equal to one.

Note: All data are measured in US dollars.

Sources: Factor data for the United States are from AQR Capital Management, market data are from Bloomberg, and calculations are from the authors.

The Russell 1000 Index has a Market β close to 1, a negative exposure to the Size factor (indicating it has a large-cap tilt), and almost no sensitivity to the Value and Momentum factors. This is what we would expect for a capitalization-weighted large-cap index. In comparison, the Russell 1000 Value Index has a lower Market β and a significant exposure to the Value factor, also in line with expectations. Finally, the mid-cap value fund has positive exposure to the Size factor (consistent with its mid-cap tilt) and a very significant exposure to the Value factor.

7 Pricing and accounting data used by AQR are from the union of the CRSP tape and the Compustat/Xpressfeed Global database. The data include all available common stocks in the merged CRSP/Xpressfeed data.

In these regression specifications, there is still a component of return that cannot be explained by the rewarded factors alone. It is often labeled "alpha." This may be true alpha, or it may be simply noise/luck. The two indexes have a relatively small alpha, whereas the value fund has a significantly negative alpha of –0.35% per month. An alpha of this magnitude is unlikely to be explained by a small misspecification in the factor model. An investor considering this fund would need to investigate the causes of this negative alpha.

In Exhibit 3, we show the sources of performance of each product in terms of its exposure to each of the four factors and its respective alpha. In all cases, the Market factor is the dominant source of performance. The Value and Momentum factors did contribute positively to performance for the Russell 1000 Value, but much of this performance was lost because of the large-cap tilt and the negative alpha. The value fund did get a significant performance boost from the Value tilt, but much of it was lost to the very poor alpha in this period.

Exhibit 3 Sources of Performance (February 1990–December 2016)

Source of Performance	Russell 1000	Russell 1000 Value	Value Fund
Market	0.63%	0.59%	0.57%
Size	–0.03%	–0.04%	0.02%
Value	0.00%	0.08%	0.11%
Momentum	–0.01%	0.08%	0.05%
Alpha	0.05%	–0.05%	–0.35%
Total monthly performance	0.64%	0.66%	0.40%

Source: Calculations by authors.

These examples illustrate the components of Equation 2. Irrespective of the manager's investment approach—whether she explicitly targets factors or focuses only on securities she believes to be attractively priced—her portfolio performance can be analyzed in terms of factors. Some portion of returns will not be explained by factors, which may be attributable to

- the unique skills and strategies of the manager (alpha),
- an incomplete factor model that ignores relevant factors, or
- exposure to idiosyncratic risks that either helped or hurt performance.

The next section discusses the alpha skills building block.

2.2.2 *Second Building Block: Alpha Skills*

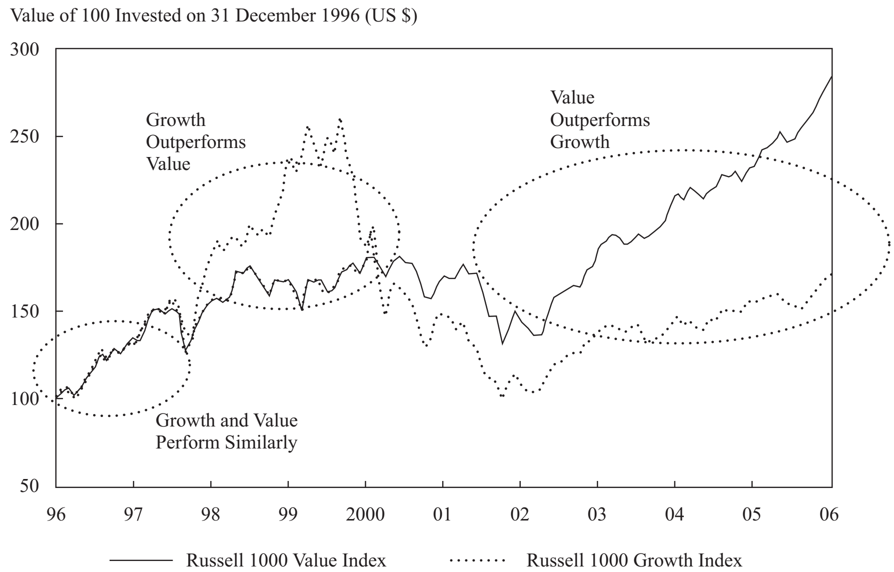
In principle, there are many approaches that can be used to generate alpha, but in practice, generating positive alpha in a zero-sum game environment (before fees) is a challenge.[8] Furthermore, the alpha generated by active managers must be sufficient to cover the higher fees usually associated with active management.

8 Investing is often considered a zero-sum game (before fees) because all investors in aggregate own the market. Assuming all investors in a specific market (such as US equity) have a similar and appropriate benchmark, for each investor that outperforms the benchmark by $1, there would be another investor or group of investors that underperforms the benchmark by $1. Hence, in a zero-sum game, we can outperform only at the expense of someone else. The average level of expertise of market participants in that market does not change this observation. Although beyond the scope of this reading, if different investors use different benchmarks, the zero-sum game analogy may not be appropriate.

Let's initially consider rewarded factors. With exposures to rewarded factors increasingly accessible via rule-based indexes, simple static exposure to known rewarded factors is no longer widely considered a source of alpha. However, successfully timing that exposure *would* be a source of alpha. For example, some managers believe part of their skill emanates from an understanding of when rewarded factor returns might be greater than or less than their average returns (factor timing). Hence, in periods when the market return is negative, a manager with an exposure (β) to the Market factor substantially less than 1 will outperform the market and will probably also outperform many other managers. Similarly, a beta greater than 1 in a rising market would drive strong portfolio performance relative to the market. Exposure to the Market factor can be adjusted by investing in securities having, on average, Market betas less than or greater than 1.

The same can be said for the other rewarded factors. Exhibit 4 shows the cumulative value of $100 invested in both the Russell 1000 Growth Index and the Russell 1000 Value Index over a 10-year period ending in 2006. The Value index produced superior performance over the full 10-year time span, although it underperformed the growth index in 1998 and 1999. A manager skilled at timing his exposure to the Value factor would have owned the Growth index until the late 1990s and the Value index afterward, outperforming a manager with static exposure to the Value factor. However, as we have indicated, factor timing is difficult, and there is no consensus on the ability to generate alpha from factor timing.[9]

Exhibit 4 Cumulative Value—Russell 1000 Growth and Russell 1000 Value



Source: Langlois and Lussier (2017, p. 44).

In principle, alpha can also be generated from timing exposure to *unrewarded* factors, such as regional exposure, sector exposure, the price of commodities, or even security selection. For example, there is no theoretical basis supporting an expectation that a portfolio with greater-than-benchmark sensitivity to oil prices will be rewarded in the long term. Oil price fluctuations are certainly a risk, but oil price is not a rewarded factor. However, a manager who held a very specific view about the

9 See Asness (2017).

future of oil prices and correctly anticipated the decline in the price of oil that started in June 2014 and ended in March 2016 would have had a strong incentive to reduce his exposure to the energy sector and especially to smaller, less integrated, and more indebted energy companies, which performed poorly as a result of the price movement. A discretionary manager might refer to these as *thematic exposures*. Although oil prices are not a rewarded "factor," his skill in timing that exposure would have been amply rewarded. The literature thus far has found little evidence of an ability to consistently time rewarded factors, but it is conceivable that a skillful manager could have identified a factor that has yet to be recognized by the academic or investment community.

In summary, active returns arising from skillful timing of exposure to rewarded factors, unrewarded factors, or even other asset classes (such as cash) constitute a manager's alpha—the second building block.

2.2.3 *Third Building Block: Sizing Positions*

Position sizing is about balancing managers' confidence in their alpha and factor insights while mitigating idiosyncratic risks. Although position sizing influences all three components of Equation 2, its most dramatic impact is often on idiosyncratic risk. For example, consider a manager seeking to create a greater exposure to the Value and Size factors. She could achieve the same average exposure (beta) to these factors by allocating her portfolio to 20 securities or 200 securities. However, the level of idiosyncratic risk and the potential impact of luck on performance will be much greater in the concentrated portfolio. In concentrated portfolios, the volatility of the active return $\left(\sigma_{R_A}\right)$ attributed to idiosyncratic risks (σ_ε) will likely be more significant. In other words, there may be greater deviations between realized portfolio returns and expected returns.

A manager's choices with respect to portfolio concentration are a function of his beliefs regarding the nature of his investment skill. The factor-oriented manager believes that she is skilled at properly setting and balancing her exposure to rewarded factors. She targets specific exposure to factors (the $\sum\left(\beta_{pk} - \beta_{bk}\right) \times F_k$ part of Equation 2) and maintains a diversified portfolio to minimize the impact of idiosyncratic risk. The stock picker believes that he is skilled at forecasting security-specific performance over a specific horizon and expresses his forward-looking views using a concentrated portfolio, assuming a higher degree of idiosyncratic risk (the $\alpha + \varepsilon$ part of Equation 2).

Diversification, Volatility, and Idiosyncratic risk

The stock picker must carefully consider influences that can substantially alter the absolute or relative risk profile of his portfolio. Consider, for example, the absolute volatility of the Russell 1000 Index and its underlying securities over the 12 months ending in October 2016. During this period:

- the index had an annualized daily volatility of 15.7%;
- the weighted average volatility of all securities in the index was substantially higher, about 26.7%;
- the average volatility of the 100 smallest securities in the index was approximately 41%;
- the average volatility of the 100 largest securities in the index was approximately 24%.

This disparity in individual stock volatility illustrates the potential of diversification. A concentrated portfolio is unlikely to achieve the low volatility of the Russell 1000 unless the manager specifically emphasizes investing in stocks that have a lower average volatility than that of the average security in the index.

Exhibit 5 illustrates the effect of diversification on total portfolio risk at two different levels of average individual stock volatility. (We use the standard deviation of returns as our measure of risk here.) Total portfolio volatility is a function of the average individual stock volatility and the number of securities in the portfolio. The calculations assume an average cross correlation of 0.24, consistent with the historical average correlation for Russell 1000 securities since 1979.

Exhibit 5 Total Portfolio Volatility as a Function of Concentration and Single Stock Volatility[10]

	Single Stock Volatility	
	25%	**30%**
Number of Securities	**Portfolio Volatility**	
10	14.1%	16.9%
30	12.9%	15.5%
50	12.6%	15.2%
100	12.4%	14.9%
500	12.3%	14.7%

Examining this table closely, we can see that diversification is a powerful tool but that it has its limitations. Even the most diversified portfolio of high-volatility stocks (the 500-stock portfolio with an average single-stock volatility of 30%) cannot achieve the same level of volatility inherent in the portfolios of lower-volatility stocks. Even the most concentrated portfolio of lower-volatility stocks displays a portfolio volatility lower than that of the highly diversified portfolio of higher-volatility stocks.

The concentrated portfolio, however, bears higher idiosyncratic risk, which can substantially influence portfolio performance. The manager's choices with respect to the magnitude of his active weights and the volatility of the securities with the highest active weights will be significant determinants of the portfolio's active return and active risk.

Active risk is a measure of the volatility of portfolio returns relative to the volatility of benchmark returns. It is expressed as follows:

$$\text{Active risk}\left(\sigma_{R_A}\right) = \sqrt{\frac{\sum_{t=1}^{T}\left(R_{At}\right)^2}{T-1}} \tag{3}$$

where R_{At} represents the active return at time t and T equals the number of return periods. Active risk is often referred to as "tracking error."

All else being equal, a 1.0% allocation to a security that has a 0.2% weighting in the benchmark (Security A) will have a greater effect on the active risk of the portfolio than a 2.0% allocation to a security that has a 2.5% weighting in the benchmark (Security B). Despite the overall smaller position size of Security A, the active decision the manager made with respect to the weighting of Security A (an 80 bp difference from the

10 This is a simplified example of Markowitz portfolio diversification where securities are equally weighted and all securities have the same volatility and cross correlation:

$$\sigma_p = \sqrt{\frac{1}{n}\sigma^2 + \frac{(n-1)}{n}\sigma^2 C},$$

where n is the number of securities, σ^2 is the equal variance of all securities, and C is the cross correlation between them.

benchmark weight) is significantly larger than the active decision with respect to the weight of Security B (a 50 bp difference). If Security A also has a higher volatility than Security B, the effect of the active decision will be magnified.

Similarly, all else equal, an active weight of 1.0% on a single security will have a greater impact on active risk than will an active weight of 0.2% on five separate securities. The imperfect cross correlations of active returns of the basket of five stocks would contribute to lowering the level of active risk.

To summarize, a manager's choice with respect to position sizing is influenced by her investment approach and the level of confidence she places on her analytic work. On the one hand, the stock picker with high confidence in her analysis of individual securities may be willing to assume high levels of idiosyncratic risk. This is consistent with her emphasis on the "$\alpha + \varepsilon$" part of Equation 2. On the other hand, a manager focused on creating balanced exposures to rewarded factors is unlikely to assume a high level of idiosyncratic risk and is, therefore, quite likely to construct a highly diversified portfolio of individual securities.

2.2.4 *Integrating the Building Blocks: Breadth of Expertise*

The three foregoing building blocks encompass all of Equation 2, which we used to describe the sources of a manager's active returns:

- exposure to rewarded risks,
- timing of exposures to rewarded and unrewarded risks, and
- position sizing and its implications for idiosyncratic risk.

A manager may be more or less successful at combining these three sources of return into a portfolio. Success is a function of a manager's breadth of expertise. Broader expertise may increase the manager's likelihood of generating consistent, positive active returns.

The importance of breadth of expertise is implicit in the fundamental law of active management (covered extensively in the Level II reading "Analysis of Active Portfolio Management"), which implies that confidence in a manager's ability to outperform his benchmark increases when that performance can be attributed to a larger sample of independent decisions. Independent decisions are not the same thing as individual securities. Independent decisions are uncorrelated decisions, much like two uncorrelated stocks are diversifying. Thus, overweighting both General Motors and Toyota, two auto companies, relative to their benchmark weights are not fully independent decisions because much of their respective returns are driven by common influences—the strength of consumer spending, the price of gasoline, and the price of steel and aluminum, for example. In evaluating portfolio construction, one must distinguish between the nominal number of decisions a manager makes about his active weights and the effective number of independent decisions. Without truly independent decisions, performance may be influenced more significantly by common exposures to specific factors.[11] According to the fundamental law, the expected active portfolio return E(R_A) is determined by the following:[12]

$$E(R_A) = IC\sqrt{BR}\sigma_{R_A}TC \tag{4}$$

where

IC = Expected **information coefficient** of the manager—the extent to which a manager's forecasted active returns correspond to the managers realized active returns

BR = **Breadth**—the number of truly independent decisions made each year

TC = **Transfer coefficient**, or the ability to translate portfolio insights into investment decisions without constraint (a truly unconstrained portfolio would have a transfer coefficient of 1)

σ_{R_A} = the manager's active risk

For example, assuming an active risk of 6% (which many institutional investors would consider to be high), a transfer coefficient of 0.25 (representative of a constrained long-only investor), and an information coefficient of 0.10, the manager could expect to generate an active return of 15 bps yearly, on average, if she makes a single independent decision. If the manager wanted to achieve excess return of 1%, she would need to make approximately 40 fully independent decisions. Even if a manager does have positive information and transfer coefficients, it does not necessarily follow that excess return will be positive every year. A horizon of many years is required to have a reasonable probability of generating the expected excess return. However, a larger number of independent decisions will increase the probability of outperforming over a shorter horizon.

What is the implication of making multiple independent decisions? Assume two managers hold similarly diversified portfolios in terms of the number of securities and that both managers have outperformed the market over a specific period. Manager A has a pure value style and favors securities that have a low price-to–book ratio (a single valuation metric), whereas Manager B has a multidimensional, factor-based approach. Manager B's approach includes considerations related to valuation, price momentum, growth, balance sheet sustainability, quality of management, and so on, and considers a much larger set of metrics for each dimension (such as several metrics for valuation). Manager A's performance is largely attributed to a single dimension: his narrowly defined value bias. Although he holds 100 securities, he did not make 100 independent decisions.[13]

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11 Although the fundamental law is an interesting concept for illustrating the main drivers of positive expected active returns, investment decisions are rarely truly independent. When using specific metrics to determine how to allocate to securities, managers emphasize securities that have common characteristics they deem to be relevant. The process by which managers determine their allocation to securities will affect the degree of independence of investment decisions. In other words, investing in the 100 securities among 1,000 that have the lowest price-to-book ratio does not lead to 100 independent decisions. Furthermore, we should not assume that the information coefficient of the manager is insensitive to the number of securities in his portfolio.

12 The basic fundamental law was initially introduced by Grinold (1989) but was further expanded into the full fundamental law with the addition of the transfer coefficient by Clarke, de Silva, and Thorley (2002).

13 Consider an active manager who has a value and momentum style. Value is measured by the price-to-book ratio, and momentum is measured over a single historical period, such as $P_{t-1\ month}/P_{t-12\ months}$. Assume that his exposure to these two factors explains more than 60% of his excess return (consistent with a study by Bender, Hammond, and Mok, 2014). The portfolio exposure to these two risk factors has, therefore, had greater bearing on excess returns than have the security selection skills of the manager.

Manager B may not have 100 independent decisions embedded in her portfolio, but she likely has more than Manager A. Thus, the historical performance of Manager B may be a more reliable indicator of her ability to outperform in the future because her portfolio construction process integrates several dimensions and metrics, as well as their interactions. Her performance is less likely to be explained by how the market has recently favored a specific management style.

Let's take this example a bit further. Suppose Manager A makes 20 independent decisions and Manager B makes 40 independent decisions. Assume they both have the same information coefficient (0.2), the same active risk (4%), and the same transfer coefficient (0.6). What would be the expected active return of each manager? Using Equation 4:

Manager A $0.2 \times \sqrt{20} \times 4\% \times 0.6 = 2.15\%$

Manager B $0.2 \times \sqrt{40} \times 4\% \times 0.6 = 3.04\%$

What if Manager A's information coefficient was only 0.1? How many independent decisions would the manager need to make to generate the same 2.15% expected active return?

Manager A: $0.1 \times \sqrt{x} \times 4\% \times 0.6 = 2.15\%$

$x \approx 80$

Assuming Manager A maintains a concentrated portfolio of twenty securities, what information coefficient would be required for Manager A to match the expected performance of Manager B?

Manager A: $x \times \sqrt{20} \times 4\% \times 0.6 = 3.04\%$

$x \approx 0.28$

Equation 4 illustrates the importance of breadth of expertise. As a practical matter, long-term success is not achieved by being right all the time but, rather, by being right often through small victories achieved consistently over long periods.

EXAMPLE 1

The Building Blocks of Asset Management

Proteus was launched as an asset management firm 20 years ago, after receiving assets of $100 million from a seed investor. Today, the firm has grown into a large organization with more than $30 billion in assets. Although the investment process has evolved, the firm has remained true to its core philosophy. It has also delivered strong risk-adjusted performance to its investors.

Proteus's emphasis has always been to invest in quality companies, appropriately priced, which are benefiting from positive and sustained price momentum. Although fairly agnostic in terms of portfolio weights compared with benchmark weights, the managers of Proteus believe in avoiding extreme views. For example, sector deviations are limited to between 80% and 120% of benchmark weights plus or minus 500 bps; for example, a sector with a 20% weight in the index could have a weight in the portfolio ranging from 11% [(0.8 × 20%) – 5%] to 29% [(1.2 × 20%) + 5%]. An individual security position can be no more than the lesser of (1) 10 times its weight in the index or (2) its weight in the index + 1%. On average, Proteus's portfolios hold between 120 and 150 securities. The active risk is above 5%.

As the firm grew in experience, research, and resources, the process of defining and measuring what is a quality company, appropriately priced, and benefiting from positive momentum evolved. Initially, the firm avoided companies that were the most indebted within their sector and favored those that generated strong cash flows to sales. It also favored companies that had a lower price-to-book value and had positive price momentum in the last 12 months.

Today, Proteus still emphasizes quality, valuation, and price momentum but has considerably improved how those characteristics are measured and weighed. It now evaluates 45 metrics related to the financial health of the companies, the quality of its financial reporting, its valuation within its sector, and its short- and medium-term price momentum. It also developed its own weighting mechanism to appropriately weight each metric. The managers at Proteus believe their competitive advantage is the effort they invest in identifying, measuring, and weighing these metrics.

Discuss the contributions of rewarded factors, alpha skills, position sizing, and breadth of expertise for Proteus.

Solution:

Overall, Proteus has integrated all the primary dimensions of the investment process.

- Rewarded factors: Proteus recognizes the existence of rewarded factors, and it has significantly enhanced its measures of Quality, Value, and Momentum over time.
- Alpha skills: Given the commercial success of Proteus as a firm, we might safely assume that there is an alpha component in the process.
- Position sizing: Position size limits are integrated into the investment process to ensure diversification limits idiosyncratic risks.
- Breadth of expertise: Proteus has 20 years of experience refining and improving an investment process based on a consistent investment philosophy.

3 APPROACHES TO PORTFOLIO CONSTRUCTION

Portfolio construction is part art and part science. It is about investment philosophy and the implementation of that philosophy. It requires an understanding of the technical principles of portfolio construction, filtered through a manager's core beliefs regarding her ability to add value using the building blocks discussed earlier:

- *Factor exposures:* How does she create her factor exposures? Does the manager believe she is skilled at extracting return premiums from rewarded factors? Or are her exposures to rewarded factors a residual of her in-depth research into the securities' fundamentals?
- *Timing:* Does she believe that she has skill in generating alpha through timing of portfolio exposures to rewarded and unrewarded factors or to security selection uncorrelated with exposures to either rewarded or unrewarded factors?

- *Position sizing:* How does she size portfolio positions? Is she confident about her expected return forecasts, and therefore runs a high-conviction portfolio? Or does she seek to reduce idiosyncratic risk by running a highly diversified portfolio?
- *Breadth or depth:* Does she rely on a specialized but narrower skill set or on a greater breadth of expertise?

A manager's portfolio construction process should reflect her beliefs with respect to the nature of her skills in each of these areas. The majority of investment approaches can be classified as either

- *systematic or discretionary* (the degree to which a portfolio construction process is subject to a set of predetermined rules or is left to the discretionary views of the manager)

and

- *bottom-up or top-down* (the degree to which security-specific factors, rather than macroeconomic factors, drive portfolio construction).

In addition, these approaches can vary in the extent to which they are *benchmark aware* versus *benchmark agnostic*. Each manager's investment approach is implemented within a framework that specifies the acceptable levels of active risk and **Active Share** relative to a clearly articulated benchmark. (Active Share is a measure of how similar a portfolio is to its benchmark.) A manager may emphasize these dimensions to varying degrees as he attempts to differentiate his portfolio from the benchmark.

3.1 The Implementation Process: The Choice of Portfolio Management Approaches

We previously identified three primary building blocks that managers can use in constructing a portfolio that reflects their core beliefs. Let's look at these in a little more detail, beginning with the systematic–discretionary continuum.

3.1.1 *Systematic vs. Discretionary*

How are a manager's beliefs regarding rewarded factor exposures, timing of factor exposures, exposure to unrewarded factors, and willingness to assume idiosyncratic risk reflected in a systematic investment process and in a discretionary investment process?

- Systematic strategies are more likely to be designed around the construction of portfolios seeking to extract return premiums from a balanced exposure to known, rewarded factors.
- Discretionary strategies search for active returns by building a greater depth of understanding of a firm's governance, business model, and competitive landscape, through the development of better factor proxies (e.g., a better definition of Quality), or through successful timing strategies. Factor timing is a challenging endeavor, and few factor-based systematic strategies have integrated a factor timing approach.
- Systematic strategies typically incorporate research-based rules across a broad universe of securities. For example, a simple systematic value methodology could filter out the 50% of securities that have the highest price-to-book ratio and then equally weight the remaining securities, leading to small individual portfolio positions. A more comprehensive approach might integrate a much larger number of considerations and balance total portfolio risk equally across them.

- Discretionary strategies integrate the judgment of the manager, usually on a smaller subset of securities. While a discretionary value manager might also rely on financial metrics to estimate the value characteristics of each security, she is likely to use her judgment to evaluate the relative importance of this information and assign appropriate weights to each security. A discretionary manager is also likely to integrate nonfinancial variables to the equation, such as the quality of management, the competitive landscape, and the pricing power of the firm. (Systematic strategies also integrate judgment, but their judgment is largely expressed up front through the design of the strategy and the learning process that comes with its implementation.)
- Systematic strategies seek to reduce exposure to idiosyncratic risk and often use broadly diversified portfolios to achieve the desired factor exposure while minimizing security-specific risk.
- Discretionary strategies are generally more concentrated portfolios, reflecting the depth of the manager's insights on company characteristics and the competitive landscape.
- Systematic strategies are typically more adaptable to a formal portfolio optimization process. The systematic manager must, however, carefully consider the parameters of that optimization. What objective function is he seeking to maximize (information ratio, Sharpe ratio, index or factor exposure, etc.) or minimize (volatility, downside risk, etc.)? Will elements of his investment style (such as performance and valuation metrics) be incorporated into the objective function or into the constraints?
- Discretionary portfolio managers typically use a less formal approach to portfolio construction, building a portfolio of securities deemed attractive, subject to a set of agreed-upon risk constraints.

Bridging the Divide

The philosophical divide between systematic and discretionary managers seems to be shrinking. Systematic and discretionary strategies were commonly differentiated in terms of their breadth and depth (discretionary managers conducting more in-depth research on a sub-set of the securities universe) and systematic managers having more breadth (less in-depth research across the entire universe of securities). Although this remains generally true today, research and technology have been narrowing the gap. Advancements in and the accessibility of technology, together with the greater range of quality data available, are allowing discretionary managers to extend their in-depth analyses across a broader universe of securities. Technology also allows systematic managers to design strategies that can capture risk premiums in rewarded factors, a source of active returns that was previously considered to be part of the alpha of discretionary managers.

3.1.2 *Bottom-Up vs. Top-Down*

A top-down approach seeks to understand the overall geo-political, economic, financial, social, and public policy environment and then project how the expected environment will affect countries, asset classes, sectors, and then securities. An investment manager who projects that growth companies will outperform value companies, that financials will outperform industrials, that the US market will outperform the European market, that oil prices will increase, or that cash will outperform equity and then targets individual securities and/or a cash/stock allocation to reflect these views is following a top-down approach.

A manager following a bottom-up approach develops his understanding of the environment by first evaluating the risk and return characteristics of individual securities. The aggregate of these risk and return expectations implies expectations for the overall economic and market environment. An investment manager who expects Ford to outperform GM, AstraZeneca (a bio-pharmaceutical company) to outperform Ford, and Sony to outperform AstraZeneca and builds a portfolio based on these stock-specific forecasts is following a bottom-up approach. Although the resulting portfolio will contain an implicit expectation for sector, style, and country performance, this is nonetheless a bottom-up approach.

- Both top-down and bottom-up strategies typically rely on returns from factors. However, top-down managers are more likely to emphasize macro factors, whereas bottom-up managers emphasize security-specific factors.
- A top-down investment process contains an important element of factor timing. A manager who opportunistically shifts the portfolio to capture returns from rewarded or unrewarded factors, such as country, sectors, and styles, is following a top-down investment process. They may also embrace the same security characteristics sought by bottom-up managers as they translate their macro views into security-specific positions. A top-down investment process is also more likely to raise cash opportunistically when the overall view of the Market factor is unfavorable.
- Bottom-up managers may embrace such styles as Value, Growth at Reasonable Price, Momentum, and Quality. These strategies are often built around documented rewarded factors, whether explicitly or implicitly.
- A top-down manager is likely to run a portfolio concentrated with respect to macro factor exposures. Bottom-up managers and top-down managers can run portfolios that are either diversified or concentrated in terms of securities. Both a bottom-up stock picker and a top-down sector rotator can run concentrated portfolios. Both a bottom-up value manager and a top-down risk allocator can run diversified portfolios.

Some managers will incorporate elements of both top-down and bottom-up investment approaches.

3.1.3 *A Summary of the Different Approaches*

While most managers make some use of all the building blocks, we can make some general assertions about the relative importance and use of these building blocks to each of the implementation choices. They are summarized in the four quadrants of Exhibit 6.

Exhibit 6 Approaches and Their Use of Building Blocks

	Systematic	Discretionary
Top-Down	• Emphasizes macro factors • Factor timing • Diversified	• Emphasizes macro factors • Factor timing • Diversified or concentrated depending on strategy and style
Bottom-Up	• Emphasizes security specific factors • No factor timing • Diversified	• Emphasizes firm specific characteristics or factors • Potential factor timing • Diversified or concentrated depending on strategy and style

- Exposure to rewarded factors can be achieved with either a systematic or discretionary approach.
- Bottom-up managers first emphasize security-specific factors, whereas top-down managers first emphasize macro factors.
- Factor timing is more likely to be implemented among discretionary managers, especially those with a top-down approach.
- Systematic managers are unlikely to run concentrated portfolios. Discretionary managers can have either concentrated or diversified portfolios, depending on their strategy and portfolio management style.
- In principle, a systematic top-down manager would emphasize macro factors and factor timing and would have diversified portfolios. However, there are few managers in this category.

3.1.4 *Active Share and Active Risk*

Managers have very specific beliefs about the level of security concentration and the absolute or relative risk that they (and their investors) are willing to tolerate. Relative risk is measured with respect to the benchmark that the manager has adopted as representative of his investment universe. We know that a manager must have active weights different from zero in order to outperform his benchmark. How do we measure these weights?

There are two measures of benchmark-relative risk used to evaluate a manager's success—Active Share and active risk—and they do not always move in tandem. A manager can pursue a higher Active Share without necessarily increasing active risk (and vice versa).

Active Share is easier to calculate than active risk; one only needs to know the weight of each security in the portfolio and the weight of the security in the benchmark. The formula for Active Share is shown in Equation 5. It measures the extent to which the number and sizing positions in a manager's portfolio differ from the benchmark.

$$\text{Active Share} = \frac{1}{2}\sum_{i=1}^{n}\left|\text{Weight}_{portfolio,i} - \text{Weight}_{benchmark,i}\right| \quad (5)$$

where *n* represents the total number of securities that are in either the portfolio or the benchmark.

The Active Share calculation involves no statistical analysis or estimation; it is simple arithmetic. If a portfolio has an Active Share of 0.5, we can conclude that 50% of the allocation positions of this portfolio are identical to that of the benchmark and 50% are not. There are only two sources of Active Share:

- Including securities in the portfolio that are not in the benchmark
- Holding securities in the portfolio that are in the benchmark but at weights different than the benchmark weights

If two portfolios are managed against the same benchmark (and if they invest only in securities that are part of the benchmark), the portfolio with fewer securities will have a higher level of Active Share than the highly diversified portfolio. A portfolio manager has complete control over his Active Share because he determines the weights of the securities in his portfolio.

Active risk is a more complicated calculation. Like Active Share, active risk depends on the differences between the security weights in the portfolio and the security weights in the benchmark. There are two different measures of active risk. One is realized active risk, which is the actual, historical standard deviation between the portfolio return and the benchmark return as described in Equation 3. This number relies on historical returns and is easy to calculate. But portfolio construction is a forward-looking exercise, and in this context, the relevant measure is predicted active risk, which requires a forward-looking estimate of correlations and variances.[14] As the accuracy of the forward-looking estimates of correlations and variances improves, the likelihood of better portfolio outcomes also improves.

The variance–covariance matrix of returns is very important in the calculation of active risk. Although portfolios that have higher active risk tend to have higher Active Share, this is not always the case. For example, underweighting one bank stock to overweight another bank stock will likely have less effect on active risk than underweighting one bank stock and overweighting an information technology stock. Active risk is affected by the degree of cross correlation, but Active Share is not. Active Share is not concerned with the efficiency of diversification.[15] If the extent of underweighting and overweighting is the same in the bank/bank over-/underweight and in the bank/technology over-/underweight, the effect on Active Share would be identical. The effect on active risk would be different, however, because the correlation of the bank/technology pair is most likely lower than the correlation of the bank/bank pair. This highlights an important difference in Active Share versus active risk. A portfolio manager can completely control Active Share, but she cannot completely

14 To generate estimates of future volatility and correlations, different levels of sophistication can be considered. Although several methodologies are available, two dominant methodologies are exponentially weighted moving average (EWMA) and generalized autoregressive conditional heteroskedasticity (GARCH). EWMA applies greater weights to recent return observations, allowing for a more accurate representation of the near-term volatility environment. However, EWMA does not allow for regression to the mean to occur. More specifically, abnormally high or low levels of volatility in financial markets are expected to eventually normalize toward a long-term mean. The family of GARCH models integrates the benefits of EWMA and regression to the mean. The efficiency of risk forecasting and its implementation are illustrated in Langlois and Lussier (2017, pp. 82–85).

15 Active Share is often used to determine how much fees an investor is paying for active management. For example, if two managers charge asset management fees of 0.5%, the manager with an Active Share of 0.80 offers twice as much "active" management per unit of fees as a manager with an Active Share of 0.40.

control active risk because active risk depends on the correlations and variances of securities that are beyond her control. Recall that in Equation 2, we decomposed active return into returns to factors, alpha, and idiosyncratic risk.

$$\sigma_{R_A} = \sqrt{\sigma^2\left(\sum\left(\beta_{pk} - \beta_{bk}\right) \times F_k\right) + \sigma_e^2} \tag{6}$$

Here, we show that the active *risk* of a portfolio $\left(\sigma_{R_A}\right)$ is a function of the *variance* attributed to the factor exposure $\sigma^2\left(\sum\left(\beta_{pk} - \beta_{bk}\right) \times F_k\right)$ and of the *variance* attributed to the idiosyncratic risk $\left(\sigma_e^2\right)$.[16] Although realized active risk will almost never be identical to predicted active risk, existing risk forecasting methodologies allow the manager to predict active risk over a short horizon with a high level of accuracy. Managers can then control the level of active risk through portfolio structure.

Sapra and Hunjan (2013) derived a relationship between active risk, Active Share, and factor exposure for an unconstrained investor, assuming a single-factor model. They found that

- high net exposure to a risk factor will lead to a high level of active risk, irrespective of the level of idiosyncratic risk;
- if the factor exposure is fully neutralized, the active risk will be entirely attributed to Active Share;
- the active risk attributed to Active Share will be smaller if the number of securities is large and/or average idiosyncratic risk is small; and
- the level of active risk will rise with an increase in factor and idiosyncratic volatility (such as occurred in 2008).[17]

These observations are very intuitive: Active risk increases when a portfolio becomes more uncorrelated with its benchmark. As discussed previously, although overweighting or underweighting GM relative to Ford will generate some Active Share, it will typically not generate much active risk. However, overweighting or underweighting energy firms versus financial firms, small-cap firms versus large-cap firms, or growth firms versus value firms will certainly contribute more to active risk.

So how do we use these two measures to discriminate between different portfolio management approaches and management styles? Using the observations from Sapra and Hunjan (2013), we could characterize a manager as

- factor neutral, factor diversified, or factor concentrated and as
- diversified (with low security concentration and low idiosyncratic risk) or concentrated (with high security concentration and high idiosyncratic risk).[18]

Exhibit 7 illustrates how various combinations of factor exposure and idiosyncratic risk affect Active Share and active risk.[19]

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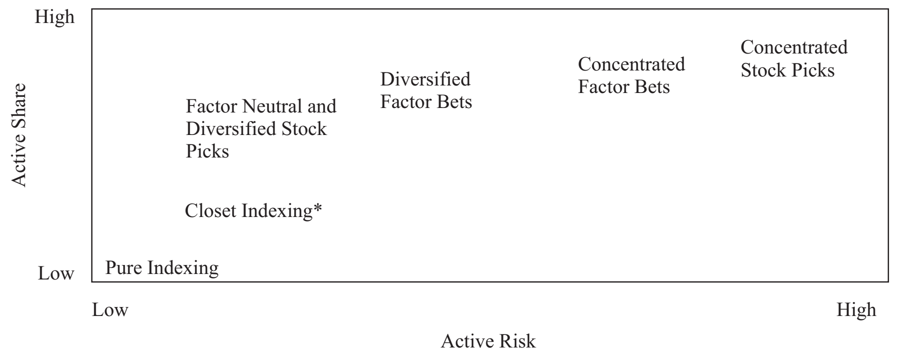
16 The variance attributed to alpha returns is embedded in the variance of idiosyncratic risks.

17 In 2008, markets were faced with the worst crisis of confidence and liquidity since the Great Depression. This situation triggered a deep global recession and rising unemployment and debt levels. The Market factor performed poorly, but the onset of the economic decline, the Lehman Brothers' bankruptcy on 15 September 2008, and the exposure of financial firms to weak mortgage and leveraged credit led to poor performance of value stocks and, consequently, of the Value factor. Furthermore, the forced deleveraging of many trades/strategies led to the biggest decline of the Momentum factor in more than 70 years.

18 See Ceria (2015).

19 Factor portfolios usually have low security concentration.

Exhibit 7 Investment Styles, Active Share, and Active Risk



*A **closet indexer** is defined as a fund that advertises itself as being actively managed but is substantially similar to an index fund in its exposures.

Using this framework, we can classify most equity strategies in terms of active risk and Active Share by analyzing the specific management style of the manager. For example, most multi-factor products have a low concentration among securities, often holding more than 250 positions (the purpose of these products is to achieve a balanced exposure to risk factors and minimize idiosyncratic risks). They are diversified across factors and securities. Thus, they typically have a high Active Share, such as 0.70, but they have reasonably low active risk (tracking error), often in the range of ±3%.

The concentrated stock picker, in contrast, has both a high Active Share (typically above 0.90) and a high active risk (such as 8%–12% or higher).[20] (The average active manager owns about 100 stocks, and fewer than 20% of managers own more than 200 stocks.) It follows, then, that the level of idiosyncratic risk in the average active discretionary portfolio is greater than that of the average multi-factor fund, with its 250+ positions. Therefore, on average, we could expect the portfolio of a typical discretionary manager to display higher active risk.

Consequently, a manager can increase his degree of control over the level of Active Share and/or active risk in his portfolio by decreasing his security concentration. For example, it would not be uncommon for a sector rotator—typically a high-active-risk strategy—to have an active risk above 8%. If he chooses to run a concentrated portfolio, he might also have high Active Share. Or he can diversify his portfolio and reduce his Active Share.[21]

Petajisto (2013) provided examples of funds of different styles and their corresponding active risk and Active Share; see Exhibit 8A. The risk tolerance and portfolio construction approach of each manager is partially revealed by his Active Share and active risk. Exhibit 8B presents the same information but plots it in the Active Share/active risk dimension using the format of Exhibit 7.

20 See Yeung, Pellizzari, Bird, and Abidin (2012).

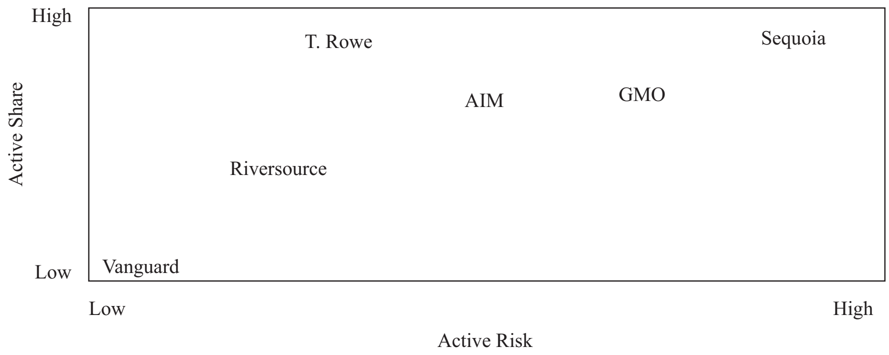
21 It is important to use an appropriate index when calculating the level of Active Share. A manager whose investment universe is the S&P 500 could see her Active Share increase by approximately 12% if the Russell 1000 index was used to compute the Active Share. By default, a portfolio of 500 stocks will have high Active Share if Active Share is measured against the Russell 1000 Index.

Exhibit 8A Active Risk, Active Share, and Portfolio Styles, 2009

Name of Fund	Style/Comments	Active Risk	Active Share
Vanguard Index Fund	Indexed	0.0%	0.00
RiverSource Disciplined Equity Fund	Large-Cap Growth (Small active weight, limited factor timing)	4.4%	0.54
T. Rowe Price Mid-Cap Value Fund	Mid-Cap Value (Limited active weights on sectors but significant stock picking)	5.4%	0.93
AIM Constellation Fund	Large-Cap Growth (Significant sector bets)	9.7%	0.66
GMO Quality Fund	Mega-Cap Core (Timing on a number of factors and cash)	12.9%	0.65
Sequoia	Stock Picker (Highly concentrated positions)	14.1%	0.97

Source: Petajisto (2013).

Exhibit 8B Active Risk, Active Share, and Portfolio Styles



Active risk and Active Share provide information about the level of managers' activism against their benchmark, but there is little research on the relative efficiency of different asset management styles translating higher active risk or Active Share into higher active returns. However, many investors are using Active Share to assess the fees that they pay per unit of active management. For example, a fund with an Active Share of 0.25 (a closet indexer) would be considered expensive relative to a fund with an Active Share of 0.75 if both funds were charging the same fees.

Not all investment products neatly fall into the categorization we have just presented. Niche equity strategies, such as statistical arbitrage, event-driven investing, and activist investing, focus on generating alpha returns generally without regard to factor exposures or factor timing. These strategies do, however, typically assume a high level of idiosyncratic risk.

EXAMPLE 2

Portfolio Construction—Approaches and Return Drivers

1 You are evaluating two equity managers. Explain how Manager A, with his high level of Active Share, is able to achieve such a low active risk. What are the implications for Manager B's performance relative to that of Manager A?

	Manager A	Manager B
Active Share	0.73	0.71
Active risk	2.8%	6.0%
Number of positions	120	125

2 Discuss the drivers of return for Managers A and B.

	Manager A	Manager B	Factor Returns
Monthly performance in excess of the risk-free rate	0.65%	0.65%	
"Alpha" (monthly)	0.00%	0.20%	
Beta to:			
Market*	0.99	1.05	0.45%
Size	0	–0.2	0.20%
Value	0.15	0.05	0.35%
Momentum	0.25	0	0.60%
R-squared	0.99	0.78	

* Market factor is built from a much larger universe of securities than traditional benchmarks such as the Russell 1000. Therefore, we should not expect the β of indexes to the Market factor to be necessarily equal to one.

3 Based on the information provided below regarding four managers benchmarked against the MSCI World Index, identify the manager most likely to be a:

a closet indexer.

b concentrated stock picker.

c diversified multi-factor investor.

d sector rotator.

Justify your response.

Manager Constraints:	A	B	C	D
Target active risk	10%	1%	4%	7%
Max. sector deviations	0%	3%	10%	15%
Max. risk contribution, single security	5%	1%	1%	3%

4 Discuss the main differences between top-down and bottom-up portfolio management approaches and how they relate to two of the building blocks: exposure to rewarded factors and alpha.

Solution to 1:

Managers A and B have a similar number of positions and similar Active Share. Manager B has much higher active risk. A high Active Share says only that a manager's security-level weights are quite different from those of the index. A 0.5% underallocation to one security and a 0.5% over-allocation to another security will have the same impact on Active Share whether these two securities are in the same sector or in different sectors. Given similar levels of Active Share, it is likely that Manager B's active risk is driven by active decisions at the sector level rather than at the security level. Clearly, they implement very different investment strategies. Although we cannot draw a direct conclusion about the ability of Manager B to outperform Manager A, we can assume that the realized outcomes of Manager B are likely to be much more dispersed about the benchmark (both in positive and negative directions) given the higher level of active risk.

Solution to 2:

Both managers generated the same absolute return, but they achieved their performance in very different ways. All of Manager A's performance can be explained from exposure to rewarded factors. There is no alpha, and the high R^2 shows that the four factors explain much of the monthly variability in returns. Manager A did outperform the Market factor by 20 bps (0.65% – 0.45%). The excess return can be attributed to the significant exposure (0.25) to the strong-performing Momentum factor (0.60%). Exposure to the Value factor explains the balance.

Manager B generated significant alpha (20 bps per month). The relatively low R^2 indicates that much of the variability of returns is unexplained by the factors. Manager B's performance must, therefore, be attributed to either her alpha skills or idiosyncratic risks that favored the manager's investment approach during the period.

Solution to 3:

Manager B is a closet indexer. The low targeted active risk combined with the narrow sector deviation constraint indicates that the manager is making very few active bets.

Manager A is likely a concentrated stock picker. The 10% active risk target indicates a willingness to tolerate significant performance deviations from the market. The 5% limit on a single security's contribution to portfolio risk indicates he is willing to run a concentrated portfolio. The unwillingness to take sector deviations combined with the high tolerance for idiosyncratic risk indicates that the manager likely focuses on stock selection and is, therefore, a stock picker.

Manager C limits single-security risk contribution to no more than 1%, which implies a highly diversified portfolio. The significant sector deviations despite this high diversification are often indicative of a multi-factor manager. The relatively low tracking error further supports the argument that Manager C is a multi-factor manager.

Manager D has characteristics consistent with a sector rotator. The significant active risk and high tolerance for sector deviations and security concentration are what one would expect to find with a sector rotator.

Solution to 4:

Factor exposure.

Bottom-up managers look at characteristics of securities to build their portfolios. The factor exposure inherent in their portfolios may be intentional, or it may be a by-product of their security selection process. Top-down managers articulate a macro view of the investment universe and build a portfolio emphasizing the macro factors that reflect those views. Although their macro views could then be translated into security views using a bottom-up approach, their performance will likely be dominated by their macro-level factor exposures.

Alpha.

In the context of Equation 2, the alpha of bottom-up managers is most likely attributable to their security selection skills. Some portion of their active return can also be explained through exposure to rewarded factors. Top-down managers' alphas are largely derived from factor timing.

3.2 The Implementation Process: The Objectives and Constraints

The simplest conceptual way to think about portfolio construction is to view it as an optimization problem. A standard optimization problem has an objective function and a set of constraints. The objective function defines the desired goal while the constraints limit the actions one can take to achieve that goal. Portfolio managers are trying to achieve desirable outcomes within the bounds of permissible actions. The nature of the objective function and the nature and specifics of the constraints can be indicative of an investment manager's philosophy and style.

A common objective function in portfolio management is to maximize a risk-adjusted return. If risk is being measured by predicted active risk, then the objective function is seeking to maximize the information ratio (the ratio of active return to active risk). If risk is being measured by predicted portfolio volatility, then the objective function is seeking to maximize the Sharpe ratio (the ratio of return in excess of the risk-free rate to portfolio volatility). Ideally, these objective functions would specify *net* returns—adjusted for the costs associated with implementation.

Typical constraints in the portfolio optimization problem may include limits on geographic, sector, industry, and single-security exposures and may also specify limits on transaction costs (to limit turnover and/or help manage liquidity issues). They may also include limits on exposure to specific factors; for example, the investment process may specify a required minimum market capitalization for any single security or a minimum weighted average capitalization for the portfolio as a whole. Or it may specify a maximum price-to–book ratio for any single security or a maximum weighted average price-to-book ratio for the portfolio. Constraints can be defined relative to the benchmark or without regard to it. Setting constraints that properly express the risk dimensions being monitored, the desired level of risk taking, and the preferred portfolio structure while still allowing sufficient flexibility to achieve the risk and return goals is a challenging task. In principle, the active equity manager's portfolio is the final blend that maximizes the objective function subject to the portfolio constraints.

Not all portfolio managers engage in such a formalistic, scientific approach to portfolio construction. The objectives and constraints of systematic managers are explicitly specified, whereas those of discretionary managers are less explicitly specified. However, most managers at least conceptually optimize their portfolios using the expected returns for each security, their own view of risk, and constraints imposed by the stated portfolio construction process or by the client. For our purposes, it is useful to frame the problem in this technical manner to provide a framework for discussion of the portfolio construction process.

Objectives and constraints may be stated in absolute terms or relative to a benchmark. Exhibit 9 illustrates two generic objective functions—one that is absolute and one that is relative. Each is subject to a few specific constraints.

Exhibit 9 Objective Functions and Constraints

	Absolute Framework	Relative Framework
Objective Function:	*Maximize Sharpe Ratio*	*Maximize Information Ratio*
Constraint		
Individual security weights (w)	$w_i \leq 2\%$	$\lvert w_{ip} - w_{ib} \rvert \leq 2\%$
Sectors weights (S)	$S_i \leq 20\%$	$\lvert S_{ip} - S_{ib} \rvert \leq 10\%$
Portfolio volatility (σ)	$\sigma_p < 0.9\ \sigma_b$	—
Active risk (TE)	—	$TE \leq 5\%$
Weighted average capitalization (Z)	$Z \geq$ 20bn	$Z \geq$ 20bn

- The absolute approach seeks to maximize the Sharpe ratio; the relative approach seeks to maximize the information ratio.
- The absolute approach limits any single security position to no more than 2% of the portfolio and any single sector to no more than 20% of the portfolio; the relative approach imposes a constraint that a security must remain within ±2% of its index weight and sector weights must remain within ±10% of the index weights.
- The absolute approach imposes a portfolio volatility limit equal to 90% of the estimated benchmark volatility and imposes a minimum weighted average security capitalization of $20 billion; the relative approach imposes a 5% active risk limit and the same capitalization constraint.
- Managers can also combine relative and absolute constraints in the same framework, such as limiting sector deviations against a benchmark while imposing absolute limits on security positions.

Other optimization approaches specify their objectives in terms of the risk metrics, such as portfolio volatility, downside risk, maximum diversification, and drawdowns. These approaches do not integrate an explicit expected return component. However, they do implicitly create an exposure to risk factors. For example, products built using a risk-based objective function (such as minimum variance or maximum diversification)[22] often exhibit a Market beta below 1.0 and have a statistically significant exposure to the Value factor and to the low-minus-high-β factor.[23] This occurs because an objective function that seeks to manage or minimize risk will tend to favor value and low-beta securities.

Finally, not all objective functions are explicitly concerned with risk or returns. For example, Equation 7 shows an explicit objective function that might be specified by a quantitative manager seeking to maximize exposure to rewarded factors:

$$\text{MAX}\left(\sum_{i=1}^{N}\frac{1}{3}\text{Size}_i + \frac{1}{3}\text{Value}_i + \frac{1}{3}\text{Momentum}_i\right) \tag{7}$$

22 The maximum diversification concept seeks to maximize the ratio of the average volatility of securities within a portfolio to portfolio volatility. It does not seek to achieve the lowest volatility, but rather, it seeks to maximize the benefits that diversification can bring.

23 The low-minus-high-β factor compensation is justified as a structural impediment. Frazzini and Pederson (2014) expanded on an idea raised by Fischer Black (1972). They made the argument that investors looking for higher returns but who are constrained by borrowing limits bid up the prices of high-β securities.

where $Size_i$, $Value_i$, and $Momentum_i$ are standardized[24] proxy measures of Size, Value, and Momentum for security i.[25] The portfolio may also be subject to additional constraints similar to those in Exhibit 9.

Of course, articulating an explicit objective of maximizing the Sharpe ratio or the information ratio or minimizing a given risk measure implies that we have information about expected returns and expected risk. Some managers—typically discretionary managers—do not make explicit return and risk forecasts and instead seek to "maximize" their exposure to securities having specific characteristics. Embedded in their investment process is an implicit return-to-risk objective.

For example, the objective function of a discretionary manager may be expressed in a mission statement such as: "We are a deep value manager in large-cap US equity with a concentrated, best ideas style." They then identify securities possessing deep value characteristics (as they define value). The portfolio construction process will balance security concentration and sector exposure as the manager seeks to maximize the return at an acceptable level of risk. The allocation may be driven by the manager's judgment about the risk and return trade-offs, or a formal risk management protocol may be used to drive the allocation process, or a feedback mechanism may be put in place to ensure that constraints are being respected as the portfolio is being assembled or rebalanced by the manager.

When an explicit objective function is not used, many heuristic methodologies can be considered to determine security weighting in a portfolio. We list a few examples below.

- Identify securities that have the desired characteristics and weight them relative to their scoring on these characteristics. For example, a security with a price-to–book ratio of 8 would have half the weight of a security with a price-to-book ratio of 4.
- Identify securities that have the desired characteristics and weight them per their ranking or risk on these characteristics. For example, if there are five securities ranked on their price-to-book ratios, the security with the lowest price-to-book ratio would constitute 33% of the portfolio value [5/(5 + 4 + 3 + 2 + 1)] and the security with the highest price-to-book ratio would constitute 6.7% of the portfolio value [1/(5 + 4 + 3 + 2 + 1)].
- Identify stocks that have the desired characteristics, rank them according to how strongly they adhere to these characteristics, select the top x% of these stocks, and assign them portfolio weights based on one of several methodologies, such as equal weight, equal risk, scoring, or ranking on these characteristics. For example, if there are 1,000 securities in an index, the 500 securities with the lowest price-to-book ratios could be selected. Each security would then be weighted using the chosen methodology.

Although these alternative methodologies may be intuitively appealing, they may not allocate active risk as efficiently as a formal optimization framework would. The constraints and objective function will be strongly reflective of the philosophy and style of a manager. For example, a stock picker is likely to have fewer and more permissive constraints on security weights than a multi-factor manager seeking to minimize idiosyncratic risks. A manager specializing in sector rotation will have more permissive constraints with respect to sector concentration than a value manager.

24 Because it can be unwise to compare securities of different size, price-to-book ratio, and other metrics across sectors or countries, proxies of factors are often standardized by sectors or countries.

25 For example, a manager could rank securities per these three measures and determine a score for each security. For example, a small firm with a high book-to–price ratio and positive price momentum would score higher than a large firm with a low book-to-price ratio and negative price momentum. Other approaches could be used to attribute scores on each factor.

EXAMPLE 3

Approaches to Portfolio Construction

Marc Cohen is a portfolio manager whose primary skill is based on having a good understanding of rewarded sources of risk. He does not believe in factor timing. Sophie Palmer is a portfolio manager who believes she has skill in anticipating shifts in sector performance. She does not profess to have skill in individual security selection but tolerates significant deviations in sector exposure. Sean Christopher is a stock picker running a high-turnover strategy based on recent movements in market price among the Russell 1000 stock universe. He is highly sector and size agnostic and has significant active risk. Discuss the expected profile of each manager in terms of

- the sensitivity of their performance to risk factors,
- the level of security concentration, and
- the contribution of idiosyncratic risk to the total active risk of their portfolios.

Solution:

We should be able to explain a large part of Cohen's excess return using the performance of rewarded factors. We would not expect alpha to be a significant component of his performance. His exposure to risk factors would be relatively stable across time periods because he does not believe in factor timing. Because his primary emphasis is on long-term exposure to risk factors, he would hold a highly diversified portfolio to minimize idiosyncratic risk. As a multi-factor manager running a diversified portfolio, his active risk should be relatively low.

Palmer's performance is likely to be explained by tactical exposures to sectors, which we have said are unrewarded risks, rather than static exposures to known rewarded factor returns. Her excess performance against her benchmark will likely be attributed to alpha. With no professed skill in security selection, she is likely to hold a large number of securities in each sector to minimize idiosyncratic risk. The active risk arising from her sector weightings will overshadow the active risk from security weightings. Her active risk is likely to be higher than that of Marc Cohen.

Christopher's portfolio is more difficult to assess. His focus on recent price movements indicates a sensitivity to the Momentum factor, although the sensitivity to this factor may depend on the time horizons and methodologies he uses to measure price momentum. He is size agnostic and may at times have exposure to the Size factor, a smaller-cap bias. With the information given, we cannot make an inference regarding the diversification of his portfolio. As a discretionary manager, he is to run a concentrated portfolio in order to more closely monitor his positions. However, if he makes extensive use of quantitative tools in monitoring his portfolio, he may be able to hold a more diversified portfolio. His active risk will be high, and his performance is likely to have a significant alpha component, whether positive or negative.

EXAMPLE 4

Approaches to Portfolio Construction

Manager A uses a scoring process and seeks to maximize the portfolio score based on the factor characteristics of individual securities. His purpose is not to time factor exposure but to achieve an appropriate diversification of factor risks. His approach is fully systematic, and he has a tracking error constraint of less than 4%. No one position can be greater than 2%, irrespective of its benchmark weight.

Manager B has a strong fundamental process based on a comprehensive understanding of the business model and competitive advantages of each firm. However, Manager B also uses sophisticated models to make explicit three-year forecasts of the growth of free cash flow to determine the attractiveness of each security's current valuation. A committee of portfolio managers meets once a month to debate the portfolio allocation. The manager has a large staff of portfolio managers and analysts and thus can maintain wide coverage of companies within each industry. Individual positions are constrained to the lower of (1) benchmark weight + 2% or (2) five times the benchmark weight.

Manager C specializes in timing sector exposure and has little appetite for idiosyncratic risks within sectors. Using technical analyses and econometric methodologies, she produces several types of forecasts. The manager uses this information to determine appropriate sector weights. The risk contribution from any single sector is limited to 30% of total portfolio risk. The final decision on sector allocations rests with the manager.

Discuss each manager's implementation approach, security selection approach, portfolio concentration, objective function, and constraints.

Solution:

Manager A is best characterized as a systematic, bottom-up manager.

- *Implementation approach.* An implementation approach that is fully quantitative (allocations are unaffected by a portfolio manager's judgment) is systematic.
- *Security selection approach.* A scoring process that ranks individual securities based on their factor characteristics is a bottom-up approach.
- *Concentration.* Although the limit of no more than 2% of the portfolio in any single position means the portfolio could hold as few as 50 securities, the tracking error constraint of 4% indicates that the portfolio is likely diversified.
- *Objective function.* A process that aims to maximize the portfolio's score based on the factor characteristics of single securities is an example of an explicit objective function.
- *Constraints.* The tracking error constraint of less than 4% is a relative constraint function. The limit on any single position to no more than 2% of the portfolio is an absolute—not a relative—constraint. It does not depend on benchmark weights.

The following table summarizes this information for all three managers:

	Manager A	Manager B	Manager C
Implementation approach	Systematic	Discretionary	Discretionary
Security selection approach	Bottom-up	Bottom-up	Top-down

(continued)

	Manager A	Manager B	Manager C
Portfolio concentration	Diversified	Diversified	Security diversified Factor concentrated
Objective function	Explicit	Explicit	Explicit
Constraints	Relative and absolute	Relative	Absolute

4 ALLOCATING THE RISK BUDGET

Risk budgeting is a process by which the total risk appetite of the portfolio is allocated among the various components of portfolio choice. As an example, if the portfolio manager has an *ex ante* active risk budget explicitly provided by the client, with risk budgeting, she seeks to optimize the portfolio's exposures relative to the benchmark to ensure that the choices she makes among stocks, sectors, or countries make efficient use of the active risk budget. But *ex ante* active risk is just one possible measure of risk. An effective risk management process requires that the portfolio manager do the following:

- Determine which type of risk measure is most appropriate to her strategy.
  - For example, a long/short equity manager benchmarked against a cash plus target will usually prefer an absolute risk measure (such as total volatility of portfolio returns), whereas a long-only equity manager benchmarked against a capitalization-weighted index may prefer a relative risk measure (such as active risk).
- Understand how each aspect of the strategy contributes to its overall risk.
  - Total portfolio variance may be dominated by exposure to rewarded risk factors or by allocations to countries, sectors, or securities. If these exposures are dynamic, the timing of portfolio exposures also introduces risk. An important step in risk budgeting is to understand what drives a portfolio's risk and to ensure the portfolio has the right kinds of specific risks.
- Determine what level of risk budget is appropriate.
  - Targeted levels of risk vary widely among managers and strategies. Although there are general principles that limit the level of advisable risk in a specific strategy, it is also very much a policy issue.
- Properly allocate risk among individual positions/factors.
  - Whether the risk measure is absolute or relative, managers must efficiently allocate their targeted risk budget.

4.1 Absolute vs. Relative Measures of Risk

The choice between an absolute and a relative risk portfolio management orientation is driven by the mandate of the manager and the goals of investors. If the mandate is to outperform a market index over a horizon, such as three years, then the manager will focus on active risk. If the investment objective is expressed in terms of total returns, then the manager will likely focus on the volatility of portfolio returns.

Managers' beliefs about how they add value can influence the choice between an absolute and a relative risk measure. Some managers may believe that the benchmark-relative constraints so common in the world of investment management today inhibit the ability of their investment approach to realize its full potential. To address this issue, they may prefer either an absolute risk measure or a relative risk measure with a wide range of allowed deviations. An absolute risk measure is just that: Whatever the risk threshold, the portfolio risk must remain at or below that level. The manager is free to construct his portfolio without regard to the characteristics of the benchmark. A relative risk measure with wide bands around a central target implies a benchmark-relative approach with significant degrees of freedom to diverge from the characteristics of the benchmark. Ultimately, however, risk and reward will be measured relative to that benchmark. Although some large institutional investors have adopted investment strategies in recent years that are agnostic to the benchmark (an absolute/total return approach) or have had a very high active risk target in a benchmark-relative framework, most assets under management are managed under benchmark-relative mandates. Irrespective of whether a manager focuses on absolute risk or relative risk, the risks he chooses to take should be related to his perceived skills. All other risk should be diversified or minimized. For example,

- market timers should be concerned with timing their factor exposure,
- sector rotators should be concerned with timing their sector exposure, and
- multi-factor managers should be concerned with balancing their factor exposure.

The first step in determining how risk should be allocated is understanding the generic drivers of absolute and relative portfolio risk.

4.1.1 *Causes and Sources of Absolute Risk*

We start with the following fundamental principles:

- If a manager adds a new asset (such as a security) to his portfolio that has a higher covariance with the portfolio than most current securities, total portfolio risk will rise. (A high covariance with the existing portfolio can be driven by a high variance or a higher correlation of the new security with the portfolio.)
- If a manager replaces an existing security with another security that has a higher covariance with the portfolio than that of the security being replaced, total portfolio risk will rise.

These principles also work in reverse. Consider the three-asset portfolio in Exhibit 10.

Exhibit 10 Absolute Risk Attribution

			Correlation			Portfolio Risk Attribution	
	Portfolio Weight	Standard Deviation	Asset A	Asset B	Asset C	Contribution to Portfolio Variance	
						Absolute	%
Asset A	40%	20%	1	0.40	0.20	0.008416	59.22%
Asset B	50%	12%	0.40	1	0.20	0.005592	39.35%
Asset C	10%	6%	0.20	0.20	1	0.000204	1.44%
Portfolio	**100%**	**11.92%**	**0.88**	**0.78**	**0.20**	**0.014212**	**100%**

(continued)

Exhibit 10 (Continued)

	Covariance		
	Asset A	**Asset B**	**Asset C**
Asset A	0.040000	0.009600	0.002400
Asset B	0.009600	0.014400	0.001440
Asset C	0.002400	0.001440	0.003600
Portfolio	**0.020926**	**0.011129**	**0.001427**

Portfolio variance is a function of the individual asset returns and the covariance of returns between assets. In this example, the total variance is 0.014212, which equates to a portfolio standard deviation of 11.92%. Equation 8a expresses the calculation of total portfolio variance (V_p), and Equation 8b determines the contribution of each asset to portfolio variance (CV_i).

$$V_p = \sum_{i=1}^{n}\sum_{j=1}^{n} x_i x_j C_{ij} \tag{8a}$$

$$CV_i = \sum_{j=1}^{n} x_i x_j C_{ij} = x_i C_{ip} \tag{8b}$$

where

x_j = the asset's weight in the portfolio
C_{ij} = the covariance of returns between asset i and asset j
C_{ip} = the covariance of returns between asset i and the portfolio

In other words, the contribution of an asset to total portfolio variance is equal to the product of the weight of the asset and its covariance with the entire portfolio. For example, Asset A's contribution to total portfolio variance is calculated as follows:

Weight of Asset A × Weight of Asset A × Covariance of Asset A with Asset A	0.40 × 0.40 × 0.04
+ Weight of Asset A × Weight of Asset B × Covariance of Asset B with Asset A	+ 0.40 × 0.50 × 0.0096
+ Weight of Asset A × Weight of Asset C × Covariance of Asset C with Asset A	+ 0.40 × 0.10 × 0.0024
= Asset A's contribution to total portfolio variance	= 0.008416

The proportion of total portfolio variance contributed by Asset A is, therefore, 0.008416/0.014212 = 59.22%. Asset A, which has an allocation of 40%, accounts for nearly 60% of total portfolio variance. This is not surprising, because the correlation of Asset A with the portfolio is 0.88. Asset B contributes 39.35% of total portfolio variance, and Asset C contributes 1.44%.

As you read the foregoing discussion, you naturally thought of Assets A, B, and C as securities, but the "assets" might also be sectors, countries, or pools of assets representing risk factors (Value versus Growth, Small versus Large). Hence, if a manager specializes in sector rotation and replaces an allocation to one sector with an allocation to another sector having a higher covariance with the portfolio, total portfolio risk will increase.

We have explained risk by looking at how a single asset contributes to total portfolio variance, but a manager might also seek to understand how his portfolio variance can be attributed to factor exposures versus that which is unexplained by these factors. As we noted earlier, the risks a manager chooses to take should be related to his perceived skills. If the manager's skills can be attributed to certain factors, then he would want to minimize the level of portfolio risk not explained by those factors. The segmentation of absolute portfolio variance into these two components—variance attributed to factor exposure and variance unexplained—is expressed by Equation 9:[26]

$$V_p = \mathrm{Var}\left(\sum_{i=1}^{K}\left(\beta_{ip} \times F_i\right)\right) + \mathrm{Var}\left(\varepsilon_p\right) \tag{9}$$

If the manager's portfolio were the market portfolio, all the variance of the portfolio returns would be explained by a beta of 1 to the Market factor. Idiosyncratic risks would be fully diversified. However, as we move away from the market portfolio, total portfolio variance will be influenced by other factor exposures and other risks unexplained by factors.[27]

Exhibit 11 presents the risk factor attribution (as measured by the variance of returns) of the three products presented earlier in Exhibit 2: the Russell 1000 Index, the Russell 1000 Value Index, and a Value fund. Exhibit 11 shows that more than 100% of the absolute risk of the Russell 1000 Index is explained by the Market factor. The size exposure (the large-cap tilt of the Russell 1000 relative to the market) has a slight negative contribution to total risk.

The risk of the Russell 1000 Value Index is also dominated by the Market factor, and unsurprisingly, the Value factor explains 12.5% of total risk.

The Value fund appears to have much idiosyncratic risk. Its sensitivity to the Market factor is only 57.7%, whereas the Value factor accounts for 18.1% of total risk. Overall, the four factors account for slightly more than 74% of total portfolio risk, and almost 26% remains unexplained. The percentage of total variance that is explained corresponds to the R^2 of the regressions as reported in Exhibit 2.

Exhibit 11 Absolute Risk Factor Attribution, February 1990–December 2016[28]

	Russell 1000 Index	Russell 1000 Value Index	Value Fund
Market	100.4%	88.9%	57.7%
Size	–1.8%	–1.6%	1.8%
Value	0.2%	12.5%	18.1%
Momentum	0.5%	–5.2%	–3.5%
Total explained risk	99.3%	94.6%	74.1%
Total unexplained risk	0.7%	5.4%	25.9%
Total absolute risk (standard deviation annualized)	14.5%	14.2%	18.0%

Source: Calculations by authors.

26 Equation 9 is the same general formulation as Equation 6. However, Equation 6 was concerned with active risk.

27 There are two ways of determining the portion of the variance of returns attributed to factors versus idiosyncratic risk. One approach consists of simply calculating each period's returns attributed to factors (the sum of the product of factor coefficients and the factor returns, which is the first term of Equation 9) and then calculating the variance of the calculated return series. This is variance attributed to factors. It can then be compared with the actual portfolio variance. A second approach identifies the variance contribution of each individual factor. However, it requires the variance–covariance matrix of factors and the vector of factor coefficients.

28 The Market factor is built from a much larger universe of securities than traditional benchmarks, such as the Russell 1000. Therefore, we should not expect the β of indexes to the Market factor to necessarily equal one.

4.1.2 *Causes and Sources of Relative/Active Risk*

Relative risk becomes an appropriate measure when the manager is concerned with her performance relative to a benchmark. One measure of relative risk is the variance of the portfolio's active return (AV_p):

$$AV_p = \sum_{i=1}^{n}\sum_{j=1}^{n}(x_i - b_i)(x_j - b_j)RC_{ij} \quad \text{(10a)}$$

where

x_i = the asset's weight in the portfolio
b_i = the benchmark weight in asset i
RC_{ij} = the covariance of relative returns between asset i and asset j

The contribution of each asset to the portfolio active variance (CAV_i) is

$$CAV_i = (x_i - b_i)RC_{ip} \quad \text{(10b)}$$

where RC_{ip} is the covariance of relative returns between asset i and the portfolio.

If you are assessing risk using a relative risk construct, you can no longer assume that a lower-risk asset reduces active risk or that a higher-risk asset increases it. In fact, depending on the composition of the benchmark, a lower-risk asset could increase active risk whereas a higher-risk asset might reduce it.

Let's consider a simple example. Assume a benchmark is composed of a 50/50 allocation to two equity indexes. The portfolio is composed of allocations to these two indexes and to a third asset—cash. What happens to the active risk of the portfolio if, instead of a 50/50 allocation to the two indexes, the portfolio allocation is 40/40 and 20% in cash? The benchmark is still 50/50. Let's look at the contribution of the active weights to the active variance of the portfolio. Exhibit 12 presents the relevant information and the results.

Exhibit 12 Relative Risk Attribution

					Correlation of Active Returns			
	Benchmark Weight	Portfolio Weight	Standard Deviation	Active Risk	Index A	Index B	Cash	Variance of Active Returns Attributed to Each Asset
Index A	50%	40%	16%	5.0%	1.00	–1.00	–0.69	14.3%
Index B	50%	40%	10%	5.0%	–1.00	1.00	0.69	–14.3%
Cash	0%	20%	0.5%	12.0%	–0.69	0.69	1.00	100%
Total	100%	100%		2.4%	–0.69	0.69	1.00	100%

Index A and Index B have absolute volatilities of 16% and 10%, respectively, whereas cash has a very low volatility. The manager is concerned with active risk, however, not portfolio volatility. Both Index A and Index B have an active risk of 5% against the 50/50 benchmark. Cash has higher active risk because it has a low correlation with the equity benchmark.

Exhibit 12 shows that the correlations of active returns between the benchmark and Index A and between the benchmark and Index B are both –1.0. This is not a coincidence; it must be so. Because the benchmark comprises just these two indexes, any outperformance of one index relative to the benchmark must be offset by underperformance of the other index. Similarly, cash has a positive correlation of relative returns with one index and a negative relative correlation with the other.

This example illustrates that this portfolio's risk (defined here as variance of active returns) can be attributed entirely to the allocation to cash, which is a low-risk asset—in an absolute sense. Hence, in the context of relative measures of risk, what matters is not the volatility of an asset but its relative (active) volatility. Introducing a low-volatility asset within a portfolio benchmarked against a high-volatility index would increase the active risk. Similarly, introducing a high-volatility asset to a portfolio might lower the active risk if the asset has a high covariance with the benchmark. These principles hold whether allocating among countries, sectors, securities, or other factors.

Exhibit 13 is similar to Exhibit 11, but it considers the attribution of active risk rather than absolute risk. It shows how much of the active risk of each product can be attributed to the four factors and how much remains unexplained. The Russell 1000 Index has some active risk (though very low, at 2% annualized). The active risk of the Russell 1000 Value Index and the Value fund are higher, at 6.0% and 11.4%, respectively.[29]

The Market factor does not explain much of the active risk; the very action of building a portfolio that is structurally different from the market creates the active risk. The two indexes have a significant portion of their active risk explained by the four rewarded factors. More than half of the active risk of the Russell 1000 Index is generated from the larger-cap tilt of the index. About 37% of the active risk remains unexplained. More than half of the active risk of the Russell 1000 Value Index is generated from the value tilt of the index. About 31% of the active risk remains unexplained. Finally, the Value fund has significant active risk (11.4%). Virtually all of this risk can be attributed the Value factor. In this case, though, nearly two-thirds of the active risk remains unexplained. An investor would want to investigate more carefully what is driving the active risk of the value manager.

Exhibit 13 Active Risk Factor Attribution, February 1990–December 2016

	Russell 1000	Russell 1000 Value	Value Fund
Total active risk	2.0%	6.0%	11.4%
Risk Factor Contribution to Active Risk			
Market	3.0%	6.0%	1.2%
Size	56.4%	15.4%	0.8%
Value	3.0%	53.9%	38.4%
Momentum	0.5%	–5.4%	–4.1%
Total explained risk	62.8%	69.9%	36.4%
Total unexplained risk	37.2%	31.1%	63.6%

Source: Calculations by authors.

4.2 Determining the Appropriate Level of Risk

Listed below are representative examples of risk targets for different mandates:

- a market-neutral hedge fund targeting an absolute risk of 10%,
- a long-only equity manager targeting an active risk of something less than 2% (a closet indexer),

29 For a detailed explanation of risk decomposition, see MacQueen (2007).

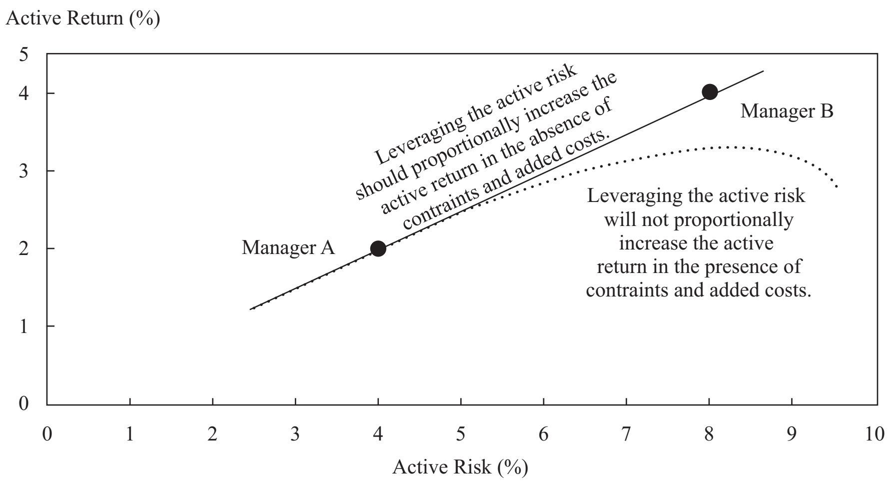
- a long-only manager targeting active risk of 6%–10% (benchmark agnostic), and
- a benchmark-agnostic equity manager targeting an absolute risk equal to 85% of the index risk.

Establishing the appropriate level of absolute or relative risk is a subjective exercise, highly sensitive to managers' investment style and their conviction in their ability to add value using the various levers at their disposal. Managers with similar investment approaches may have very different risk appetites. This has implications for portfolio structure, portfolio turnover, and other facets of portfolio implementation. Managers must clearly communicate to investors their overall risk orientation, and investors must understand the implications of this risk orientation. This does not mean that a strategy can or should be executed at any level of risk. Here are three scenarios that give some insights into practical risk limits:

- portfolios may face implementation constraints that degrade the information ratio if active risk increases beyond a specific level;
- portfolios with high absolute risk targets face limited diversification opportunities, which may lead to a decrease in the Sharpe ratio; and
- there is a level of leverage beyond which volatility reduces expected compounded returns.

Implementation constraints. Consider two managers (A and B), each with a relative risk focus. Irrespective of the targeted level of active risk, the managers seek to use that risk efficiently. They are concerned with the ratio of active return to active risk—the information ratio. Assume that their portfolios have the same information ratio but different levels of active risk. If the investor is willing to tolerate the higher level of active risk, Manager A might proportionately scale up his active risk to match the active risk level of Manager B. He would accomplish this by scaling up his active weights, which would increase Manager A's excess returns while maintaining the same information ratio. This scenario is illustrated in Exhibit 14.

Exhibit 14 Active Returns and Active Risk



However, there may be constraints that prevent Manager A from scaling his active weights. For example, if the investment policy does not allow short positions, he may be unable to increase underweights. If the policy does not allow leverage, he may be unable to increase overweights. If some of the security positions have poor liquidity, leveraging these positions may be imprudent and may also have a trading cost impact. If the policy restricts maximum position sizes, Manager A may be unable to proportionately scale his active risk.[30]

Limited diversification opportunities. Consider a manager with a high absolute risk target. Despite his higher risk tolerance, he still strives to use risk efficiently. We know, though, that twice the absolute risk will not lead to twice the return: The mathematics of the Markowitz efficient investment frontier clearly shows that the relationship between return and risk is concave. Expected returns increase with risk but at a declining pace. Portfolios with higher risk/return targets eventually run out of high-return investment opportunities and lose the ability to diversify efficiently, thereby reducing the Sharpe ratio.

Leverage and its implications for risk. Sharpe demonstrated that if there is a risk-free rate at which investors can borrow or lend, there is a linear relationship between absolute risk and return in a one-period setting. Managers can scale expected returns and absolute risk up or down proportionately and maintain a constant, optimal Sharpe ratio. A manager could choose to leverage her portfolio to extend the implementation limits of a strategy. However, as we show below, leverage eventually leads to a reduction of expected compounded return in a multi-period setting.

We know that the expected compounded/geometric return of an asset (R_g) is approximately related to its expected arithmetic/periodic return (R_a) and its expected volatility (σ):[31]

$$R_g = R_a - \sigma^2/2 \tag{11}$$

For example, let's consider again the performance of the Russell 1000 between February 1990 and December 2016. The average monthly compounded return was 0.789%, the monthly arithmetic return was 0.878%, and the volatility, as measured by the standard deviation of return, was 4.199%. Applying Equation 11, we obtain the compounded return as follows:

$$R_g = 0.878\% - \frac{4.199\%^2}{2} = 0.790\%$$

which is very close to the realized compounded return. Now, what happens to the relationship between the arithmetic return and the compounded return when leverage is used? Let's consider an asset with a 20% standard deviation and a 10% expected arithmetic return. This asset has an expected compounded return of 8%:

$$10\% - 20\%^2/2 = 8\%$$

Ignoring the cost of funding, if we leverage the asset by a factor of 2, the expected compounded return increases to 12%:

$$2 \times 10\% - (2 \times 20\%)^2/2 = 12\%$$

If we leverage the asset by a factor of 3, however, there is no additional improvement in return:

$$3 \times 10\% - (3 \times 20\%)^2/2 = 12\%$$

30 This constraint is also implicit in the full fundamental law of active management, which expresses the main sources of active returns. The transfer coefficient represents the ability to translate portfolio insights into investment decisions without constraint. If a manager is limited in his ability to implement his strategy, the transfer coefficient will decline. If he attempts to maintain the same level of active risk, his information ratio will also decline. In this case, there is an optimal/maximum level of active risk.

31 The arithmetic return and the geometric returns are the same only when there is no volatility.

If we incorporate the cost of funding leverage, the active return is reduced while the volatility remains proportional to the amount of leverage. The Sharpe ratio will decline even faster. For example, using the same example, we could show that a portfolio with a leverage of 3× would have the same expected return as an unlevered portfolio if the cost of funding leverage were 2%:

$$(3 \times 10\% - 2 \times 2\%) - (3 \times 20\%)^2/2 = 8\%$$

Furthermore, if the realized volatility is significantly greater than expected, such as in crisis time, the combined impact of volatility and leverage on compounded return could be dramatic.

The information ratio and the Sharpe ratio will not always be degraded by a reasonable rise in active or absolute risk, and a reasonable level of leverage can increase expected compounded return. The appropriate tactics must be evaluated by the manager in the context of his investment approach and investors' expectations.

4.3 Allocating the Risk Budget

We have explained how absolute and relative risk are determined by the position sizing of assets/factors (absolute or relative) and by the covariance of assets/factors with the portfolio (absolute or relative). By understanding both components (position sizing and covariance), a manager can determine the contribution of each position (whether a factor, country, sector, or security) to the portfolio's variance or active variance.

Let's consider a benchmark-agnostic US sector rotator. Although he himself is benchmark agnostic, his client is going to evaluate his performance relative to *some* benchmark—one that represents the universe of securities he typically draws from. The nature of his strategy indicates that he will likely exhibit a high level of active risk. In assessing whether he has effectively used this risk budget, the client will look to decompose the sources of realized risk: How much is attributable to market risk and other risk factors? How much is attributable to other decisions, such as sector and security allocation? If the manager runs a concentrated portfolio, we should expect sector and security allocation to be the main source of active risk. Although all these aspects may not be explicit elements of his portfolio construction process, because his effectiveness will be evaluated using these metrics, he would be well served to understand their contributions to his risk and return.

A fund's style and strategy will also dictate much of the structure of its risk budget. We explore this further with an examination of the three US equity managers presented in Exhibit 15A. All managers draw their securities from a universe of large-cap and mid-cap securities defined by the Russell 1000, which has a weighted average market capitalization of approximately $133 billion. The first two managers believe their skill is their ability to create balanced exposures to rewarded risk factors. The third specializes in sector timing, but he also makes significant use of cash positions. The first two managers have many securities in their portfolios, which suggests that their active risk is unlikely to be driven by idiosyncratic risks related to security concentration. Their low level of security concentration is consistent with their respective investment style.

The third manager runs a highly concentrated portfolio. As a sector rotator, he is exposed to significant unrewarded risk related to his sector views and to idiosyncratic risk related to his security views. A sector rotator could choose to run either a diversified portfolio or a highly concentrated portfolio within sectors. Manager C chose the latter. A greater concentration of risk implicitly leads to a greater sensitivity to unrewarded factors and idiosyncratic risks.

Exhibit 15A Comparative Sources of Risk, Drivers of Return

	Manager A	Manager B	Manager C
Investment Approach:	**Factor Diversified**	**Factor Diversified**	**Sector Rotator**
Number of securities	251	835	21
Weight of top 5 securities	6.54%	3.7%	25.1%
Cash and bond position	0.8%	0.0%	21.3%
Weighted average capitalization ($ billions)	33.7	21.3	164.0
Market beta	0.90	0.97	1.28
Absolute risk	10.89%	10.87%	11.69%
Active risk	3.4%	3.6%%	4.5%
Active Share	0.76	0.63	0.87
Average sector deviation	3.6%	3.9%	5.6%
Source of risk: Market	98.0%	99.2%	69.2%
Source of risk: Sectors	–0.8%	–3.8%	11.6%
Source of risk: Styles	1.8%	4.2%	9.7%
Unexplained	1.0%	0.4%	9.5%

Note: Manager C owns 49 positions, but several of these positions are cash and bond related.
Source: Bloomberg.

None of the managers is tightly tracking the benchmark; active risk exceeds 3% for all three. Somewhat surprisingly, the active risk of the sector rotator (4.5%) is only slightly greater than that for the other managers, especially given that the rotator has 25.1% of his portfolio invested in the top five positions and holds 21.3% in cash and bonds.[32] The large position in cash and bonds may also explain why the absolute volatility is not higher. We can see, however, that the sector rotator is taking less of a size bet: The weighted average capitalization of his portfolio is close to that of the index, whereas the weighted average capitalization of the two factor managers is quite low. This smaller size bet is likely what has constrained the active risk of the sector rotator.

Although managers may view their investment process and evaluation of securities as benchmark agnostic, the outcomes may, in fact, be similar to the benchmark along critical dimensions, such as active risk. The portfolio construction process of multi-factor managers often leads to a balanced exposure to risk factors, constraining active risk. The sector rotator has a higher level of active risk, but not dramatically so. The returns of the sector rotator are more driven by concentrated sector and style exposures than are the returns of the multi-factor managers. These differences are likely to influence returns over shorter horizons. Two strategies with similar active risk may have very different patterns of realized returns. When evaluating an investment manager, the asset owner needs to understand the drivers of active risk that can lead to differences in realized portfolio returns over time.

The strategy and portfolio structure of Manager C is also revealed by the sources of absolute risk. The risk attribution in Exhibit 15 not only considers the Market factor but also adds a sector factor and a style factor.

32 The active risk is calculated from daily data over a one-year horizon. This calculation usually leads to a lower active risk than would be obtained from monthly data over a longer period.

The exposures of Managers A and B are dominated by the Market factor. Manager B's active risk, however, can be explained in part by the sector and style factors: The sector exposure reduces risk by 3.8%, and the style exposure increases it by 4.2%.

Let's look more closely at the risk profile of Manager C in Exhibit 15B.

Exhibit 15B

	Manager C	
Investment Approach:	**Sector Rotator**	**Risk Positioning Relative to Managers A and B**
Number of securities	21	Very concentrated; high levels of security-specific risk
Weight of top 5 securities	25.1%	
Cash and bond position	21.3%	Large cash position dampens overall portfolio volatility
Weighted average capitalization ($ billions)	164.0	Much closer to the capitalization of the index
Market beta	1.28	Significantly higher, consistent with the absolute risk measures
Absolute risk	11.69%	Absolute risk only slightly higher, likely dampened by the large cash position
Active risk	4.5%	Higher
Active Share	0.87	High, consistent with the level of security concentration
Average sector deviation	5.6%	Higher, consistent with willingness to take sector bets
Source of risk: Market	69.2%	Significantly less exposure to the Market factor, consistent with a concentrated, high-Active-Share manager
Source of risk: Sectors	11.6%	Significantly more Sector risk
Source of risk: Styles	9.7%	Significantly more Style risk
Unexplained	9.5%	Significantly higher proportion of risk is unexplained

Taken together, these measures indicate a benchmark-agnostic strategy with significant and concentrated security, sector, and style exposures.

EXAMPLE 5

Application of Risk Budgeting Concepts

1 Using the information in Exhibit 15, discuss key differences in the risk profiles of Manager A and Manager C.

2 The table below presents the risk factor coefficients of a four-factor model and the factor variance–covariance matrix of a manager running a low-risk strategy. All data are monthly. The monthly standard deviation of the manager's return is 3.07%. What portion of the total portfolio risk is explained by the Market factor?

		Variance/Covariance of Returns			
	Coefficients	**Market**	**Size**	**Value**	**Momentum**
Market	0.733	0.00178	0.00042	0.00066	–0.00062
Size	–0.328	0.00042	0.00048	0.00033	–0.00035
Value	0.045	0.00066	0.00033	0.00127	–0.00140
Momentum	0.042	–0.00062	–0.00035	–0.00140	0.00214

3 If a manager benchmarked against the FTSE 100 makes a significant allocation to cash, how will that allocation affect the portfolio's absolute risk and active risk?

4 Manager A has been running a successful strategy achieving a high information ratio with a relatively low active risk of 3.4%. The manager is considering offering a product with twice the active risk. What are the obstacles that may make it difficult for the manager to maintain the same information ratio?

Solution to 1:

Manager C holds significantly fewer positions than Manager A, and the weight of his top five securities is nearly four times that of Manager B. This indicates a willingness to assume a much higher level of idiosyncratic risk. This observation is reinforced by Manager C's higher Active Share and higher proportion of unexplained risk. The Market beta of Manager C is significantly greater, and the risk decomposition indicates that Manager C appears more willing to make sector and style bets. Finally, the absolute risk of Manager's C portfolio is higher, even though it appears that he makes greater use of lower-risk bond and cash positions.

Solution to 2:

91% of total portfolio risk is explained by the Market factor. From Equation 8b (repeated below), the contribution of an asset to total portfolio variance is equal to the product of the weight of the asset and its covariance with the entire portfolio. To calculate the variance attributed to the Market factor,

$$CV_i = \sum_{j=1}^{n} x_i x_j C_{ij} = x_i C_{ip} \quad \text{(8b)}$$

where

x_j = the asset's weight in the portfolio

C_{ij} = the covariance of returns between asset i and asset j

C_{ip} = the covariance of returns between asset i and the portfolio

Therefore, the variance attributed to the Market factor is

(0.733 × 0.00178 × 0.733) + (0.733 × 0.00042 × −0.328) + (0.733 × 0.00066 × 0.045) + (0.733 × −0.00062 × 0.042) = 0.000858

Divide this result by the portfolio variance of returns:

$0.000858/3.07\%^2$ = 0.000858/0.000942 = 91% of total portfolio variance is explained by the Market factor.

Solution to 3:

Cash has a low volatility and a low correlation of returns with any asset. Therefore, it will contribute to a reduction in absolute risk. However, because cash has a low correlation with other assets, it will contribute to an increase in active risk.

Solution to 4:

If the manager is running a long-only portfolio without leverage, she is likely able to increase her exposure to securities she wants to overweight, but she may be limited in her ability to reduce exposure to securities she wishes to avoid or underweight. Increased exposure to the most desirable securities (in her view) will lead to increased security concentration and may substantially increase active risk. The manager risks a degradation of her information ratio if there is not a corresponding increase in her active return. If the manager can short, she will be able to increase underweighting when desired (assuming the securities can be easily borrowed). Although leverage can increase total exposure and reduce concentration issues, its impact on volatility may be substantial, and the additional return enabled by leverage may be eroded by the impact of the increased volatility on compounded returns and the other associated costs.

5 ADDITIONAL RISK MEASURES USED IN PORTFOLIO CONSTRUCTION AND MONITORING

5.1 Heuristic Constraints

Risk constraints imposed as part of the portfolio construction process may be either formal or heuristic. Heuristic constraints appear as controls imposed on the permissible portfolio composition through some exogenous classification structure. Such constraints are often based on experience or practice, rather than empirical evidence of their effectiveness. These risk controls may be used to limit

- exposure concentrations by security, sector, industry, or geography;
- net exposures to risk factors, such as beta, size, value, and momentum;
- net exposures to currencies;
- degree of leverage;
- degree of illiquidity;
- turnover/trading-related costs;
- exposures to reputational and environmental risks, such as actual or potential carbon emissions; and
- other attributes related to an investor's core concerns.

A major concern of any portfolio manager is a risk that is unknown or unexpected. Risk constraints are one way that managers try to limit the portfolio losses from unexpected events. Listed below are sample heuristic constraints that may be used by a portfolio manager:

- Any single position is limited to the lesser of
  - five times the weight of the security in the benchmark or
  - 2%.
- The portfolio must have a weighted average capitalization less than 75% of that of the index.
- The portfolio may not size any position such that it exceeds two times the average daily trading volume of the past three months.
- The portfolio's carbon footprint must be limited to no more than 75% of the benchmark's exposure.

Such heuristic constraints as these may limit active managers' ability to fully exploit their insights into expected returns, but they might also be viewed as safeguarding against overconfidence and hubris.

Managing risk through portfolio characteristics is a "bottom-up" risk management process. Managers that rely on such an approach express their risk objectives through the heuristic characteristics of their portfolios. The resulting statistical risk measures of such portfolios do not drive the portfolio construction process but are an outcome of those heuristic characteristics. For example, if a manager imposes maximum sector deviations of ±3% and limits security concentration to no more than the index weight + 1% or twice the weight of any security in the index, then we could expect the active risk of that portfolio to be small even if no constraint on active risk is explicitly imposed. The portfolio construction process ensures that the desired heuristic risk is achieved. Continuous monitoring is necessary to determine whether the evolution of market prices causes a heuristic constraint to be breached or nearly breached.

Managers will often impose constraints on the heuristic characteristics of their portfolios even if they also use more formal statistical measures of risk. The investment policy of most equity products, for example, will usually specify constraints on allocations to individual securities and to sectors or, for international mandates, regions. Some may also have constraints related to liquidity and capitalization. Even managers with a low-volatility mandate will have security and sector constraints to avoid unbalanced and concentrated portfolio solutions that may have significant idiosyncratic risk or allocations that are unduly influenced by estimation error.

5.2 Formal Constraints

Formal risk measures are distinct from these heuristic controls. They are often statistical in nature and directly linked to the distribution of returns for the portfolio.

Formal measures of risk include the following:

- Volatility
- Active risk
- Skewness
- Drawdowns
- Value at risk (VaR)
- Conditional Value at risk (CVaR)
- Incremental Value at risk (IVaR)
- Marginal Value at risk (MVaR)

A major difference between formal and heuristic risk measures is that formal measures require a manager to estimate or predict risk. For example, a formal risk measure might be that predicted active risk be no more than, say, 5%. With the benefit of hindsight, one can always calculate the historical active risk, but in portfolio construction, the forward-looking view of risk and active risk is what matters: Portfolio decisions are based on these forward-looking estimates. If predicted risk deviates substantially from realized risk, it is likely that portfolio performance will be quite different than expected. In times of crisis or financial stress, predicted and realized risks could diverge very significantly.

Exhibit 16 presents five different risk measures for the same three products discussed in Exhibit 15. Four one-day VaR measures are presented: VaR and CVaR at two different levels of probability (1% and 5%).

Exhibit 16 Risk Measures

	Manager A	Manager B	Manager C
Risk Measure	**Factor Diversified**	**Factor Diversified**	**Sector Rotator**
Absolute risk	10.89%	10.87%	11.69%
Active risk	3.4%	3.6%%	4.5%

(continued)

Exhibit 16 (Continued)

Risk Measure	Manager A Factor Diversified	Manager B Factor Diversified	Manager C Sector Rotator
VaR (5%)	1.08%	1.11%	1.20%
VaR (1%)	1.77%	1.77%	1.87%
CVaR (5%)	1.50%	1.53%	1.65%
CVaR (1%)	2.21%	2.24%	2.41%

Source: Bloomberg.

In this example, Manager A has a 5% probability of realizing a one-day loss greater than 1.08% and a 1% probability of a loss greater than 1.77%. If we look at the distribution of losses beyond the 5% and 1% probability levels, the averages of the tail losses (CVaR) are 1.50% and 2.21%, respectively. Despite the high security concentration, the loss estimates of Manager C are not much higher than those of Managers A and B, most likely because of the large position in cash and bonds.

Risk Measures

- Volatility is the standard deviation of portfolio returns.
- Active risk is the standard deviation of the differences between a portfolio's returns and its benchmark's returns. It is also called *tracking error* or *tracking risk*.
- Skewness is a measure of the degree to which return expectations are non-normally distributed. If a distribution is positively skewed, the mean of the distribution is greater than its median (more than half of the deviations from the mean are negative and less than half are positive) and the average magnitude of positive deviations is larger than the average magnitude of negative deviations. Negative skew indicates that the mean of the distribution lies below its median and the average magnitude of negative deviations is larger than the average magnitude of positive deviations.
- Drawdown measures the portfolio loss from its high point until it begins to recover.
- VaR is the minimum loss that would be expected a certain percentage of the time over a specific period of time (e.g., a day, a week, a month) given the modeled market conditions. It is typically expressed as the minimum loss that can be expected to occur 5% of the time.
- CVaR is the average loss that would be incurred if the VaR cutoff is exceeded. It is also sometimes referred to as the **expected tail loss** or **expected shortfall**. It is not technically a VaR measure.
- IVaR is the change in portfolio VaR when adding a new position to a portfolio, thereby reducing the position size of current positions.
- MVaR reflects the effect of a very small change in the position size. In a diversified portfolio, marginal VaR may be used to determine the contribution of each asset to the overall VaR.

Formal risk constraints may be applied as part of a portfolio optimization process (as is common with systematic strategies) or using an iterative feedback mechanism to determine whether the portfolio would remain within the risk tolerance limits given the proposed change (an approach more common among discretionary managers).

All risk measures, whether formal or heuristic, can be expressed on an absolute basis or relative to a benchmark. For example, a benchmark-aware long-only equity manager may limit sector deviations to 5%, whereas a long/short hedge fund manager concerned with the overall diversification of his portfolio may limit any given sector exposure to no more than 30% of his gross exposure. Similarly, a long-only equity manager may limit active risk to 5%, whereas a long/short equity manager may limit overall portfolio volatility to 10%. In many cases, the investment policy imposes both formal and heuristic constraints on a portfolio. Exhibit 17 illustrates a product for which the investment policy statement considers constraints on both types of risk measures.

Exhibit 17 Sample Investment Policy Risk Constraints

The MSCI Diversified Multi-Factor Index

This index uses an optimization process to maximize the exposure score to several risk factors. The index seeks to achieve this objective while controlling for several portfolio and risk characteristics, such as the following:

- Weight of index constituents: maximum of weight in the parent (capitalization-weighted) index + 2% or 10 times weight in the parent index
- Sector weights: restricted to a 5% deviation against the parent index
- Exposure to style factors, such as growth and liquidity: restricted to a 0.25 standard deviation from the parent index
- Limit on volatility: restricted to a 0.25 standard deviation from the parent index

5.3 The Risks of Being Wrong

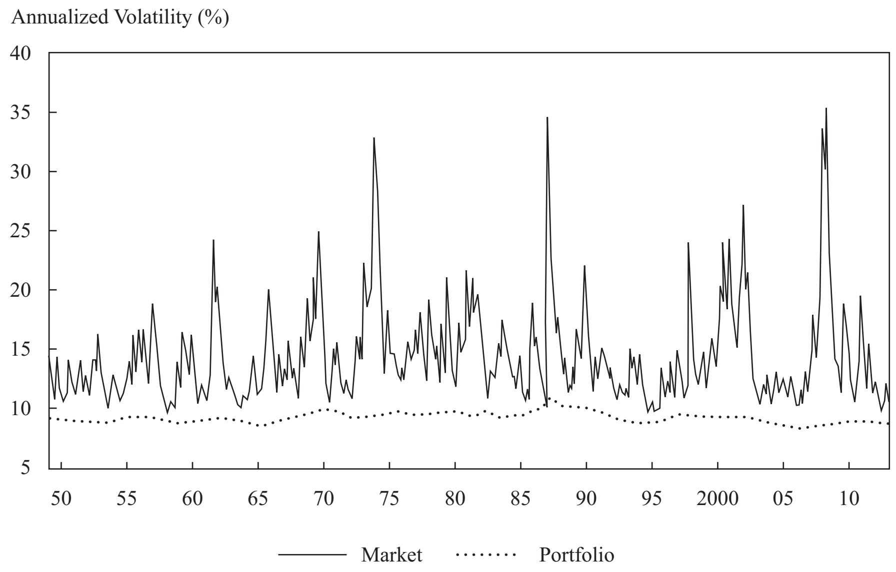
The consequences of being wrong about risk expectations can be significant but even more so when a strategy is leveraged. In 2008, for example, a hedge fund owned a two-times levered portfolio of highly rated mortgage-related securities. Although the specific securities were not materially exposed to subprime mortgages, concerns about the economy and poor market liquidity led to a steep decline in the prices of these securities. Prices quickly recovered, but the presence of the 2× leverage combined with an unprecedented price decline led to a forced liquidation of the assets just a few days before prices recovered. The manager and his investors lost all capital.

Similarly, a pension fund created an indexed equity position by combining an investment of short-term highly rated (AAA) commercial paper with an equivalent notional position in equity derivatives (a receiver swap on a large-cap equity index), creating a synthetic indexed equity position. In principle, this pension fund believed it owned the equivalent of an index equity position. However, as the liquidity crisis worsened in 2008 and early 2009, the pension fund was faced with a substantial decline in equity markets *and* a simultaneous spike in the perceived riskiness of the short-term commercial paper. The equity derivatives position and the commercial paper each lost 50% of their value, creating a paper loss equivalent to 100% of the invested capital. Although both components eventually recovered, such unexpected losses can lead to a forced liquidation of all or part of the portfolio in an unfavorable market environment, crystalizing the losses.

Exhibit 18 illustrates the time-varying volatility of the S&P 500. Although volatility remains in a range of 10%–20% most of the time, periods of much higher volatility are observed: in 1973–1974 during the first oil shock, in 1987 during the October crisis, in 2000–2002 when technology stocks collapsed, and during the 2008 liquidity crisis. Effective risk management requires the manager to account for the fact that unexpected volatility can derail the investment strategy. Furthermore, spikes in volatility can also be sector specific—the technology sector in the early 2000s and the energy sector in 2014 and 2015. Therefore, what may seem to be an acceptable sector deviation limit in normal times may be the source of significant active losses in a different environment. Some managers may tighten risk constraints in more volatile periods to protect the portfolio against excessive variability.

Despite these "tail events," risk can usually be managed efficiently. The dotted line in Exhibit 18[33] shows the realized volatility of a portfolio dynamically allocated between the S&P 500 Index and short-term bonds. The portfolio targets a 10% annualized volatility.[34] The realized volatility stayed very close to the target.

Exhibit 18 Volatility of the S&P 500, 1950–2015



The statistical risk measures used in equity portfolio construction often depend on the style of management. A benchmark-agnostic manager with an absolute return philosophy is less likely to be concerned with active risk but is much more likely to be concerned with drawdowns. A long/short equity manager who neutralizes market risk but is exposed to other risk premiums is likely to target a volatility within a specific range.

33 Langlois and Lussier (2017).

34 The management of this portfolio required forecasts of volatility and correlation for both assets. The same general techniques described in footnote 15 were used.

Portfolios with a very limited number of securities may be more difficult to manage using formal risk measures because estimation errors in portfolio risk parameters are likely to be higher: The dispersion in possible outcomes may be wide, and the distributions may not easily conform to standard assumptions underlying many of the formal risk measures.

This does not mean, however, that these measures cannot be used on an *ex ante* basis. It merely suggests that they should be used with an understanding of their limitations. For example, VaR is particularly useful to a pension plan sponsor that has a multi-asset-class portfolio and needs to measure its exposure to a variety of risk factors (Simons, 2000). However, this information may be less useful to an equity manager holding only 40 equity positions. Measures of risk and their efficacy must be appropriate to the nature and objective of the portfolio mandate.

Formal, statistical measures of risk are often not outlined in investment policy statements even if the manager is actively tracking such risks and using such measures to adjust security weights. One reason may be the difficulty in measuring and forecasting such measures as volatility and value at risk. The resultant answers are likely to be different depending on what methodology is used. Even if the historical measures were in alignment with one another, what happened in the past will not necessarily be indicative of what is to come. When formal, statistical measures of risk are used by managers, they are typically expressed as a soft target, such as, "We are targeting a 10%–12% annualized volatility."

Calibrating risk is as much an art as it is a science. If an active manager imposes restrictions that are too tightly anchored to her investment benchmark (or perhaps these restrictions are imposed by the investor), the resulting portfolio may have performance that too closely mirrors that of the benchmark.

EXAMPLE 6

Risk Measures in Portfolio Construction

Matthew Rice runs a discretionary equity strategy benchmarked on the Russell 1000 Index. His fund contains approximately 80 securities and has recently passed $2 billion in assets. His strategy emphasizes quality companies that are attractively priced within their sector. This determination is based on careful analyses of the balance sheet, free cash flows, and quality of management of the companies they invest in. Rice is not benchmark agnostic, but his strategy does require the ability to tolerate some sector deviations because attractive positions are sometimes concentrated in three or four sectors. Rice is supported by a team of six analysts but makes all final allocation decisions. Historically, no single position or bet has dominated the performance of the fund. However, Rice believes there is no point in holding a position so small that it will barely affect excess returns even if it is successful. Rice does not believe in taking aggressive views. His investors do not expect him to have the active risk of a sector rotator. The portfolio has lower turnover than that of most of his peers. Single positions can easily remain in the portfolio for two or three years.

1 What heuristic constraints could be appropriate for such a fund?

2 What role might such statistical measures as VaR or active risk play in the management of Rice's fund?

Solution to 1:

Because no single position or bet has dominated historical returns, a heuristic constraint on maximum position size is a logical one. Given that his portfolio is built around a relatively small number of positions (80), single positions might be constrained to no more than 3%. Given his view on small position sizes, a minimum position size of 0.5% might also be appropriate.

Rice's strategy requires some active risk, but he could not tolerate the sector deviations taken by a sector rotator. A sector constraint in the range of ±5%–7.5% relative to the index is appropriate for his strategy.

The fund's benchmark incorporates many mid-cap securities. With $2 billion in assets, a single position can be as small as $10 million (0.5%) but as high as perhaps $60 million (3%). Positions on the higher end of this range could represent a large portion of the average daily trading of some mid-cap securities, which range in size from $2 billion to $10 billion. The fund's long investment horizon means that trading into and out of a position can be stretched over days or even weeks. Nevertheless, it could make sense to consider a constraint that accounts for the size (capitalization) of individual securities and their trading volume, such as not owning more than five times the capitalization weight in the index of any security.

Solution to 2:

Discretionary managers usually do not use statistical measures as hard constraints, but they can be used as guidelines in the portfolio management process. A fund that contains only 80 positions out of a universe of 1,000 possible securities and takes views across capitalization and sectors is likely to see significant variability in its active risk or VaR over time. Although Rice is not very sensitive to what happens in the short run (he is a long-term investor), statistical measures can be used to monitor changes in the risks within his portfolio. If these risk exposures deviate from his typical risk exposures, it might signal a need to investigate the sources of such changes and initiate some portfolio changes if those exposures are unwanted.

6 IMPLICIT COST-RELATED CONSIDERATIONS IN PORTFOLIO CONSTRUCTION

There are numerous costs that can affect the net performance of an investment product. The same investment strategy can easily cost twice as much to manage if a manager is not careful with her implementation approach. Assets under management (AUM) will affect position size. Position size and the liquidity of the securities in the portfolio will affect the level of turnover that can be sustained at an acceptable level of costs.[35] Although smaller-AUM funds may pay more in explicit costs (such as broker commissions), these funds may incur lower implicit costs (such as delay and market impact) than large-AUM funds. Overall, smaller funds may be able to sustain greater turnover and still deliver superior performance. A manager needs to carefully weigh both explicit and implicit costs in his implementation approach.

35 The portfolio turnover ratio is a measure of the fund's trading activity. It is computed by taking the lesser of purchases or sales and dividing by average monthly net assets.

Thoughtful portfolio management requires a manager to balance the potential benefits of turnover against the costs of turnover. When considering a rebalancing or restructuring of the portfolio, the benefits of the post-trade risk/return position must justify the costs of getting there.

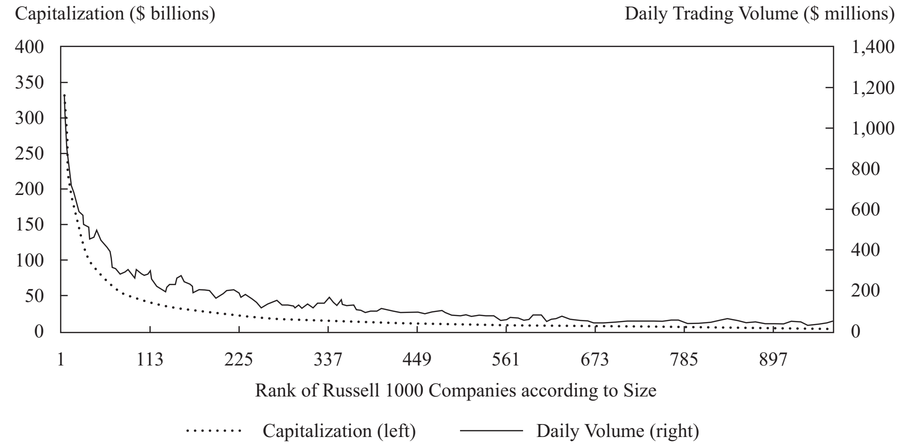
This section concerns the implicit costs of implementing an active strategy and implementation issues related to asset under management, position sizing, turnover, and market liquidity. Explicit costs, such as broker commissions, financial transaction taxes, custody/safekeeping fees, and transaction processing, are covered in other parts of the CFA Program curriculum.

6.1 Implicit Costs—Market Impact and the Relevance of Position Size, Assets under Management, and Turnover

The price movement (or market impact) resulting from a manager's purchase or sale of a security can materially erode a manager's alpha. Market impact is a function of the liquidity and trade size of the security. A manager's investment approach and style will influence the extent to which he is exposed to market impact costs. A manager whose strategy demands immediacy in execution or requires a higher portfolio turnover is likely to incur higher market impact costs relative to a manager who patiently trades into a position. A manager who believes her investment insights will be rewarded over a longer-term investment horizon may be able to mitigate market impact costs by slowly building up positions as liquidity becomes available. A manager whose trades contain "information" is more vulnerable to market impact costs. A trade contains information when the manager's decision to buy or sell the security signals to the market that something has changed. If a discretionary manager with sizable assets under management begins to buy a stock, the trade signals to other market participants that there is likely to be upward pressure on the stock price as the manager builds the position. Some market participants may try to "front-run" the manager, buying up known supply to sell it to the manager at a higher price. If that same manager begins to sell his position following a company "event," it signals to the market that the manager's view on the stock has changed and he is likely to be selling off his position, putting downward pressure on the price. Assets under management, portfolio turnover, and the liquidity of the underlying assets all affect the potential market impact costs.

Consider the relationship between the size of a security, as measured by its capitalization, and a manager's ability to trade in this security, as measured by its average daily trading volume. Exhibit 19 presents the capitalization and average daily trading volume of the Russell 1000 companies in declining order of their capitalization. The figure is built using a moving average of the capitalization of groups of 20 companies. The first point on the graph shows the average capitalization and trading volume of the largest 20 companies by capitalization. The next point on the graph presents the same information for the averages of the companies ranking 2nd to 21st in terms of capitalization, and so on.

Exhibit 19 Capitalization and Trading Volume (in $) of the Russell 1000 Companies in Declining Order of Capitalization



Source: Data from Bloomberg.

Two observations are warranted. First, the distribution of market cap is skewed: The average capitalization declines quickly. The combined capitalization of the top 500 companies is more than seven times that of the bottom 500 companies. Second, smaller-capitalization companies have lower daily trading volume (in dollars). However, smaller-cap companies trade a greater percentage of their capitalization. The smallest 900 companies within the index trade nearly two times more volume—as a percentage of their market capitalization—than the 100 largest companies (e.g., the 900 smallest companies on average trade 1% of their market cap daily, whereas the 100 largest companies trade 0.5% of their market cap daily). Nevertheless, the lower absolute level of average trading volume of the smaller securities can be a significant implementation hurdle for a manager running a strategy with significant assets under management and significant positive active weights on smaller companies.

For example, let's assume the smallest company within an index has a capitalization of $2 billion and that 1% of its capitalization trades each day on average—about $20 million. Let's also assume that a manager has a policy not to own a position that constitutes more than 10% of the average trading volume of a security and that no position in the portfolio can be larger than 2% of total assets. If this manager has $200 million under management, the allocation constraint indicates that he could own as much as $4 million of that security ($200 million × 2% = $4 million), but the liquidity constraint limits the position to $2 million ($20 million × 10%). Thus, the position size is limited to about 1.0% of the fund's assets. A $1 billion fund with similar constraints would be limited to the same $2 million position, a much smaller position size relative to his total portfolio.

A $100 million fund can typically implement its strategy with very few obstacles arising from trading volume and position size constraints. However, the manager of a $5 billion fund could not effectively operate with the same constraints. A 2% position in a $5 billion fund is $100 million, yet only approximately 35% of the securities in the Russell 1000 have an average daily trading volume greater than $100 million. The trading volume constraint significantly limits the manager's opportunity set. A large-AUM fund can address this issue in several ways:

- It may establish position limits on individual securities that consider their respective market-cap weights on both an absolute and relative basis. For example, it may limit the allocation to the lesser of market-cap weight + 1% (100 bps) or 10 times the market-cap weight allocation of the security within the index. In other words, the position limit would be related to the market cap of each security.

- It may establish position limits based on the average daily trading volume of a security. For example, it may limit the position size to, say, no more than 10 days of average trading volume.
- It may build a rebalancing strategy into the investment process that anticipates a longer rebalancing period or that gradually and consistently rebalances over time, assuming the performance of the strategy is not affected by the implementation delay.

The challenges are even greater for small-cap funds. The weighted average capitalization of the Russell 2000 Index is only $2.2 billion, and nearly 60% of the companies in the index have a market capitalization below $1 billion (as of March 2017). The average market cap of companies over this $1 billion market-cap threshold is only $1.2 billion. The average daily volume of these "larger" companies is approximately 2% of their market capitalization—less than $25 million. Approximately 75% of securities within the index have a lower average daily trading volume.

A small-cap manager with the same limits on position size relative to trading volume as the manager above would have an average position size of no more than $2.5 million, based on average daily trading volume. A strategy rooted in a smaller number of securities—say, 40—may find it difficult to run a $100 million fund and may have to concentrate its allocation among the 25% largest securities in the index or accept a lower turnover. Although a strategy with a larger number of securities—say, 200—would be able to support a substantially higher level of AUM, it may still be constrained to concentrate its exposure among the larger and more liquid securities. Small-cap funds with capacities of $1 billion or greater may very well need to hold 400 securities or more.

The strategy of the manager must be consistent with the feasibility of implementing it. A high-turnover strategy with a significant allocation to smaller securities will at some point reach a level of AUM at which the strategy becomes difficult to implement successfully. The level of idiosyncratic risk inherent in the strategy will also play a role in the suitable level of AUM. A manager targeting low levels of idiosyncratic risk in his portfolio is likely to have more securities and smaller position sizes and could, therefore, conceivably support a higher level of AUM.

6.2 Estimating the Cost of Slippage

Slippage is often measured as the difference between the execution price and the midpoint of the bid and ask quotes at the time the trade was first entered.[36] It incorporates both the effect of volatility/trend costs and market impact. (Volatility/trend costs are the costs associated with buying in a rising market and selling in a declining market.) This measure provides an estimate of the cost to execute a transaction when the order is executed in a single trade.

When a larger trade is executed in increments over multiple days, the estimate of market impact costs for later trades does not account for the impact of earlier trades on subsequent execution prices. Depending on the size of the trade, the manager's own sell (buy) orders may put downward (upward) pressure on the security's price, thereby increasing the effective cost of implementation. Large institutional investors today will often try to camouflage the potential size of their trade by breaking a trade

36 See Taleb (1997).

into many smaller trades or by trading in "unlit" venues. Unlit venues allow buyers and sellers to trade anonymously with one another. Dark pools and crossing networks are examples of unlit venues.[37]

Studies have shown that small-cap stocks have consistently had higher effective trading costs than large-cap stocks and that illiquidity can be very cyclical, increasing prior to the beginning of a recession and decreasing prior to the end of a recession.[38] It is difficult to quantify this cost, but we know intuitively that a given trading volume causes a larger price move for a less liquid asset.[39] The larger a trade size relative to a stock's average daily volume is, the more likely it is that the trade will affect prices. Thus, a fund with a focus on large-cap stocks can support a higher level of AUM than can a similar-strategy fund focused on small-cap stocks. A fund focused on small-cap stocks must either limit its AUM, hold a more diversified portfolio, limit turnover, or devise a trading strategy to mitigate market impact costs.

Exhibit 20 provides estimates of the average slippage for several markets in 2016 and for the last two quarters of 2009. The table also presents the information per capitalization segment for the US market alone. There are four conclusions we can draw:

- Slippage costs are usually more important than commission costs.
- Slippage costs are greater for smaller-cap securities than for large-cap securities.
- Slippage costs are not necessarily greater in emerging markets.
- Slippage costs can vary substantially over time, especially when market volatility is higher.

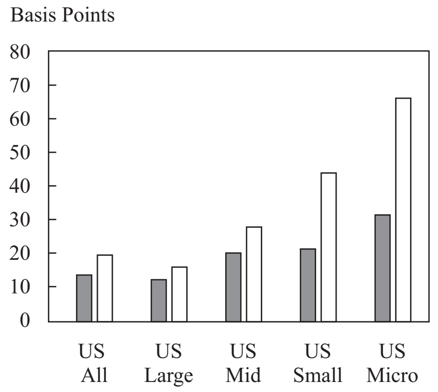
37 If a large institution wants to sell a a big block of stock but doesn't want to alert other market participants about the pending activity, it may choose to trade anonymously. Unlit venues—private trading venues where transactions are completed "in the dark" (without full transparency)—have become an powerful force in financial markets.

38 Hasbrouck (2009) and Amihud (2002).

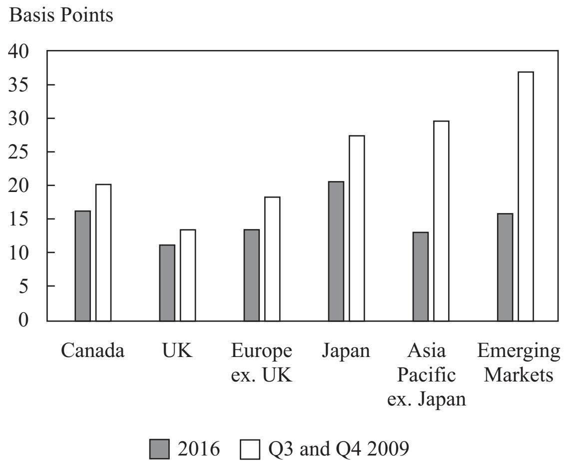
39 Ilmanen (2011).

Exhibit 20 Average Slippage by Cap Size and Country

A. US Market by Cap Size



B. By Country



Source: ITG, "Global Cost Review Q4/2016" (2017).

Slippage cost can be managed with a strategic approach to implementation. Smaller-AUM managers have an advantage in this respect. For example, two hypothetical \$100 million trades were sent to an execution platform that provides estimates of trading costs. The first trade mirrored the Russell 1000. The second trade bought just 250 securities in the same Russell 1000 universe, but the weighted average capitalization was only \$26 billion (versus \$133 billion for the index). Assuming the trading was accomplished in the course of a single day, the first trade had an estimated implementation cost of just 1 bp, whereas the second trade incurred implementation costs of 3%.

For some strategies, the true cost of slippage may be the opportunity cost of not being able to implement the strategy as assets grow. Investors choose a given fund based on the manager's stated strategy and implementation approach. If this approach is modified as the manager's level of AUM grows, it may have unanticipated consequences for expected risks and returns to investors. In these situations, the manager must either inform investors of changes being made to the strategy and its implementation or they must limit the size of the fund assets—that is, close the fund to new investors or new contributions from existing investors. Managers need to very carefully think about capacity as a new product is launched; although historical results based on a lower level of AUM may attract attention and clients, if the strategy cannot be scaled for the larger AUM, the product delivered to clients may be different from the strategy they thought they were investing in.

A study by Frazzini, Israel, and Moskowitz (2012) examined the scalability of well-known factor-based strategies, such as Size, Value, Momentum, and Short-Term Reversal, and considered the price impact of implementing such strategies. The study covered 19 developed markets over the period 1998–2001. It concluded that strategies based on Value could support significant scale. However, scaling up Size and especially Short-Term Reversal led to a steeper decline in performance and an increase in tracking error. Clearly, investors need to monitor a strategy's capacity by observing the evolution of portfolio turnover and portfolio characteristics, such as an increasing allocation to larger-cap stocks.[40]

EXAMPLE 7

Issues of Scale

1 Stephen Lo has been the sole portfolio manager of the Top Asia Fund since its inception 20 years ago. He is supported by a group of analysts. The fund has been highly successful as it grew from assets of less than \$30 million in his first year to more than \$7 billion. As a potential investor in the Top Asia Fund, you have been asked to determine how Lo has been able to generate his performance and whether his style has evolved over the years. You prepared the following analysis of the return and risk characteristics of the fund for its first five years and last five years of existence.

Discuss the evolution of the fund's characteristics and its implications for Lo's success as a manager.

Top Asia Fund Characteristics	First Five Years	Last Five Years
Average assets (\$ millions)	200	5,000
Average number of positions	80	300
Market Beta	0.90	0.91
Size coefficient	–0.30	0.10
Value coefficient	0.25	0.24
Momentum coefficient	0.20	0.10
Portfolio turnover	100%	30%
Alpha (gross of fees)	2.5%	0.40%

2 Andrew Isaac runs a \$100 million diversified equity portfolio (about 200 positions) using the the Russell 1000 as his investable universe. The total capitalization of the index is approximately \$20 trillion. Isaac's strategy is very much size agnostic. He consistently owns securities along the entire size spectrum of permissible securities. The strategy was designed with the following constraints:

- No investment in any security whose index weight is less than 0.015% (approximately 15% of the securities in the index)

40 Peter Lynch, while managing the highly successful Magellan Fund, generated a 2% gross *monthly* alpha on average (less than \$1 million per year) assets under management of \$40 million during his first five years of tenure and a 0.20% alpha per month during his last five years on assets of about \$10 billion (more than \$20 million per year). It is likely that the portfolio management approach evolved as the asset base grew.

- Maximum position size equal to the lesser of 10× the index weight or the index weight plus 150 bps
- No position size that represents more than 5% of the security's average daily trading volume (ADV) over the trailing three months

The smaller securities in Isaac's permissible universe trade about 1% of shares outstanding daily. At what level of AUM is Isaac's strategy likely to be affected by the liquidity and concentration constraints?

Solution to 1:

AUM grew rapidly over the past 20 years. The number of positions in the portfolio nearly quadrupled while assets grew by a factor of 25. Still, there are aspects of his style that have not changed: He is still very much a value manager investing in lower-beta securities. However, the portfolio no longer has a small-cap tilt, and the exposure to the momentum factor has also declined. It is likely that these are both byproducts of the increase in AUM; for example, a large fund has greater difficulty executing in small-cap securities. This last point is supported by the decline in portfolio turnover. The decline in alpha indicates that the growth in AUM has altered the implementation of the investment approach.

Solution to 2:

Based on the index capitalization of $20 trillion, the size constraint indicates that the smallest stocks in his portfolio will have a minimum market cap of about $3 billion (0.015% × $20 trillion). The ADV of the stocks at the lower end of his capitalization constraint would be about $30 million (1% × $3 billion). Because Isaac does not want to represent more than 5% of any security's ADV, the maximum position size for these smaller-cap stocks is about $1.5 million (5% × $30 million). It appears that Isaac's strategy will not be constrained until the portfolio reaches about $1 billion in size ($1.5 million ÷ 0.15% = $1 billion). If the level of AUM exceeds $1 billion, his position size constraints will require the portfolio to hold a larger number of smaller-cap positions. There is room to grow this strategy.

THE WELL-CONSTRUCTED PORTFOLIO

7

A well-constructed portfolio should deliver results consistent with investors' risk and return expectations. It will not guarantee excess return relative to the appropriate benchmark, especially over a shorter horizon, but it will be designed to deliver the risk characteristics desired by the manager and promised to investors. The well-constructed portfolio possesses

- a clear investment philosophy and a consistent investment process,
- risk and structural characteristics as promised to investors,
- a risk-efficient delivery methodology, and
- reasonably low operating costs given the strategy.

Investors and managers may have different requirements with respect to the characteristics they seek in a well-structured portfolio. For some managers, substantial diversification is required, whereas others seek a high-conviction, less diversified strategy. Some investors require formal and heuristic risk metrics that are tightly constrained, and others tolerate more permissive risk limits. A well-structured portfolio must, at the very least, deliver the promised characteristics in a cost- and risk-efficient way.

Consider the following large-cap US equity products, Product A and Product B. Between January 1999 and September 2016, the two products had similar annualized absolute volatility, 15.1% and 15.2%, and similar active risk, 4.9% and 4.8%. However, they differ on other dimensions. Exhibit 21 presents the factor exposure of each product using a six-factor model. The factors are Market, Size, Value, Momentum, Betting against Beta (BAB), and Quality. The exhibit also shows the volatility of each factor. Exhibit 22 illustrates the contribution to the total variance of each product originating from these factors, as well as the portion of total variance that remains unexplained. Other characteristics are also presented.[41]

Exhibit 21 Factor Exposure, January 1999–September 2016

Factor	Product A	Product B	Factor Volatility
Market	0.92	1.08	15.8%
Size	–0.29	0.04	9.7%
Value	0.33	0.06	14.7%
Momentum	0.04	0.06	19.2%
BAB	0.02	0.09	14.4%
Quality	0.03	0.23	11.4%

Sources: Data are from Bloomberg and AQR.

Exhibit 22 Risk Characteristics

	Factor Risk Contribution	
Factor	**Product A**	**Product B**
Market	87.4%	105.9%
Size	–2.3%	0.6%
Value	14.0%	1.2%
Momentum	–2.7%	–2.0%
BAB	–0.4%	–2.0%
Quality	–1.6%	–10.5%
Unexplained	5.5%	6.8%
Total	100%	100%
	Other Characteristics	
Number of securities	≈320	≈120
Annualized active risk	4.9%	4.8%
Active Share	0.43	0.80

41 The style of a particular product may evolve over time because of changes in investment philosophy and even changes in the product management team. Although the two products presented in Exhibits 21 and 22 were selected for the consistency of their respective approaches over time, when the period covers several decades, it would be prudent to do factor analyses over several sub periods to determine whether changes in management style did, in fact, occur.

Exhibit 22 (Continued)

	Other Characteristics	
Annualized volatility	15.1%	15.2%
Maximum drawdown	54.6%	51.8%

Since the two products have similar volatility and active risk, what opinion can we form about the risk efficiency of each product?

Product A exhibits the following relevant characteristics:

- A Market β slightly less than 1
- A large-cap bias (a negative coefficient on the Size factor)
- A very large exposure to the Value factor
- Greater security-level diversification than Product B
- Market risk representing only 87.4% of the total portfolio risk
- A significant portion of the absolute risk attributed to the Value factor

The relevant characteristics for Product B are:

- A Market β slightly more than 1
- A more balanced exposure to all factors
- A large exposure to the Quality factor (although the factor itself has a relatively low volatility)
- Active Share nearly double that of Product A
- Modestly lower drawdowns
- More than 100% of its absolute risk attributed to the Market factor

Thus, Product B's emphasis on quality companies having a high return on equity, a low debt-to-equity ratio, and a low earnings variability is a likely explanation for absolute and relative risk measures that are not significantly different from those of Manager A. That Product B can achieve this level of risk efficiency with less than half the number of securities held by Product A indicates that risk management is an important component of the portfolio construction process of Product B. Although there is no guarantee that a more efficiently risk-structured portfolio will outperform, Product B outperformed Product A by more than 3.1% annually over the period.

In a well-constructed portfolio, we would be looking for risk exposures that are aligned with investor expectations and constraints and low idiosyncratic risk (unexplained) relative to total risk. If two products have comparable factor exposures, the product with a lower absolute volatility and lower active risk will likely be preferred (assuming similar costs). If two products have similar active and absolute risks, the portfolios have similar costs, and the alpha skills of the managers are similar, the product having a higher Active Share is preferable, because it leverages the alpha skills of the manager and will have higher expected returns.

Finally, the "risk efficiency" of any given portfolio approach should be judged in the context of the investor's total portfolio. The active risk of a concentrated stock picker should be higher than that of a diversified factor investor, and the concentrated stock picker may have a lower information ratio. Yet both managers could be building a well-structured portfolio relative to their mandate. It is important to consider the diversification effect of a manager's portfolio on the total portfolio of the investor to arrive at an appropriate solution.

EXAMPLE 8

The Well-Structured Portfolio

David Larrabee is CIO of a pension fund with $5 billion in assets. The fund has 60% of its assets invested in equities with more than 10 managers. Larrabee is considering creating a core equity position that would represent 65% of all equity assets. The remaining 35% would then be allocated to approximately five active satellite (non-core) managers. The core position would be invested in a customized passive portfolio designed specifically for the pension fund using a well-documented construction and rebalancing process. The portfolio would be implemented by a known counterparty at a low cost (less than 10 bps). The main specifications for the custom portfolio were the following:

- Investable universe composed of securities within the MSCI World Index
- Low volatility achieved through an optimization process
- High payout yield (dividend and share repurchase)
- No fewer than 250 securities
- No position greater than 2%
- Average portfolio turnover less than 50% annually

Larrabee understands that a low-volatility objective usually leads to portfolios with large-cap, Value, and Quality biases.

Exhibits 23 and 24 present the results of a pro forma analysis of the custom portfolio. The portfolio was simulated over a period of 12 years. Exhibit 23 presents some key risk and structural characteristics, as well as the average active sector exposure. Exhibit 24 presents the results of factor analyses for both the MSCI World and the custom portfolio.

Exhibit 23

	MSCI World	Custom Portfolio
Return annualized	7.0%	8.45%
Volatility annualized	11.3%	9.0%
Active risk	—	6.0%
Number of securities	1,700	325
Turnover	2.4%	35%
Dividend yield	2.6%	3.6%
Average Active Sector Exposure		
Energy	—	–2.00%
Materials	—	–1.50%
Industrials	—	–1.50%
Consumer discretionary	—	3.00%
Consumer staples	—	4.20%
Health care	—	2.40%
Financials	—	–1.00%
Information technology	—	–10.00%

Exhibit 23 (Continued)

	MSCI World	Custom Portfolio
Telecommunication services	—	3.20%
Utilities	—	3.20%

Exhibit 24

	Factor Exposure		Factor Relative Risk Attribution	
	MSCI World	Custom Portfolio	MSCI World	Custom Portfolio
Alpha (annualized)	–1.0%	–3.1%	—	—
Market	1.00	0.84	103%	105%
Size	–0.13	–0.26	–1%	–1%
Value	0.06	0.30	2%	10%
Momentum	0.02	0.02	–1%	–3%
BAB	0.01	0.32	0%	2%
Quality	0.10	0.54	–4%	–22%
Unexplained	—	—	1%	9%

Larrabee has hired you to advise him on the proposed core product. Considering the information provided,

1 Does the pro forma custom portfolio meet the specifications of a well-structured portfolio, and are there any characteristics of this product that concern you?

2 If the custom portfolio were implemented, what recommendations would you make to Larrabee in terms of the style of the satellite managers or in general?

Solution to 1:

The proposed solution is aligned with many of the characteristics of a well-constructed portfolio. It is based on a consistent investment process, and it appears to meet the requirements of the investor: It has significantly lower volatility than the MSCI World and a significantly higher dividend yield (although we do not have the information on the payout yield), the portfolio has a low security concentration, and the estimated turnover is lower than the required limit. It can also be implemented at a low cost. The factor analysis also confirms what we could expect from a high-payout/low-volatility portfolio. The Market beta is significantly below 1, the negative Size coefficient indicates a larger-capitalization bias, and finally, the portfolio has a Value and Quality bias. The risk attribution analysis indicates that the exposure to Quality companies is largely responsible for reducing the total risk of the portfolio.

However, there are some aspects of the portfolio that create some concerns. Although the custom portfolio meets all of Larrabee's specified objectives, the portfolio construction process leads to a high tracking error (active risk). Given the size of this allocation relative to the total equity portfolio, this poses a problem. Some of this tracking error may be attributed to a significant underallocation to the information technology sector. Finally, although the portfolio would have generated an excess return on average over the past 12 years, the alpha is negative. Understanding the source of this negative alpha is essential. In this instance, the excess return was achieved largely through a very high and intentional exposure to rewarded factors, such as Value, BAB, and Quality, which may not have been rewarded over the simulated period.

Solution to 2:

The first recommendation would be to investigate further the source of the significant negative alpha. Because the excess performance is so strongly explained by exposure to specific factors, we should be concerned about how the portfolio would perform if factor returns were to decline. Is there a systemic reason that can explain this observation? Secondly, if tracking error is a concern, it is important to identify satellite managers whose active returns have a low correlation with the core mandate, perhaps even a lower active risk. Finally, considering the importance of the information technology sector, it could be prudent to hire a manager that has a strong technology orientation. The objective is not necessarily to maintain a technology exposure equal to that of the MSCI World Index but perhaps to lower the consistent underexposure to a more reasonable level. At the very least, these structural biases should be continuously monitored.

8 LONG/SHORT, LONG EXTENSION, AND MARKET-NEUTRAL PORTFOLIO CONSTRUCTION

Long/short, long extension, and market-neutral portfolio approaches are all variations on a theme: Each is predicated on the belief that research insights can be exploited not only in the pursuit of stocks that are expected to perform well but also to profit from the negative insights gathered during the research process. "Long/short" is the most encompassing term and can include long extension and market-neutral products. Most commonly, the term "long/short" refers to strategies that are relatively unconstrained in the extent to which they can lever both positive and negative insights.

Long extension strategies are constrained long/short strategies. The capital committed by the client is invested similarly to a manager's long-only strategy but levered to some extent to exploit the manager's insights on projected losers as well as winners. A typical long-extension strategy is constrained to have a net exposure of 100%; for example, 130% of the capital is invested long and 30% of the capital is invested short, for a net exposure of 100%—the same as it would be in a long-only portfolio. There may or may not be a relationship between the long and the short portfolios.

Market-neutral strategies are long/short portfolios constructed in a manner to ensure that the portfolio's exposures to a wide variety of risk factors is zero. In addition, these portfolios may be neutralized against a wide variety of other risk factors.

8.1 The Merits of Long-Only Investing

An investor's choice of whether to pursue a long-only strategy or some variation of a long/short strategy is likely to be influenced by several considerations:

- Long-term risk premiums
- Capacity and scale (the ability to invest assets)
- Limited legal liability and risk appetite
- Regulatory constraints
- Transactional complexity
- Management costs
- Personal ideology

Long-term risk premiums. A major motivation for investors to be long only is the generally accepted belief that there is a positive long-run premium to be earned from bearing market risk. Investors may also believe that risk premiums can be earned from other sources of risk, such as Size, Value, or Momentum. To capture these risk premiums, investors must over time own (go net "long") the underlying securities that are exposed to these risks. Although risk premiums have been shown to earn a return in the long run, realized risk premium returns can be negative in the short run; the market can and does experience returns less than the risk-free rate, and recall the earlier discussion regarding the cyclicality of the Size, Value, and Momentum factors. For investors with shorter-term investment horizons, the potential benefits of a positive expected risk premium over the long run may not offset the potential risk of market declines or other reversals. These investors may pursue an approach other than strictly long-only investing and may prefer to short-sell some securities.

Capacity and scalability. Long-only investing, particularly strategies that focus on large-cap stocks, generally offers greater investment capacity than other approaches. For example, the MSCI ACWI has a total market cap of nearly $37 trillion, and the 10 largest companies are worth $3.4 trillion.[42] For large institutional investors, such as pension plans, there are no effective capacity constraints in terms of the total market cap available for long-only large-cap investing. Long-only strategies may face capacity constraints, however, if they focus on smaller and illiquid stocks or employ a strategy reliant on a high level of portfolio turnover. Unlike long-only strategies, the capacity of short-selling strategies is limited by the availability of securities to borrow.

Limited legal liability. Common stocks are limited liability financial instruments. The lowest a stock price can fall to is zero, so the maximum amount that a long-only investor in a common stock can lose is the amount of money that she invested in the stock. Thus, long-only investing puts a firm floor on how much an investor can lose. In contrast, a short-seller's potential losses are unlimited in principle. The short-seller loses money as the stock price rises, and there is no ceiling limiting the price increase. This type of "naked" short-selling is quite risky. To offset this risk, investors often combine a short-selling strategy with a long-only strategy. Indeed, long/short strategies are often less risky than long-only or short-only strategies.

Regulatory. Some countries ban short-selling activities. Others have temporarily restricted or banned short-selling. For example, on 18 September 2008, the UK Financial Services Authority (FSA) temporarily prohibited the short-selling of financial companies to protect the integrity of the financial system. The US Securities and Exchange

42 Market cap is not necessarily the same as shares available for general investors, because some shares may be closely held and not traded. Most index providers now calculate "float," which represents shares the public can trade.

Commission (SEC) followed suit the next day. Additionally, many countries that allow short-selling prohibit or restrict naked short-selling, a practice consisting of short-selling a tradable asset without first borrowing the security or ensuring that it can be borrowed.

Transactional complexity. The mechanics of long-only investing are relatively simple and easy to understand. The investment manager instructs a broker (or uses an electronic platform) to buy stock XYZ. The broker executes the trade on the client's behalf and arranges for the security to be delivered to the client's account. Typically, a custodial bank sits between the investment adviser and the client. In this case, the custodian would deliver the cash for the stock and take possession of the shares of XYZ stock. If the shares are held in a custodial bank, the adviser can liquidate the position at any time (a caveat is that to exercise this flexibility completely, the custodian must be instructed not to lend out the shares). In long-only investing, buying and selling stocks are straightforward, intuitive transactions.

A short-selling transaction is more complex. The investor first needs to find shares of stock to borrow. Although many stocks are easy to borrow, others may be hard to locate, and the cost to borrow these shares can be much higher. Investors must also provide collateral to ensure that they can repay the borrowed stock if the price moves up. Borrowed stock may also be recalled at an inopportune time for the short-seller.

In many regions, regulated investment entities must use a custodian for all the transactions. When a custodian is involved, complicated three-party agreements (between the fund, prime broker, and custodian) are required. The agreements govern the buying and selling of securities as well as the management of collateral. An investor who does not use a custodian is exposed to counterparty risk—the collateral is often held in a general operating account of a prime broker. If the prime broker goes bankrupt, the collateral can vanish (which happened to many investors in the Lehman Brothers bankruptcy). Operational risk is significantly greater with long/short investing.

Management costs. Long-only investing is less expensive, both in terms of management fees and from an operational perspective. Managers of long/short products often charge fees that are a multiple of what long-only managers typically charge. Three categories of long/short products are active extension, market neutral, and directional.[43] As of 2016, management fees on active extension strategies usually range from 0.50% to 1.5%, whereas market-neutral and directional strategies typically charge hedge fund fixed fees of 1%–2% and performance fees of 20%. It follows, then, that the investor in a long/short product must have a high degree of confidence in the manager's ability to extract premiums or generate alpha relative to lower-fee, long-only managers.

Personal ideology. Some investors may express a preference for long-only investment for ideological reasons. They may feel that directly gaining from the losses of others is morally wrong, as might be the case in short-selling. Some investors may believe that short-selling requires significantly greater expertise than long-only investing and that such expertise is not reliably available or consistent. And some might argue that short-selling requires significant leverage to achieve the targeted long-term expected return, and they may be unwilling to assume this risk. In short, some investors may "just say no" to anything other than long-only investing.

8.2 Long/Short Portfolio Construction

Investors may be interested in long/short strategies for a variety of reasons. For example, the conviction of negative views can be more strongly expressed when short-selling is permitted than in a long-only approach. In addition, short-selling can help reduce

43 See Pavilion (2011).

exposures to sectors, regions, or general market movements and allow managers to focus on their unique skill set. Finally, the full extraction of the benefits of risk factors requires a long/short approach (i.e., short large cap and long small cap, short growth and long value, short poor price momentum and long high price momentum, etc.). Long-only investors can profit from only part of the opportunity set.

There are many different styles of long/short strategies, each driven by its own investment thesis. Exhibit 25 presents a range of possible options to structure a long/short portfolio. Implementation of long/short strategies varies with their intended purpose. In a long-only portfolio construction process, the weights assigned to every asset must be greater than or equal to 0 and the weights must sum to 1. In the long/short approach, position weights can be negative and the weights are not necessarily constrained to sum to 1. Some long/short portfolios may even have aggregate exposure of less than 1. The absolute value of the longs minus the absolute value of the shorts is called the portfolio's *net exposure*. The sum of the longs plus the absolute value of the shorts is called the portfolio's *gross exposure*.

A comprehensive use of long/short strategies can also be found in the design of equal-risk-premium products. Such products seek to extract return premiums from rewarded factors, often across asset classes. To do so, the manager must create long/short sub-portfolios extracting these premiums (such as Size, Value, Momentum, and Low Beta) and combine these sub-portfolios using weightings that ensure each component will contribute the same amount of risk to the overall portfolio. The combination may be levered across all sub-portfolios to achieve a specific volatility level. In other words, the manager is using long and short positions as well as leverage (or deleveraging) to achieve the most efficient combination of rewarded factors.

Exhibit 25 Illustrative Long/Short Portfolio Structures (as a percentage of capital)

	Long Positions	Short Positions	Cash	Gross Exposure	Net Exposure
Long only	100	0	0	100	100
130/30 long extension	130	30	0	160	100
Market neutral – low risk	50	50	100	100	0
Market neutral – higher risk	100	100	100	200	0
Directional – low risk	80	40	60	120	40
Net short	40	100	160	140	–60

Long/short managers typically define their exposure constraints as part of the portfolio construction process. For example, many equity hedge funds have a strategy of targeting a gross exposure (long plus short) of 150%–200% while targeting a net exposure (long minus short) of 0%–60%. A net exposure greater than zero implies some positive exposure to the Market factor. Regardless of the investment approach, all long/short strategies must establish parameters regarding the desired level of gross and net exposure, and these parameters will provide the investor with meaningful information about the manager's strategy and its expected risk profile.

8.3 Long Extension Portfolio Construction

Long extension strategies are a hybrid of long-only and long/short strategies. They are often called “enhanced active equity” strategies. A particular enhanced active equity strategy called “130/30” was popular until the market decline during the global financial crisis.[44] This strategy is making inroads again as investors better understand the potential pitfalls of shorting and are seeking more return in a low interest rate environment. A 130/30 strategy builds a portfolio of long positions worth 130% of the wealth invested in the strategy—that is, 1.3 times the amount of capital. At the same time, the portfolio holds short positions worth 30% of capital. The long and short positions combined equal 100% of capital. In essence, the short positions are funding the excess long positions, and the resulting gross leverage (160% = 130% + 30%) potentially allows for greater alpha and a more efficient exposure to rewarded factors. Unlike leverage incurred via cash borrowing in a long-only portfolio, which can be used only to exploit *long* insights, the long/short approach allows the portfolio to benefit not only from insights on companies that are forecasted to perform well (the long positions) but also from insights on companies forecasted to perform poorly (the short positions). In theory, this strategy offers the opportunity to magnify total returns. Of course, the long/short approach could also lead to greater losses if the manager is simultaneously wrong on both his long and short picks.

Another benefit of the 130/30 strategy is that long-only managers are limited in their ability to underallocate to securities that have a small initial allocation in the benchmark. For example, if Security X has a 0.25% allocation within the benchmark, a long-only manager can express a negative view on the stock only to the extent of its 0.25% benchmark weight by omitting the security from the portfolio. A 130/30 strategy affords the possibility of sizing the underweight in line with the manager’s expectations for the stock. This ability allows the strength of the positive and negative views to be expressed more symmetrically.

8.4 Market-Neutral Portfolio Construction

Market-neutral portfolio construction is a specialized form of long/short portfolio construction. At a very simple, naive level, one might think that in this strategy, the dollars invested in long securities are identical to the dollars associated with short-selling—that is, a portfolio with zero net investment, often called “dollar neutral.” But dollar neutral is not the same thing as market neutral, because the economic drivers of returns for the long side may not be the same as the economic drivers for the short side.

True market-neutral strategies hedge out most market risk. They are often employed when the investor wants to remove the effects of general market movements from returns to explicitly focus on the manager’s skill in forecasting returns of stocks, sectors, factors, or geographic regions. In essence, the investor wants to remove the “noise” that market movements can create to better focus on the creation of positive abnormal returns. In isolation, this strategy could be considered risky. For example, if stock prices appreciate rapidly (and historically, stock prices do rise), then the investor would miss out on this appreciation. However, some investors might add this type of strategy to their overall portfolio to increase diversification and at least partially offset losses in other parts of the portfolio when stock prices decline.

Market-neutral portfolio construction attempts to exactly match and offset the systematic risks of the long positions with those of the short positions. For example, if one uses beta as the measure of systematic risk, then a market-neutral portfolio,

44 130/30 strategies can accentuate losses. For example, Value strategies performed poorly during the financial crisis of 2007–2008, whereas Momentum strategies performed poorly after March 2009, as the equity markets rebounded. Many 130/30 products were built on these rewarded factors and performed poorly.

using longs and shorts, would have a Market beta of zero. A simple example of zero-beta investment would be a fund that is long \$100 of assets with a Market beta of 1 and short \$80 of assets with a Market beta of 1.25. This concept can be extended to include other systematic factors that influence returns, such as Size, Value, and Momentum. In other words, the market-neutral concept can be implemented for a variety of risk factors. The main constraint is that in aggregate, the targeted beta(s) of the portfolio be zero.

A market-neutral strategy is still expected to generate a positive information ratio. Although market neutral may seek to eliminate market risk and perhaps some other risks on an *ex ante* basis, the manager cannot eliminate all risks. If she could—and did—the expected return would likely be equal to the risk-free rate minus the manager's fees. The objective is to neutralize the risks for which the manager believes she has no comparative forecasting advantage, thus allowing the manager to concentrate on her very specific skills.

Given that market-neutral strategies seek to remove major sources of systematic risk from a portfolio, these strategies are usually less volatile than long-only strategies. They are often considered absolute return strategies because their benchmarks might be fixed-income instruments. Even if a market-neutral strategy is not fully successful in its implementation, the correlation of market-neutral strategies with other types of strategies is typically quite low. Thus, some market-neutral strategies may serve more of a diversification role in a portfolio, rather than a high-return-seeking role.

A specific form of market-neutral strategy is pairs trading, where an investor will go long one security in an industry and short another security in the same industry, trying to exploit what the investor perceives as "mispricing." A more quantitatively oriented form of pairs trading called *statistical arbitrage* ("stat arb") uses statistical techniques to identify two securities that are historically highly correlated with each other. When the price correlation of these two securities deviates from its long-term average (and if the manager believes that the deviation is temporary), the manager will go long the underperforming stock and simultaneously short the outperforming stock. If the prices do converge to the long-term average as forecasted, the manager will close the trade and realize a profit.

In other variations of market-neutral investing, one might find portfolios constructed with hundreds of securities identified using systematic multi-factor models that evaluate all securities in the investable universe. The manager will buy the most favorably ranked securities and short the least favorably ranked ones. The manager may impose constraints on exposures of the longs and the shorts to keep gross and net exposures at the desired levels.

Market-neutral strategies have two inherent limitations:

1 Practically speaking, it is no easy task to maintain a beta of zero. Not all risks can be efficiently hedged, and correlations between exposures are continually shifting.

2 Market-neutral strategies have a limited upside in a bull market unless they are "equitized." Some investors, therefore, choose to index their equity exposure and overlay long/short strategies. In this case, the investor is not abandoning equity-like returns and is using the market-neutral portfolio as an overlay.

8.5 Benefits and Drawbacks of Long/Short Strategies

Long/short strategies offer the following benefits:

- Ability to more fully express short ideas than under a long-only strategy

- Efficient use of leverage and of the benefits of diversification
- Greater ability to calibrate/control exposure to factors (such as Market and other rewarded factors), sectors, geography, or any undesired exposure (such as, perhaps, sensitivity to the price of oil)

We've explored the first two benefits of long/short portfolio construction listed above. Let's look more closely at the last one.

A fully invested long-only strategy will be exposed to market risk. To reduce the level of market risk, the manager must either concentrate holdings in low-beta stocks or hold a portion of the assets in cash, an asset that produces minimal return. Conversely, to increase the level of market risk, the long-only manager must own high-beta stocks or use financial leverage; the cost of leverage will reduce future returns. Practically speaking, the portfolio beta of a long-only manager is likely constrained within a range of, say, 0.8–1.2. In contrast, a long/short manager has much more flexibility in adjusting his level of market exposure to reflect his view on the current opportunities.

In long-only portfolios, total portfolio risk is dominated by the Market factor, and the Market factor is a long-only factor. However, all other factor returns can be thought of as long/short portfolios: *Size* is long small cap and short large cap, *Value* is long value and short growth, *Momentum* is long positive momentum and short less positive or negative momentum, and so on. Just like with beta, the ability to tilt a portfolio in favor of these other factors or diversify efficiently across factors is structurally restricted in a long-only portfolio. Because the average of cross correlations among rewarded factors is close to zero or even negative, efficiently allocating across factors could bring significant diversification benefits. But the ability to reduce overall risk and to distribute sources of risk more evenly cannot be optimally achieved without short-selling.

Strategies that short securities contain the following inherent risks, which must be understood:

1. Unlike a long position, a short position will move against the manager if the price of the security increases.
2. Long/short strategies sometimes require significant leverage. Leverage must be used wisely.
3. The cost of borrowing a security can become prohibitive, particularly if the security is hard to borrow.
4. Collateral requirements will increase if a short position moves against the manager. In extreme cases, the manager may be forced to liquidate some favorably ranked long positions (and short positions that might eventually reverse) if too much leverage has been used. The manager may also fall victim to a short squeeze. A short squeeze is a situation in which the price of the stock that has been shorted has risen so much and so quickly that many short investors may be unable to maintain their positions in the short run in light of the increased collateral requirements. The "squeeze" is worsened as short-sellers liquidate their short position, buying back the security and possibly pushing the price even higher.

As previously indicated, to short-sell securities, investors typically rely on a prime broker who can help them locate the securities they wish to borrow. But the prime broker will require collateral from the short-sellers to assure the lenders of these securities that their contracts will be honored. The higher the relative amount of short-selling in a portfolio, the greater the amount of collateral required. A portfolio with 20% of capital invested short may be required to put up collateral equal to 40% of the short positions, whereas a portfolio with 100% of capital invested short could be required to put up collateral equal to 200% of the short positions. In addition, different types of assets are weighed differently in the calculation of collateral value. For example, a

US Treasury bill may be viewed as very safe collateral and accorded 100% of its value toward the required collateral. In contrast, a high-yield bond or some other asset with restricted liquidity would have only a portion of its market value counted toward the collateral requirement.

These collateral requirements are designed to protect the lender in the event of adverse price movements. When stock prices are rising rapidly, the lender may recall all the borrowed shares, fearing that the borrower's collateral will be wiped out. If this were to happen, the leveraged long/short manager would be forced to close out his short positions at an inopportune time, leaving significant profits on the table. In the end, long/short investing is a compromise between return impacts, sources of risk, and costs, as illustrated in the table below.

Benefits	Costs
■ Short positions can reduce market risk. ■ Shorting potentially expands benefits from other risk premiums and alpha. ■ The combination of long and short positions allows for a greater diversification potential.	■ Short positions might reduce the market return premium. ■ Shorting may amplify the active risk. ■ There are higher implementation costs and greater complexity associated with shorting and leverage relative to a long-only approach.

EXAMPLE 9

Creating a 130/30 Strategy

Alpha Prime has been managing long-only equity portfolios for more than 15 years. The firm has a systematic investment process built around assessing security valuation and price momentum. Each company is attributed a standardized score (F_k) that is based on a combination of quantitative and fundamental metrics. Positions are selected from among those securities with a positive standardized score and are weighted based on the strength of that score. The security weightings within sectors can be significantly different from those of the benchmark, but the portfolio's sector weightings adhere closely to the benchmark weights. Investment decisions are made by the portfolio management team and are re-evaluated monthly. A constrained optimization process is used to guide investment decision making. Listed below are the objective function and the primary constraints used by the firm.

- *Objective function:* Maximize the portfolio factor score
- *Total exposure constraint:* Sum of portfolio weights must = 1
- *Individual security constraint:* Minimum weight of 0% and maximum weight of 3%
- *Sector constraint:* Benchmark weight ±5%
- *Constraint on active risk (TE):* Active risk less than 5%

The managers at Alpha Prime have realized that their investment process can also generate a negative signal, indicating that a security is likely to underperform. However, the signal is not quite as reliable or stable when it is used for this purpose. There is much more noise around the performance of the expected losers than there is around the performance of the winners. Still, the signal has value.

1 You are asked to draft guidelines for the creation of a 130/30 strategy. What changes to the objective function and to each of the constraints would you recommend?

2 Discuss the potential challenges of incorporating short positions into the portfolio strategy.

Solution to 1:

- *Objective function:* The objective function would remain the same. Securities with a positive standardized score would be eligible for positive weights, and securities with a negative standardized factor score would receive negative weights (the fund would short these securities).
- *Total exposure constraint:* The portfolio now needs a constraint for gross exposure and one for net exposure. The net exposure constraint in a 130/30 product is constrained to 100%. (The notional value of the longs minus the absolute value of the shorts must be equal to 1.) The portfolio's gross exposure constraint is implicit in the nature of the 130/30 product. (The notional value of the longs plus the absolute value of the shorts cannot exceed 160%.)
- *Individual security constraint:* To take advantage of the negative signals from the model, the portfolio must allow shorting. The minimum weight constraint must be relaxed. Given the issues associated with short-selling, the firm's relative inexperience in this area, and the lower reliability of the short signal, the maximum short position size should be smaller than the maximum long position size. One might recommend that the initial short constraint be set at 1%. Position limits on the long side could stay the same, but that would likely lead to more long positions, given the increase in long exposure to 130%. The manager must assess whether to expand the number of securities held in the portfolio or to raise the maximum position size limit.
- *Sector constraint:* There is no need to change the aggregate sector constraint. The manager now has the ability to offset any overweight on the long side with a short position that would bring the portfolio's exposure to that sector back within the current constraint.
- *Tracking error target:* Sector deviations have a greater bearing on active risk than do security-level differences. Alpha Prime's sector bets are very limited; thus, no change in the tracking error constraint is necessary. The ability to short gives them greater opportunity to exploit investment ideas without changing the firm's approach to sector weightings.

Solution to 2:

Shorting adds complexity to both the operational and the risk aspects of portfolio management. Operationally, the firm must establish relationships with one or more prime brokers and ensure that adequate collateral for the short positions remains available. Some securities can be difficult to borrow, and the cost of borrowing some stocks can be prohibitive. This may inhibit Alpha Prime's ability to implement its short ideas and will raise the operational costs of running the portfolio. In addition, shorting introduces a new type of risk: A short transaction has no loss limit. If the stock moves against the manager in the short run, the manager may have to close the position before he is proven right.

EXAMPLE 10

Long Only vs. Long/Short

Marc Salter has been running a long-only unlevered factor-based strategy in the US market for more than five years. He has delivered a product that has all the expected exposure to rewarded risk factors promised to investors. Salter just met with a pension fund investor looking at a multi-factor based approach. However, the pension fund manager indicates they are also considering investing with a competitor that runs a leveraged long/short factor-based strategy. It appears the competitor's product has a significantly higher information ratio. The product of the competitor neutralizes market risk and concentrates on exposure to other rewarded factors.

1 Why would the competitor's long/short product have a higher information ratio?

2 What are its drawbacks?

Solution to 1:

Factor returns are usually built from a long portfolio having the desired factor characteristic against a short portfolio that does not. A long-only factor investor is limited in his ability to short (relative to the benchmark) positions that do not have the desired characteristics. Adding the ability to leverage negative as well as positive research insights should improve the transfer coefficient and increase the potential to generate better excess returns.

In addition, in a long-only strategy, the Market factor dominates all other risks. Adding the ability to short could facilitate a more balanced distribution of risk. Given the similar volatilities and low cross correlations among factors, the more balanced distribution of risk can be expected to reduce the tracking error of the strategy, thereby improving the information ratio.

Solution to 2:

Multi-factor products often contain several hundred securities, some of which may be difficult to borrow. The complexity of shorting across this large number of names combined with higher management fees and implementation costs may necessitate more implementation constraints on the short side.

Removing the risk associated with the Market factor implies that the long/short product would most likely be used as an overlay on long-only mandates. The mandate may also be leveraged (more than 1× long and 1× short) to maximize the potential return per dollar of capital. For example, equal-risk-premium products (that remove the effect of the Market factor) often need three units of leverage long and short to achieve a 10% absolute risk target. Some investors may be uncomfortable with such leverage.

SUMMARY

Active equity portfolio construction strives to make sure that superior insights about forecasted returns get efficiently reflected in realized portfolio performance. Active equity portfolio construction is about thoroughly understanding the return objectives of a portfolio, as well as its acceptable risk levels, and then finding the right mix of securities that balances predicted returns against risk and other impediments that can interfere with realizing these returns. These principles apply to long-only, long/short, long-extension, and market-neutral approaches. Below, we highlight the discussions of this reading.

- The four main building blocks of portfolio construction are the following:
  - Overweight, underweight, or neutralize rewarded factors: The four most recognized factors known to offer a persistent return premium are Market, Size, Value, and Momentum.
  - Alpha skills: Timing factors, securities, and markets. Finding new factors and enhancing existing factors.
  - Sizing positions to account for risk and active weights.
  - Breadth of expertise: A manager's ability to consistently outperform his benchmark increases when that performance can be attributed to a larger sample of independent decisions. Independent decisions are uncorrelated decisions.
- Managers can rely on a combination of approaches to implement their core beliefs:
  - Systematic vs. discretionary
    - Systematic strategies incorporate research-based rules across a broad universe of securities.
    - Discretionary strategies integrate the judgment of the manager on a smaller subset of securities.
  - Bottom up vs. top down
    - A bottom-up manager evaluates the risk and return characteristics of individual securities. The aggregate of these risk and return expectations implies expectations for the overall economic and market environment.
    - A top-down manager starts with an understanding of the overall market environment and then projects how the expected environment will affect countries, asset classes, sectors, and securities.
  - Benchmark aware vs. benchmark agnostic
- Portfolio construction can be framed as an optimization problem using an objective function and a set of constraints. The objective function of a systematic manager will be specified explicitly, whereas that of a discretionary manager may be set implicitly.
- Risk budgeting is a process by which the total risk appetite of the portfolio is allocated among the various components of portfolio choice.
- Active risk (tracking error) is a function of the portfolio's exposure to systematic risks and the level of idiosyncratic, security-specific risk. It is a relevant risk measure for benchmark-relative portfolios.
- Absolute risk is the total volatility of portfolio returns independent of a benchmark. It is the most appropriate risk measure for portfolios with an absolute return objective.

- Active Share measures the extent to which the number and sizing of positions in a manager's portfolio differ from the benchmark.
- Benchmark-agnostic managers usually have a greater level of Active Share and most likely have a greater level of active risk.
- An effective risk management process requires that the portfolio manager
  - determine which type of risk measure is most appropriate,
  - understand how each aspect of the strategy contributes to its overall risk,
  - determine what level of risk budget is appropriate, and
  - effectively allocate risk among individual positions/factors.
- Risk constraints may be either formal or heuristic. Heuristic constraints may impose limits on
  - concentration by security, sector, industry, or geography;
  - net exposures to risk factors, such as Beta, Size, Value, and Momentum;
  - net exposures to currencies;
  - the degree of leverage;
  - the degree of illiquidity;
  - exposures to reputational/environmental risks, such as carbon emissions; and
  - other attributes related to an investor's core concerns.
- Formal risk constraints are statistical in nature. Formal risk measures include the following:
  - Volatility—the standard deviation of portfolio returns
  - Active risk—also called *tracking error* or *tracking risk*
  - Skewness—a measure of the degree to which return expectations are non-normally distributed
  - Drawdown—a measure of portfolio loss from its high point until it begins to recover
  - Value at risk (VaR)—the minimum loss that would be expected a certain percentage of the time over a certain period of time given the modeled market conditions, typically expressed as the minimum loss that can be expected to occur 5% of the time
  - CVaR (expected tail loss or expected shortfall)—the average loss that would be incurred if the VaR cutoff is exceeded
  - IVaR—the change in portfolio VaR when adding a new position to a portfolio
  - MVaR—the effect on portfolio risk of a change in the position size. In a diversified portfolio, it may be used to determine the contribution of each asset to the overall VaR.
- Portfolio management costs fall into two categories: explicit costs and implicit costs. Implicit costs include delay and slippage.
- The costs of managing assets may affect the investment strategy and the portfolio construction process.
  - Slippage costs are significantly greater for smaller-cap securities and during periods of high volatility.
  - A strategy that demands immediate execution is likely to incur higher market impact costs.

- A patient manager can mitigate market impact costs by slowly building up positions as liquidity becomes available, but he exposes himself to greater volatility/trend price risk.

- A well-constructed portfolio exhibits
  - a clear investment philosophy and a consistent investment process,
  - risk and structural characteristics as promised to investors,
  - a risk-efficient delivery methodology, and
  - reasonably low operating costs.
- Long/short investing is a compromise between
  - reducing risk and not capturing fully the market risk premium,
  - expanding the return potential from alpha and other risk premiums at the potential expense of increasing active risk, and
  - achieving greater diversification and higher costs and complexity.

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PRACTICE PROBLEMS

The following information relates to questions 1–8

Monongahela Ap is an equity fund analyst. His manager asks him to evaluate three actively managed equity funds from a single sponsor, Chiyodasenko Investment Corp. Ap's assessments of the funds based on assets under management (AUM), the three main building blocks of portfolio construction, and the funds' approaches to portfolio management are presented in Exhibit 1. Selected data for Fund 1 is presented in Exhibit 2.

Exhibit 1 Ap's Assessments of Funds 1, 2, and 3

Fund	Fund Category	Fund Size (AUM)	Number of Securities	Description
1	Small-cap stocks	Large	Small	Fund 1 focuses on skillfully timing exposures to factors, both rewarded and unrewarded, and to other asset classes. The fund's managers use timing skills to opportunistically shift their portfolio to capture returns from factors such as country, asset class, and sector. Fund 1 prefers to make large trades.
2	Large- cap stocks	Large	Large	Fund 2 holds a diversified portfolio and is concentrated in terms of factors. It targets individual securities that reflect the manager's view that growth firms will outperform value firms. Fund 2 builds up its positions slowly, using unlit venues when possible.
3	Small- cap stocks	Small	Large	Fund 3 holds a highly diversified portfolio. The fund's managers start by evaluating the risk and return characteristics of individual securities and then build their portfolio based on their stock-specific forecasts. Fund 3 prefers to make large trades.

Exhibit 2 Selected Data for Fund 1

Factor	Market	Size	Value	Momentum
Coefficient	1.080	0.098	–0.401	0.034
Variance of the market factor return and covariances with the market factor return	0.00109	0.00053	0.00022	–0.00025
Portfolio's monthly standard deviation of returns				3.74%

Ap learns that Chiyodasenko has initiated a new equity fund. It is similar to Fund 1 but scales up active risk by doubling all of the active weights relative to Fund 1. The new fund aims to scale active return linearly with active risk, but implementation is problematic. Because of the cost and difficulty of borrowing some securities, the new fund cannot scale up its short positions to the same extent that it can scale up its long positions.

Ap reviews quarterly holdings reports for Fund 3. In comparing the two most recent quarterly reports, he notices differences in holdings that indicate that Fund 3 executed two trades, with each trade involving pairs of stocks. Initially, Fund 3 held active positions in two automobile stocks—one was overweight by 1 percentage point (pp), and the other was underweight by 1pp. Fund 3 traded back to benchmark weights on those two stocks. In the second trade, Fund 3 selected two different stocks that were held at benchmark weights, one energy stock and one financial stock. Fund 3 overweighted the energy stock by 1pp and underweighted the financial stock by 1pp.

In Fund 3's latest quarterly report, Ap reads that Fund 3 implemented a new formal risk control for its forecasting model that constrains the predicted return distribution so that no more than 60% of the deviations from the mean are negative.

1 Based on Exhibit 1, the main building block of portfolio construction on which Fund 1 focuses is *most likely*:

A alpha skills.

B position sizing.

C rewarded factor weightings.

2 Which fund in Exhibit 1 *most likely* follows a bottom-up approach?

A Fund 1

B Fund 2

C Fund 3

3 Which fund in Exhibit 1 *most likely* has the greatest implicit costs to implement its strategy?

A Fund 1

B Fund 2

C Fund 3

4 Based on Exhibit 2, the portion of total portfolio risk that is explained by the market factor in Fund 1's existing portfolio is *closest* to:

A 3%.

B 81%.

C 87%.

5 Relative to Fund 1, Chiyodasenko's new equity fund will *most likely* exhibit a lower:

A information ratio.

B idiosyncratic risk.

C collateral requirement.

6 As a result of Fund 3's two trades, the portfolio's active risk *most likely*:

A decreased.

B remained unchanged.

C increased.

7 What was the effect of Fund 3's two trades on its active share? Fund 3's active share:

A decreased.
B remained unchanged.
C increased.

8 Which risk measure does Fund 3's new risk control explicitly constrain?
A Volatility
B Skewness
C Drawdown

The following information relates to questions 9–15

Ayanna Chen is a portfolio manager at Aycrig Fund, where she supervises assistant portfolio manager Mordechai Garcia. Aycrig Fund invests money for high-net-worth and institutional investors. Chen asks Garcia to analyze certain information relating to Aycrig Fund's three sub-managers, Managers A, B, and C.

Manager A has $250 million in assets under management (AUM), an active risk of 5%, an information coefficient of 0.15, and a transfer coefficient of 0.40. Manager A's portfolio has a 2.5% expected active return this year.

Chen directs Garcia to determine the maximum position size that Manager A can hold in shares of Pasliant Corporation, which has a market capitalization of $3.0 billion, an index weight of 0.20%, and an average daily trading volume (ADV) of 1% of its market capitalization.

Manager A has the following position size policy constraints:

- Allocation: No investment in any security may represent more than 3% of total AUM.
- Liquidity: No position size may represent more than 10% of the dollar value of the security's ADV.
- Index weight: The maximum position weight must be less than or equal to 10 times the security's weight in the index.

Manager B holds a highly diversified portfolio that has balanced exposures to rewarded risk factors, high active share, and a relatively low active risk target.

Selected data on Manager C's portfolio, which contains three assets, is presented in Exhibit 1.

Exhibit 1 Selected Data on Manager C's Portfolio

	Portfolio Weight	Standard Deviation	Covariance		
			Asset 1	Asset 2	Asset 3
Asset 1	30%	25.00%	0.06250	0.01050	0.00800
Asset 2	45%	14.00%	0.01050	0.01960	0.00224
Asset 3	25%	8.00%	0.00800	0.00224	0.00640

Chen considers adding a fourth sub-manager and evaluates three managers' portfolios, Portfolios X, Y, and Z. The managers for Portfolios X, Y, and Z all have similar costs, fees, and alpha skills, and their factor exposures align with both Aycrig's and investors' expectations and constraints. The portfolio factor exposures, risk contributions, and risk characteristics are presented in Exhibits 2 and 3.

Exhibit 2 Portfolio Factor Exposures and Factor Risk Contribution

	Factor Exposure			Factor Risk Contribution		
	Portfolio X	Portfolio Y	Portfolio Z	Portfolio X	Portfolio Y	Portfolio Z
Market	1.07	0.84	1.08	103%	82%	104%
Size	–0.13	0.15	–0.12	–2%	7%	–3%
Value	0.04	0.30	0.05	–5%	18%	–6%
Momentum	0.08	0.02	0.07	7%	–3%	7%
Quality	0.10	0.35	0.11	–4%	–21%	–5%
Unexplained	—	—	—	1%	17%	3%
Total	n/a	n/a	n/a	100%	100%	100%

Exhibit 3 Portfolio Risk Characteristics

	Portfolio X	Portfolio Y	Portfolio Z
Annualized volatility	10.50%	13.15%	15.20%
Annualized active risk	2.90%	8.40%	4.20%
Active share	0.71	0.74	0.63

Chen and Garcia next discuss characteristics of long–short and long-only investing. Garcia makes the following statements about investing with long–short and long-only managers:

Statement 1 A long–short portfolio allows for a gross exposure of 100%.

Statement 2 A long-only portfolio generally allows for greater investment capacity than other approaches, particularly when using strategies that focus on large-cap stocks.

Chen and Garcia then turn their attention to portfolio management approaches. Chen prefers an approach that emphasizes security-specific factors, does not engage in factor timing, and builds a diversified portfolio.

9 The number of truly independent decisions Manager A would need to make in order to earn her expected active portfolio return this year is *closest* to:

A 8.

B 11.

C 69.

10 Which of the following position size policy constraints is the most restrictive in setting Manager A's maximum position size in shares of Pasliant Corporation?

A Liquidity

B Allocation

C Index weight

11 Manager B's portfolio is *most likely* consistent with the characteristics of a:

A pure indexer.

B sector rotator.

C multi-factor manager.

12 Based on Exhibit 1, the proportion of Manager C's total portfolio variance contributed by Asset 2 is *closest to*:

A 0.0025.

B 0.0056.

C 0.0088.

13 Based on Exhibits 2 and 3, which portfolio *best* exhibits the risk characteristics of a well-constructed portfolio?

A Portfolio X

B Portfolio Y

C Portfolio Z

14 Which of Garcia's statements regarding investing with long–short and long-only managers is correct?

A Only Statement 1

B Only Statement 2

C Both Statement 1 and Statement 2

15 Chen's preferred portfolio management approach would be *best* described as:

A top down.

B systematic.

C discretionary.

SOLUTIONS

1 A is correct. The three main building blocks of portfolio construction are alpha skills, position sizing, and rewarded factor weightings. Fund 1 generates active returns by skillfully timing exposures to factors, both rewarded and unrewarded, and to other asset classes, which constitute a manager's alpha skills.

2 C is correct. Bottom-up managers evaluate the risk and return characteristics of individual securities and build portfolios based on stock-specific forecasts; Fund 3 follows this exact approach. Example views of bottom-up managers include expecting one auto company to outperform another, expecting a pharmaceutical company to outperform an auto company, and expecting a technology company to outperform a pharmaceutical company. Both bottom-up and top-down managers can be either diversified or concentrated in terms of securities.

3 A is correct. Because Fund 1 has a large AUM but focuses on small-cap stocks, holds a relatively small number of securities in its portfolio, and prefers to make large trades, Fund 1 likely has the highest implicit costs. Each of these characteristics serves to increase the market impact of its trades. Market impact is a function of the security's liquidity and trade size. The larger a trade size relative to a stock's average daily volume, the more likely it is that the trade will affect prices. The relatively low level of trading volume of small-cap stocks can be a significant implementation hurdle for a manager running a strategy with significant assets under management and significant positive active weights on smaller companies.

4 C is correct. The portion of total portfolio risk explained by the market factor is calculated in two steps. The first step is to calculate the contribution of the market factor to total portfolio variance as follows:

$$\text{CVmarket factor} = \sum_{j=1}^{n} x_{market\ factor} x_j C_{mf,j} = x_{market\ factor} \sum_{j=1}^{n} x_j C_{mf,j}$$

where

$CV_{market\ factor}$ = contribution of the market factor to total portfolio variance
$x_{market\ factor}$ = weight of the market factor in the portfolio
x_j = weight of factor j in the portfolio
$C_{mf,j}$ = covariance between the market factor and factor j

The variance attributed to the market factor is as follows:

$$CV_{market\ factor} = (1.080 \times 0.00109 \times 1.080) + (1.080 \times 0.00053 \times 0.098) + (1.080 \times 0.00022 \times -0.401) + (1.080 \times -0.00025 \times 0.034)$$

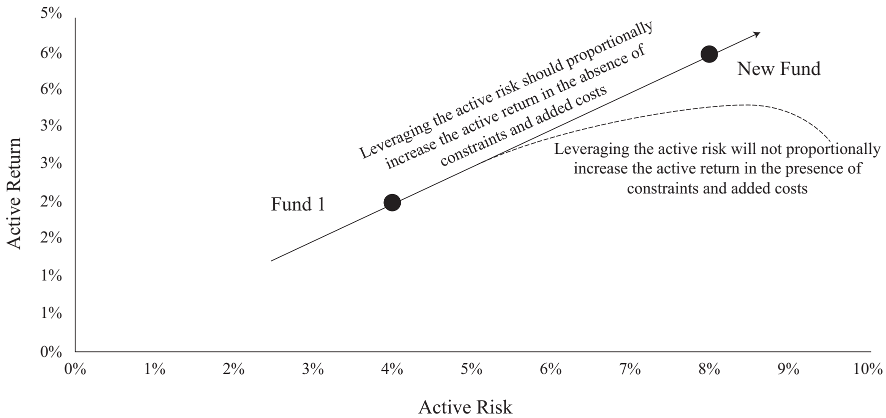
$$CV_{market\ factor} = 0.001223$$

The second step is to divide the resulting variance attributed to the market factor by the portfolio variance of returns, which is the square of the standard deviation of returns:

Portion of total portfolio risk explained by the market factor = $0.001223/(0.0374)^2$

Portion of total portfolio risk explained by the market factor = 87%

5 A is correct. As the new fund scales up active risk by doubling active weights, it will face implementation constraints that will prevent it from increasing the weights of many of its short positions. The information ratio (IR) is defined as the ratio of active return to active risk. If there were no constraints preventing the new fund from scaling up active weights, it could scale up active risk by scaling up active weights, proportionally increase active return, and keep the IR unchanged. Implementation constraints experienced by the new fund, however, such as the cost and difficulty in borrowing securities to support the scaled-up short positions, will prevent the active return from proportionally increasing with the active risk. Therefore, the IR would most likely be lower for the new fund than for Fund 1. As the following chart illustrates, as active risk is scaled up, implementation constraints create diminishing returns to scale for active returns, thereby degrading the IR.



6 C is correct. Active risk is affected by the degree of cross-correlation. The correlation of two stocks in different sectors is most likely lower than the correlation of two stocks in the same sector. Therefore, the correlation of the energy/financial pair is most likely lower than that of the automobile/automobile pair. Because both positions were implemented as an overweight and underweight, the lower correlation of the two stocks in the new position should contribute more to active risk than the two-stock position that it replaced.

7 B is correct. Active share changes only if the total of the absolute values of the portfolio's active weights changes. For the two trades in Fund 3, both the initial position and the new position involved two stocks such that one was 1pp underweighted and the other was 1pp overweighted. Although the active weights of particular securities did change between the initial position and the new position, the total absolute active weights did not change. Therefore, the portfolio's active share did not change.

8 B is correct. Skewness measures the degree to which return expectations are non-normally distributed. If a distribution is positively skewed, the mean of the distribution is greater than its median—more than half of the deviations from the mean are negative and less than half are positive—and the average magnitude of positive deviations is larger than the average magnitude of negative deviations. Negative skew indicates that that the mean of the distribution lies below its median, and the average magnitude of negative deviations is larger than the average magnitude of positive deviations. Fund 3's new risk control constrains its model's predicted return distribution so that no more than 60% of the deviations from the mean are negative. This is an explicit constraint on skewness.

9 C is correct. The breadth (number of truly independent decisions made each year by the manager) required to earn the expected portfolio active return of 2.5% per year is approximately 69 decisions, calculated as follows:

$$E(R_A) = IC \times \sqrt{BR} \times \sigma_{R_A} \times TC$$

$$E(R_A) = 0.15 \times \sqrt{BR} \times 5\% \times 0.40 = 2.5\%$$

$$2.5\% = 0.15 \times \sqrt{BR} \times 5\% \times 0.40$$

$$\sqrt{BR} = \frac{2.5\%}{0.3\%} = 8.33$$

$$BR = 69.44$$

10 A is correct. The maximum position size in shares of Pasliant Corporation (PC) is determined by the constraint with the lowest dollar amount. The maximum position size for PC under each constraint is calculated as follows:

Liquidity Constraint

Dollar value of PC traded daily = PC market cap × Average daily trading volume

Dollar value of PC traded daily = $3 billion × 1.0% = $30 million

Liquidity constraint = Dollar value of PC traded daily × Liquidity % threshold

Liquidity constraint = $30 million × 10% = $3 million

Allocation Constraint

Allocation constraint = AUM × Maximum position size threshold

Allocation constraint = $250 million × 3.0% = $7.5 million

Index Weight Constraint

Index weight constraint = AUM × (Index weight × 10)

Index weight constraint = $250 million × (0.20% × 10) = $5.0 million

The liquidity constraint of $3.0 million is less than both the $5.0 million index weight constraint and the $7.5 million allocation constraint. Therefore, the maximum allowable position size that Manager A may take in PC is $3.0 million.

11 C is correct. Most multi-factor products are diversified across factors and securities and typically have high active share but have reasonably low active risk (tracking error), often in the range of 3%. Most multi-factor products have a low concentration among securities in order to achieve a balanced exposure to risk factors and minimize idiosyncratic risks. Manager B holds a highly diversified portfolio that has balanced exposures to rewarded risk factors, a high active share, and a relatively low target active risk—consistent with the characteristics of a multi-factor manager.

12 B is correct. The contribution of an asset to total portfolio variance equals the summation of the multiplication between the weight of the asset whose contribution is being measured, the weight of each asset (x_j), and the covariance between the asset being measured and each asset (C_{ij}), as follows:

$$\text{Contribution of each asset to portfolio variance} = CV_i = \sum_{j=1}^{n} x_i x_j C_{ij}$$

The contribution of Asset 2 to portfolio variance is computed as the sum of the following products:

Weight of Asset 2 × Weight of Asset 1 × Covariance of asset 2 with Asset 1, plus	0.45 × 0.30 × 0.01050
Weight of Asset 2 × Weight of Asset 2 × Covariance of Asset 2 with Asset 2, plus	0.45 × 0.45 × 0.01960
Weight of Asset 2 × Weight of Asset 3 × Covariance of Asset 2 with Asset 3	0.45 × 0.25 × 0.00224
= Asset 2's contribution to total portfolio variance	0.005639

13 A is correct. Well-constructed portfolios should have low idiosyncratic (unexplained) risk relative to total risk. Portfolio Y exhibits extremely high unexplained risk relative to total risk, and Portfolios X and Z have low unexplained risk relative to total risk. Therefore, Portfolio Y may be eliminated.

Portfolios X and Z have comparable factor exposures. In comparing portfolios with comparable factor exposures, the portfolio with lower absolute volatility and lower active risk will likely be preferred, assuming similar costs. Portfolio X has lower absolute volatility and lower active risk than Portfolio Z, although both have similar costs.

Finally, for managers with similar costs, fees, and alpha skills, if two products have similar active and absolute risks, the portfolio having a higher active share is preferred. Portfolio X has lower absolute volatility, lower active risk, and higher active share than Portfolio Z. As a result, Portfolio X best exhibits the risk characteristics of a well-constructed portfolio.

14 C is correct. Both Statement 1 and Statement 2 are correct.

Statement 1 is correct because, similar to a long-only portfolio, a long–short portfolio can be structured to have a gross exposure of 100%. Gross exposure of the portfolio is calculated as the sum of the long positions and the absolute value of the short positions, expressed as percentages of the portfolio's capital.

Gross exposure = Long positions + |Short positions|

Gross exposure long-only portfolio = 100% (Long positions) + 0% (Short positions) = 100%

Gross exposure long–short portfolio = 50% (Long positions) + |–50%| (Short positions) = 100%

Statement 2 is correct because long-only investing generally offers greater investment capacity than other approaches, particularly when using strategies that focus on large-cap stocks. For large institutional investors such as pension plans, there are no effective capacity constraints in terms of the total market cap available for long-only investing.

15 C is correct. Chen prefers an approach that emphasizes security specific factors, does not engage in factor timing, and runs a concentrated portfolio. These characteristics all reflect a discretionary bottom-up portfolio management approach.

Glossary

Absolute return benchmark A minimum target return that an investment manager is expected to beat.

Accounting defeasance Also called in-substance defeasance, accounting defeasance is a way of extinguishing a debt obligation by setting aside sufficient high-quality securities to repay the liability.

Accumulation phase Phase where the government predominantly contributes to a sovereign wealth pension reserve fund.

Active management An approach to investing in which the portfolio manager seeks to outperform a given benchmark portfolio.

Active return The portfolio's return in excess of the return on the portfolio's benchmark.

Active risk The annualized standard deviation of active returns, also referred to as *tracking error* (also sometimes called *tracking risk*).

Active risk budgeting Risk budgeting that concerns active risk (risk relative to a portfolio's benchmark).

Active share A measure, ranging from 0% to 100%, of how similar a portfolio is to its benchmark. The measure is based on the differences in a portfolio's holdings and weights relative to its benchmark's holdings and their weights. A manager who precisely replicates the benchmark will have an active share of zero; a manager with no holdings in common with the benchmark will have an active share of one.

Active Share A measure of how similar a portfolio is to its benchmark. A manager who precisely replicates the benchmark will have an Active Share of zero; a manager with no holdings in common with the benchmark will have an Active Share of one.

Activist short selling A hedge fund strategy in which the manager takes a short position in a given security and then publicly presents his/her research backing the short thesis.

Adaptive markets hypothesis (AMH) A hypothesis that applies principles of evolution—such as competition, adaptation, and natural selection—to financial markets in an attempt to reconcile efficient market theories with behavioral alternatives.

Agency trade A trade in which the broker is engaged to find the other side of the trade, acting as an agent. In doing so, the broker does not assume any risk for the trade.

Alpha decay In a trading context, alpha decay is the erosion or deterioration in short term alpha after the investment decision has been made.

Alternative trading systems (ATS) Non-exchange trading venues that bring together buyers and sellers to find transaction counterparties. Also called *multilateral trading facilities (MTF).*

Anchoring and adjustment An information-processing bias in which the use of a psychological heuristic influences the way people estimate probabilities.

Anchoring and adjustment bias An information-processing bias in which the use of a psychological heuristic influences the way people estimate probabilities.

Anomalies Apparent deviations from market efficiency.

Arithmetic attribution An attribution approach which explains the arithmetic difference between the portfolio return and its benchmark return. The single-period attribution effects sum to the excess return, however, when combining multiple periods, the sub-period attribution effects will not sum to the excess return.

Arrival price In a trading context, the arrival price is the security price at the time the order was released to the market for execution.

Aspirational risk bucket In goal-based portfolio planning, that part of wealth allocated to investments that have the potential to increase a client's wealth substantially.

Asset location The type of account an asset is held within, e.g., taxable or tax deferred.

Asset-only With respect to asset allocation, an approach that focuses directly on the characteristics of the assets without explicitly modeling the liabilities.

Authorized participants Broker/dealers who enter into an agreement with the distributor of the fund.

Availability bias An information-processing bias in which people take a heuristic approach to estimating the probability of an outcome based on how easily the outcome comes to mind.

Back-fill bias The distortion in index or peer group data which results when returns are reported to a database only after they are known to be good returns.

Barbell A fixed income portfolio combining securities concentrated in short and long maturities relative to the benchmark.

Base With respect to a foreign exchange quotation of the price of one unit of a currency, the currency referred to in "one unit of a currency."

Base-rate neglect A type of representativeness bias in which the base rate or probability of the categorization is not adequately considered.

Basis risk The risk resulting from using a hedging instrument that is imperfectly matched to the investment being hedged; in general, the risk that the basis will change in an unpredictable way.

Bayes' formula A mathematical rule explaining how existing probability beliefs should be changed given new information; it is essentially an application of conditional probabilities.

Bear spread An option strategy that becomes more valuable when the price of the underlying asset declines, so requires buying one option and writing another with a *lower* exercise price. A put bear spread involves buying a put with a higher exercise price and selling a put with a lower exercise price. A bear spread can also be executed with calls.

Behavioral biases A tendency to behave in a way that is not strictly rational.

Behavioral finance macro A focus on market level behavior that considers market anomalies that distinguish markets from the efficient markets of traditional finance.

Behavioral finance micro A focus on individual level behavior that examines the behavioral biases that distinguish individual investors from the rational decision makers of traditional finance.

Benchmark spread The yield on a credit security over the yield on a security with little or no credit risk (benchmark bond) and with a similar duration.

Best-in-class An ESG implementation approach that seeks to identify the most favorable companies and sectors based on ESG considerations. Also called *positive screening.*

Bid price In a price quotation, the price at which the party making the quotation is willing to buy a specified quantity of an asset or security.

Bottom-up approach A credit strategy approach that involves selecting the individual bonds or issuers that the investor views as having the best relative value from among a set of bonds or issuers with similar features.

Bounded rationality The notion that people have informational and cognitive limitations when making decisions and do not necessarily optimize when arriving at their decisions.

Breadth The number of truly independent decisions made each year.

Brinson model The approach to return attribution established in various papers co-authored by Gary Brinson; the Brinson–Hood–Beebower and Brinson–Fachler models viewed as a group. The value added by the portfolio manager is decomposed in allocation, selection, and interaction effects.

Buffering Establishing ranges around breakpoints that define whether a stock belongs in one index or another.

Bull spread An option strategy that becomes more valuable when the price of the underlying asset rises, so requires buying one option and writing another with a *higher* exercise price. A call bull spread involves buying a call with a lower exercise price and selling a call with a higher exercise price. A bull spread can also be executed with puts.

Bullet A fixed income portfolio made up of securities targeting a single segment of the curve.

Business cycle Fluctuations in GDP in relation to long-term trend growth, usually lasting 9-11 years.

Butterfly spread An option strategy that combines two bull or bear spreads and has three exercise prices, or, a measure of yield curve curvature.

Calendar rebalancing Rebalancing a portfolio to target weights on a periodic basis; for example, monthly, quarterly, semiannually, or annually.

Calendar spread A strategy in which one sells an option and buys the same type of option but with different expiration dates, on the same underlying asset and with the same strike. When the investor buys the more distant (near-term) call and sells the near-term (more distant) call, it is a long (short) calendar spread.

Canada model Characterized by a high allocation to alternatives. Unlike the endowment model, however, the Canada model relies more on internally managed assets. The innovative features of the Canada model are the: a) reference portfolio, b) total portfolio approach, and c) active management.

Capital market expectations (CME) Expectations concerning the risk and return prospects of asset classes.

Capital needs analysis See *capital sufficiency analysis.*

Capital sufficiency analysis The process by which a wealth manager determines whether a client has, or is likely to accumulate, sufficient financial resources to meet his or her objectives; also known as *capital needs analysis.*

Capture ratio A measure of the manager's gain or loss relative to the gain or loss of the benchmark.

Carhart model A four factor model used in performance attribution. The four factors are: market (RMRF), size (SMB), value (HML), and momentum (WML).

Carry trade A trading strategy that involves buying a security and financing it at a rate that is lower than the yield on that security.

Cash drag Tracking error caused by temporarily uninvested cash.

Cash flow matching Immunization approach that attempts to ensure that all future liability payouts are matched precisely by cash flows from bonds or fixed-income derivatives, such as interest rate futures, options, or swaps.

Cash-secured put An option strategy involving the writing of a put option and simultaneously depositing an amount of money equal to the exercise price into a designated account (this strategy is also called a fiduciary put).

Cell approach See *stratified sampling.*

Certainty equivalent The maximum sum of money a person would pay to participate or the minimum sum of money a person would accept to not participate in an opportunity.

Civil law A legal system derived from Roman law, in which judges apply general, abstract rules or concepts to particular cases. In civil systems, law is developed primarily through legislative statutes or executive action.

Closet indexer A fund that advertises itself as being actively managed but is substantially similar to an index fund in its exposures.

Code of ethics An established guide that communicates an organization's values and overall expectations regarding member behavior. A code of ethics serves as a general guide for how community members should act.

Cognitive dissonance The mental discomfort that occurs when new information conflicts with previously held beliefs or cognitions.

Cognitive errors Behavioral biases resulting from faulty reasoning; cognitive errors stem from basic statistical, information processing, or memory errors.

Collar An option position in which the investor is long shares of stock and then buys a put with an exercise price below the current stock price and writes a call with an exercise price above the current stock price. Collars allow a shareholder to acquire downside protection through a protective put but reduce the cash outlay by writing a covered call.

Common law A legal system which draws abstract rules from specific cases. In common law systems, law is developed primarily through decisions of the courts.

Community property regime A marital property regime under which each spouse has an indivisible one-half interest in property received during marriage.

Company-specific risk The non-systematic or idiosyncratic risk specific to a particular company's operations, reputation, and business environment.

Completion overlay A type of overlay that addresses an indexed portfolio that has diverged from its proper exposure.

Confirmation bias A belief perseverance bias in which people tend to look for and notice what confirms their beliefs, to ignore or undervalue what contradicts their beliefs, and to misinterpret information as support for their beliefs.

Conjunction fallacy An inappropriate combining of probabilities of independent events to support a belief. In fact, the probability of two independent events occurring in conjunction is never greater than the probability of either event occurring alone; the probability of two independent events occurring together is equal to the multiplication of the probabilities of the independent events.

Conservatism bias A belief perseverance bias in which people maintain their prior views or forecasts by inadequately incorporating new information.

Contingent immunization Hybrid approach that combines immunization with an active management approach when the asset portfolio's value exceeds the present value of the liability portfolio.

Controlled foreign corporation A company located outside a taxpayer's home country and in which the taxpayer has a controlling interest as defined under the home country law.

Convexity A measure of how interest rate sensitivity changes with a change in interest rates.

Core capital The amount of capital required to fund spending to maintain a given lifestyle, fund goals, and provide adequate reserves for unexpected commitments.

Covered call An option strategy in which a long position in an asset is combined with a short position in a call on that asset.

Creation units Large blocks of ETF shares often traded against a basket of underlying securities.

Credit method When the residence country reduces its taxpayers' domestic tax liability by the amount of taxes paid to a foreign country that exercises source jurisdiction.

Credit risk The risk of loss caused by a counterparty's or debtor's failure to make a timely payment or by the change in value of a financial instrument based on changes in default risk. Also called *default risk*.

Cross-currency basis swap A swap in which notional principals are exchanged because the goal of the transaction is to issue at a more favorable funding rate and swap the amount back to the currency of choice.

Cross hedge A hedge involving a hedging instrument that is imperfectly correlated with the asset being hedged; an example is hedging a bond investment with futures on a non-identical bond.

Cross-sectional consistency A feature of expectations setting which means that estimates for all classes reflect the same underlying assumptions and are generated with methodologies that reflect or preserve important relationships among the asset classes, such as strong correlations. It is the internal consistency across asset classes.

Cross-sectional momentum A managed futures trend following strategy implemented with a cross-section of assets (within an asset class) by going long those that are rising in price the most and by shorting those that are falling the most. This approach generally results in holding a net zero (market-neutral) position and works well when a market's out- or underperformance is a reliable predictor of its future performance.

Currency overlay A type of overlay that helps hedge the returns of securities held in foreign currency back to the home country's currency.

Currency overlay programs A currency overlay program is a program to manage a portfolio's currency exposures for the case in which those exposures are managed separately from the management of the portfolio itself.

Custom security-based benchmark Benchmark that is custom built to accurately reflect the investment discipline of a particular investment manager. Also called a *strategy benchmark* because it reflects a manager's particular strategy.

Decision price In a trading context, the decision price is the security price at the time the investment decision was made.

Decision-reversal risk The risk of reversing a chosen course of action at the point of maximum loss.

Decumulation phase Phase where the government predominantly withdraws from a sovereign wealth pension reserve fund.

Dedicated short-selling A hedge fund strategy in which the manager takes short-only positions in equities deemed to be expensively priced versus their deteriorating fundamental situations. Short exposures may vary only in terms of portfolio sizing by, at times, holding higher levels of cash.

Deduction method When the residence country allows taxpayers to reduce their taxable income by the amount of taxes paid to foreign governments in respect of foreign-source income.

Deemed dispositions Tax treatment that assumes property is sold. It is sometimes seen as an alternative to estate or inheritance tax.

Deemed distribution When shareholders of a controlled foreign corporation are taxed as if the earnings were distributed to shareholders, even though no distribution has been made.

Default risk The probability that a borrower defaults or fails to meet its obligation to make full and timely payments of principal and interest, according to the terms of the debt security.

Deferred annuity An annuity that enables an individual to purchase an income stream that will begin at a later date.

Defined benefit A retirement plan in which a plan sponsor commits to paying a specified retirement benefit.

Defined contribution A retirement plan in which contributions are defined but the ultimate retirement benefit is not specified or guaranteed by the plan sponsor.

Delay cost The (trading related) cost associated with not submitting the order to the market in a timely manner.

Delta The change in an option's price in response to a change in price of the underlying, all else equal.

Delta hedging Hedging that involves matching the price response of the position being hedged over a narrow range of prices.

Demand deposits Accounts that can be drawn upon regularly and without notice. This category includes checking accounts and certain savings accounts that are often accessible through online banks or automated teller machines (ATMs).

Diffusion index An index that measures how many indicators are pointing up and how many are pointing down.

Direct market access (DMA) Access in which market participants can transact orders directly with the order book of an exchange using a broker's exchange connectivity.

Disability income insurance A type of insurance designed to mitigate earnings risk as a result of a disability in which an individual becomes less than fully employed.

Discretionary portfolio management An arrangement in which a wealth manager has a client's pre-approval to execute investment decisions.

Discretionary trust A trust structure in which the trustee determines whether and how much to distribute in the sole discretion of the trustee.

Dispersion The weighted *variance* of the times to receipt of cash flow; it measures the extent to which the payments are spread out around the duration.

Disposition effect As a result of loss aversion, an emotional bias whereby investors are reluctant to dispose of losers. This results in an inefficient and gradual adjustment to deterioration in fundamental value.

Dividend capture A trading strategy whereby an equity portfolio manager purchases stocks just before their ex-dividend dates, holds these stocks through the ex-dividend date to earn the right to receive the dividend, and subsequently sells the shares.

Domestic asset An asset that trades in the investor's domestic currency (or home currency).

Domestic currency The currency of the investor, i.e., the currency in which he or she typically makes consumption purchases, e.g., the Swiss franc for an investor domiciled in Switzerland.

Domestic-currency return A rate of return stated in domestic currency terms from the perspective of the investor; reflects both the foreign-currency return on an asset as well as percentage movement in the spot exchange rate between the domestic and foreign currencies.

Donor-advised fund A fund administered by a tax-exempt entity in which the donor advises on where to grant the money that he or she has donated.

Double inflection utility function A utility function that changes based on levels of wealth.

Downside capture ratio A measure of capture when the benchmark return is negative in a given period; downside capture less (greater) than 100% generally suggests out (under) performance relative to the benchmark.

Drawdown A decline in value (represented by a series of negative returns only) following a peak fund valuation.

Due diligence Investigation and analysis in support of an investment action, decision, or recommendation.

Duration matching Immunization approach based on the duration of assets and liabilities. Ideally, the liabilities being matched (the liability portfolio) and the portfolio of assets (the bond portfolio) should be affected similarly by a change in interest rates.

Dynamic asset allocation A strategy incorporating deviations from the strategic asset allocation that are motivated by longer-term valuation signals or economic views than usually associated with tactical asset allocation.

Dynamic hedge A hedge requiring adjustment as the price of the hedged asset changes.

Earnings risk The risk associated with the earning potential of an individual.

Econometrics The application of quantitative modeling and analysis grounded in economic theory to the analysis of economic data.

Economic balance sheet A balance sheet that provides an individual's total wealth portfolio, supplementing traditional balance sheet assets with human capital and pension wealth, and expanding liabilities to include consumption and bequest goals. Also known as *holistic balance sheet.*

Economic indicators Economic statistics provided by government and established private organizations that contain information on an economy's recent past activity or its current or future position in the business cycle.

Economic net worth The difference between an individual's assets and liabilities; extends traditional financial assets and liabilities to include human capital and future consumption needs.

Effective convexity A second-order effect that describes how a bond's interest rate sensitivity changes with changes in yield. Effective convexity is used when the bond has cash flows that change when yields change (as in the case of callable bonds or mortgage-backed securities).

Effective duration Duration adjusted to account for embedded options.

Effective federal funds (FFE) rate The fed funds rate actually transacted between depository institutions, not the Fed's target federal funds rate.

Emotional biases Behavioral biases resulting from reasoning influenced by feelings; emotional biases stem from impulse or intuition.

Empirical duration A measure of interest rate sensitivity that is determined from market data.

Endowment bias An emotional bias in which people value an asset more when they hold rights to it than when they do not.

Endowment model Characterized by a high allocation to alternative investments (private investments and hedge funds), significant active management, and externally managed assets.

Enhanced indexing strategy Method investors use to match an underlying market index in which the investor purchases fewer securities than the full set of index constituents but matches primary risk factors reflected in the index.

Environmental, social, and corporate governance (ESG) Also called socially responsible investing, refers to the explicit inclusion of ethical, environmental, or social criteria when selecting a portfolio.

Equity forward sale contract A private contract for the forward sale of an equity position.

Equity monetization The realization of cash for an equity position through a manner other than an outright sale.

Estate All of the property a person owns or controls; may consist of financial assets, tangible personal assets, immovable property, or intellectual property.

Estate planning The process of preparing for the disposition of one's estate (e.g., the transfer of property) upon death and during one's lifetime.

Estate tax freeze A plan usually involving a corporation, partnership, or limited liability company with the goal to transfer *future* appreciation to the next generation at little or no gift or estate tax cost.

Ethical principles Beliefs regarding what is good, acceptable, or obligatory behavior and what is bad, unacceptable, or forbidden behavior.

Evaluated pricing See *matrix pricing.*

Excess capital An investor's capital over and above that which is necessary to fund their lifestyle and reserves.

Excess return Used in various senses appropriate to context: 1) The difference between the portfolio return and the benchmark return; 2) The return in excess of the risk-free rate.

Exchange-traded fund Exchange-traded Funds or ETFs are hybrid investment products with many features of mutual funds combined with the trading features of common stocks or bonds. Essentially, ETFs are typically portfolios of stocks or bonds or commodities that trade throughout the day like common stocks.

Execution cost The difference between the (trading related) cost of the real portfolio and the paper portfolio, based on shares and prices transacted.

Exemption method When the residence country imposes no tax on foreign-source income by providing taxpayers with an exemption, in effect having only one jurisdiction impose tax.

Exhaustive An index construction strategy that selects every constituent of a universe.

Expected shortfall The average loss conditional on exceeding the VaR cutoff; sometimes referred to as *conditional VaR* or *expected tail loss*.

Expected tail loss See *expected shortfall.*

Extended portfolio assets and liabilities Assets and liabilities beyond those shown on a conventional balance sheet that are relevant in making asset allocation decisions; an example of an extended asset is human capital.

Factor-model-based benchmarks Benchmarks constructed by examining a portfolio's sensitivity to a set of factors, such as the return for a broad market index, company earnings growth, industry, or financial leverage.

Fiduciary duty The obligation to act in the best interest of the client, exercising a reasonable level of care, skill, and diligence.

Financial buyers Buyers who lack a strategic motive.

Financial capital The tangible and intangible assets (excluding human capital) owned by an individual or household.

Fixed trust A trust structure in which distributions to beneficiaries are prescribed in the trust document to occur at certain times or in certain amounts.

Forced heirship rules Legal ownership principles whereby children have the right to a fixed share of a parent's estate.

Foreign assets Assets denominated in currencies other than the investor's home currency.

Foreign currency Currency that is not the currency in which an investor makes consumption purchases, e.g., the US dollar from the perspective of a Swiss investor.

Foreign-currency return The return of the foreign asset measured in foreign-currency terms.

Forward conversion with options The construction of a synthetic short forward position against the asset held long.

Forward rate bias Persistent violation of uncovered interest rate parity that is exploited by the carry trade.

Framing An information-processing bias in which a person answers a question differently based on the way in which it is asked (framed).

Framing bias An information-processing bias in which a person answers a question differently based on the way in which it is asked (framed).

Fulcrum securities Partially-in-the-money claims (not expected to be repaid in full) whose holders end up owning the reorganized company in a corporate reorganization situation.

Full replication approach When every issue in an index is represented in the portfolio, and each portfolio position has approximately the same weight in the fund as in the index.

Fund-of-funds A fund of hedge funds in which the fund-of-funds manager allocates capital to separate, underlying hedge funds (e.g., single manager and/or multi-manager funds) that themselves run a range of different strategies.

Funding currencies The low-yield currencies in which borrowing occurs in a carry trade.

G-spread The yield on a credit security over the yield of an actual or interpolated government bond.

Gamblers' fallacy A misunderstanding of probabilities in which people wrongly project reversal to a long-term mean.

Gamma The change in an option's delta for a change in price of the underlying, all else equal.

General account Account holding assets to fund future liabilities from traditional life insurance and fixed annuities, the products in which the insurer bears all the risks—particularly mortality risk and longevity risk.

Goals-based With respect to asset allocation or investing, an approach that focuses on achieving an investor's goals (for example, related to supporting lifestyle needs or aspirations) based typically on constructing sub-portfolios aligned with those goals.

Goals-based investing An investment industry term for approaches to investing for individuals and families focused on aligning investments with goals (parallel to liability-driven investing for institutional investors).

Grinold–Kroner model An expression for the expected return on a share as the sum of an expected income return, an expected nominal earnings growth return, and an expected repricing return.

Hague Conference on Private International Law An intergovernmental organization working toward the convergence of private international law. Its 69 members consist of countries and regional economic integration organizations.

Halo effect An emotional bias that extends a favorable evaluation of some characteristics to other characteristics.

Hard-catalyst event-driven approach An event-driven approach in which investments are made in reaction to an already announced corporate event (mergers and acquisitions, bankruptcies, share issuances, buybacks, capital restructurings, re-organizations, accounting changes) in which security prices related to the event have yet to fully converge.

Health insurance A type of insurance used to cover health care and medical costs.

Health risk The risk associated with illness or injury.

Hedge ratio The relationship of the quantity of an asset being hedged to the quantity of the derivative used for hedging.

Herding When a group of investors trade on the same side of the market in the same securities, or when investors ignore their own private information and act as other investors do.

High-water mark A specified net asset value level that a fund must exceed before performance fees are paid to the hedge fund manager.

Hindsight bias A bias with selective perception and retention aspects in which people may see past events as having been predictable and reasonable to expect.

Holdings-based attribution A "buy and hold" attribution approach which calculates the return of portfolio and benchmark components based upon the price and foreign exchange rate changes applied to daily snapshots of portfolio holdings.

Holdings-based style analysis A bottom-up style analysis that estimates the risk exposures from the actual securities held in the portfolio at a point in time.

Holistic balance sheet See *economic balance sheet.*

Home bias A preference for securities listed on the exchanges of one's home country.

Home-country bias The favoring of domestic over non-domestic investments relative to global market value weights.

Home currency See *domestic currency*.

Horizon matching Hybrid approach that combines cash flow and duration matching approaches. Under this approach, liabilities are categorized as short-and long-term liabilities.

Human capital An implied asset; the net present value of an investor's future expected labor income weighted by the probability of surviving to each future age. Also called *net employment capital*.

I-spread The yield on a credit security over the swap rate (denominated in the same currency as the credit security). Also known as interpolated spread.

Illusion of control A bias in which people tend to believe that they can control or influence outcomes when, in fact, they cannot. Illusion of knowledge and self-attribution biases contribute to the overconfidence bias.

Illusion of control bias A bias in which people tend to believe that they can control or influence outcomes when, in fact, they cannot. Illusion of knowledge and self-attribution biases contribute to the overconfidence bias.

Immediate annuity An annuity that provides a guarantee of specified future monthly payments over a specified period of time.

Immunization An asset/liability management approach that structures investments in bonds to match (offset) liabilities' weighted-average duration; a type of dedication strategy.

Impact investing Investment approach that seeks to achieve targeted social or environmental objectives along with measurable financial returns through engagement with a company or by direct investment in projects or companies.

Implementation shortfall (IS) The difference between the return for a notional or paper portfolio, where all transactions are assumed to take place at the manager's decision price, and the portfolio's actual return, which reflects realized transactions, including all fees and costs.

Implied volatility The outlook for the future volatility of the underlying asset's price. It is the value (i.e., standard deviation of underlying's returns) that equates the model (e.g., Black–Scholes–Merton model) price of an option to its market price.

Implied volatility surface A three-dimensional plot, for put and call options on the same underlying asset, of days to expiration (x-axis), option strike prices (y-axis), and implied volatilities (z-axis). It simultaneously shows the volatility skew (or smile) and the term structure of implied volatility.

Indexing A common passive approach to investing that involves holding a portfolio of securities designed to replicate the returns on a specified index of securities.

Indifference curve analysis A decision-making approach whereby curves of consumption bundles, among which the decision-maker is indifferent, are constructed to identify and choose the curve within budget constraints that generates the highest utility.

Information coefficient Formally defined as the correlation between forecast return and actual return. In essence, it measures the effectiveness of investment insight.

Input uncertainty Uncertainty concerning whether the inputs are correct.

Interaction effect The attribution effect resulting from the interaction of the allocation and selection decisions.

Intertemporal consistency A feature of expectations setting which means that estimates for an asset class over different horizons reflect the same assumptions with respect to the potential paths of returns over time. It is the internal consistency over various time horizons.

Intestate Having made no valid will; a decedent without a valid will or with a will that does not dispose of their property is considered to have died intestate.

Intrinsic value The difference between the spot exchange rate and the strike price of a currency option.

Investment currencies The high-yielding currencies in a carry trade.

Investment policy statement A written planning document that describes a client's investment objectives and risk tolerance over a relevant time horizon, along with the constraints that apply to the client's portfolio.

Investment style A natural grouping of investment disciplines that has some predictive power in explaining the future dispersion of returns across portfolios.

Irrevocable trust A trust arrangement wherein the settlor has no ability to revoke the trust relationship.

Joint ownership with right of survivorship Jointly owned; assets held in joint ownership with right of survivorship automatically transfer to the surviving joint owner or owners outside the probate process.

Key person risk The risk that results from over-reliance on an individual or individuals whose departure would negatively affect an investment manager.

Key rate duration A method of measuring the interest rate sensitivities of a fixed-income instrument or portfolio to shifts in key points along the yield curve.

Knock-in/knock-out Features of a vanilla option that is created (or ceases to exist) when the spot exchange rate touches a pre-specified level.

Leading economic indicators A set of economic variables whose values vary with the business cycle but at a fairly consistent time interval before a turn in the business cycle.

Leveraged recapitalization A leveraging of a company's balance sheet, usually accomplished by working with a private equity firm.

Liability-driven investing An investment industry term that generally encompasses asset allocation that is focused on funding an investor's liabilities in institutional contexts.

Liability driven investing (LDI) model In the LDI model, the primary investment objective is to generate returns sufficient to cover liabilities, with a focus on maximizing expected surplus return (excess return of assets over liabilities) and managing surplus volatility.

Liability glide path A specification of desired proportions of liability-hedging assets and return-seeking assets and the duration of the liability hedge as funded status changes and contributions are made.

Liability insurance A type of insurance used to manage liability risk.

Liability-relative With respect to asset allocation, an approach that focuses directly only on funding liabilities as an investment objective.

Liability risk The possibility that an individual or household may be held legally liable for the financial costs associated with property damage or physical injury.

Life-cycle finance A concept in finance that recognizes as an investor ages, the fundamental nature of wealth and risk evolves.

Life insurance A type of insurance that protects against the loss of human capital for those who depend on an individual's future earnings.

Life settlement The sale of a life insurance contract to a third party. The valuation of a life settlement typically requires detailed biometric analysis of the individual policyholder and an understanding of actuarial analysis.

Lifetime gratuitous transfer A lifetime gift made during the lifetime of the donor; also known as *inter vivos* transfers.

Limited-life foundations A type of foundation where founders seek to maintain control of spending while they (or their immediate heirs) are still alive.

Liquidity budget The portfolio allocations (or weightings) considered acceptable for the liquidity categories in the liquidity classification schedule (or time-to-cash table).

Liquidity classification schedule A liquidity management classification (or table) that defines portfolio liquidity "buckets" or categories based on the estimated time it would take to convert assets in that particular category into cash.

Longevity risk The risk associated with living to an advanced age in retirement, including the uncertainty surrounding how long retirement will last; the risk of outliving one's financial resources.

Loss-aversion bias A bias in which people tend to strongly prefer avoiding losses as opposed to achieving gains.

Loss given default See *loss severity*.

Loss severity The amount of loss if a default occurs. Also called *loss given default*.

Macaulay duration The percentage change in price for a percentage change in yield. The term, named for one of the economists who first derived it, is used to distinguish the calculation from modified duration. (See also *modified duration*).

Macro attribution Attribution at the sponsor level.

Manager peer group See *manager universe*.

Manager universe A broad group of managers with similar investment disciplines. Also called *manager peer group*.

Market risk bucket In goal-based portfolio planning, that part of wealth allocated to investments intended to maintain the client's current standard of living.

Matrix pricing An approach for estimating the prices of thinly traded securities based on the prices of securities with similar attributions, such as similar credit rating, maturity, or economic sector. Also called *evaluated pricing*.

Mental accounting bias An information-processing bias in which people treat one sum of money differently from another equal-sized sum based on which mental account the money is assigned to.

Micro attribution Attribution at the portfolio manager level.

Minimum-variance hedge ratio A mathematical approach to determining the optimal cross hedging ratio.

Mismatch in character The potential tax inefficiency that can result if the instrument being hedged, and the tool that is being used to hedge it, produce income and loss of a different character.

Mission-related investing Aims to direct a significant portion of assets in excess of annual grants into projects promoting a foundation's mission.

Model uncertainty Uncertainty as to whether a selected model is correct.

Modified duration An adjustment of the duration for the level of the yield. Contrast with *Macaulay duration*.

Monetize To access an item's cash value without transferring ownership of it.

Money duration A measure of the price change in units of the currency in which the bond is denominated given a change in its yield-to-maturity.

Mortality table A table that indicates individual life expectancies at specified ages.

Multi-class trading An equity market-neutral strategy that capitalizes on misalignment in prices and involves buying and selling different classes of shares of the same company, such as voting and non-voting shares.

Multi-manager fund Can be of two types—one is a multi-strategy fund in which teams of portfolio managers trade and invest in multiple different strategies within the same fund; the second type is a fund of hedge funds (or fund-of-funds) in which the manager allocates capital to separate, underlying hedge funds that themselves run a range of different strategies.

Multi-strategy fund A fund in which teams of portfolio managers trade and invest in multiple different strategies within the same fund.

Multilateral trading facilities (MTF) See *Alternative trading systems (ATS)*.

Mutual funds A professionally managed investment pool in which investors in the fund typically each have a pro-rata claim on the income and value of the fund.

Negative screening An ESG implementation approach that excludes certain sectors or companies that deviate from an investor's accepted standards.

Net asset value Value established at the end of each trading day based on the fund's valuation of all existing assets minus liabilities, divided by the total number of shares outstanding.

Net employment capital See *human capital*.

Net worth tax or net wealth tax A tax based on a person's assets, less liabilities.

Non-deliverable forwards Forward contracts that are cash settled (in the non-controlled currency of the currency pair) rather than physically settled (the controlled currency is neither delivered nor received).

Nonstationarity A characteristic of series of data whose properties, such as mean and variance, are not constant through time. When analyzing historical data it means that different parts of a data series reflect different underlying statistical properties.

Norway model Characterized by an almost exclusive reliance on public equities and fixed income (the traditional 60/40 equity/bond model falls under the Norway model), with largely passively managed assets and with very little to no allocation to alternative investments.

Offer price The price at which a counterparty is willing to sell one unit of the base currency.

Opportunity cost The (trading related) cost associated with not being able to transact the entire order at the decision price.

Option-adjusted spread The constant spread that, when added to all the one-period forward rates on the interest rate tree, makes the arbitrage-free value of the bond equal to its market price.

Optional stock dividends A type of dividend in which shareholders may elect to receive either cash or new shares.

Overbought When a market has trended too far in one direction and is vulnerable to a trend reversal, or correction.

Overconfidence bias A bias in which people demonstrate unwarranted faith in their own intuitive reasoning, judgments, and/or cognitive abilities.

Overlay A derivative position (or positions) used to adjust a pre-existing portfolio closer to its objectives.

Oversold The opposite of overbought; see *overbought*.

Packeting Splitting stock positions into multiple parts.

Pairs trading An equity market-neutral strategy that capitalizes on the misalignment in prices of pairs of similar under- and overvalued equities. The expectation is the differential valuations or trading relationships will revert to their long-term mean values or their fundamentally-correct trading relationships, with the long position rising and the short position declining in value.

Parameter uncertainty Uncertainty arising because a quantitative model's parameters are estimated with error.

Participant/cohort option Pools the DC plan member with a cohort that has a similar target retirement date.

Participant-switching life-cycle options Automatically switch DC plan members into a more conservative asset mix as their age increases. There may be several automatic de-risking switches at different age targets.

Passive investment Investment that seeks to mimic the prevailing characteristics of the overall investments available in terms of credit quality, type of borrower, maturity, and duration rather than express a specific market view.

Passive management A buy-and-hold approach to investing in which an investor does not make portfolio changes based upon short-term expectations of changing market or security performance.

Percent-range rebalancing An approach to rebalancing that involves setting rebalancing thresholds or trigger points, stated as a percentage of the portfolio's value, around target values.

Performance attribution Attribution, including return attribution and risk attribution; often used as a synonym for return attribution.

Permanent life insurance A type of life insurance that provides lifetime coverage.

Personal risk bucket In goal-based portfolio planning, that part of wealth allocated to investments intended to protect the client from a drastic decrease in lifestyle.

Portfolio overlay An array of derivative positions managed separately from the securities portfolio to achieve overall intended portfolio characteristics.

Position delta The overall or portfolio delta. For example, the position delta of a covered call, consisting of long 100 shares and short one at-the-money call, is +50 (= +100 for the shares and -50 for the short ATM call).

Positive screening An ESG implementation approach that seeks to identify the most favorable companies and sectors based on ESG considerations. Also called *best-in-class*.

Premature death risk The risk of an individual dying earlier than anticipated; sometimes referred to as *mortality risk*.

Premium Regarding life insurance, the asset paid by the policy holder to an insurer who, in turn, has a contractual obligation to pay death benefit proceeds to the beneficiary named in the policy.

Prepaid variable forward A collar and loan combined within a single instrument.

Present value of distribution of cash flows methodology Method used to address a portfolio's sensitivity to rate changes along the yield curve, this approach seeks to approximate and match the yield curve risk of an index over discrete time periods.

Price value of a basis point (PVBP) The change in the bond price for a 1 basis point change in yield. Also called *basis point value* (BPV).

Primary capital Assets held outside a concentrated position that are at least sufficient to provide for the owner's lifetime spending needs.

Principal trade A trade in which the market maker or dealer becomes a disclosed counterparty and assumes risk for the trade by transacting the security for their own account. Also called *broker risk trades*.

Probate The legal process to confirm the validity of a will so that executors, heirs, and other interested parties can rely on its authenticity.

Profession An occupational group that has specific education, expert knowledge, and a framework of practice and behavior that underpins community trust, respect, and recognition.

Program trading A strategy of buying or selling many stocks simultaneously.

Property insurance A type of insurance used by individuals to manage property risk.

Property risk The possibility that a person's property may be damaged, destroyed, stolen, or lost.

Prospect theory An alternative to expected utility theory, it assigns value to gains and losses (changes in wealth) rather than to final wealth, and probabilities are replaced by decision weights. In prospect theory, the shape of a decision maker's value function is assumed to differ between the domain of gains and the domain of losses.

Protective put An option strategy in which a long position in an asset is combined with a long position in a put on that asset.

Pure indexing Method investors use to match an underlying market index in which the investor aims to replicate an existing market index by purchasing all of the constituent securities in the index to minimize tracking risk.

Put spread A strategy used to reduce the upfront cost of buying a protective put, it involves buying a put option and writing another put option.

Quantitative market-neutral An approach to building market-neutral portfolios in which large numbers of securities are traded and positions are adjusted on a daily or even an hourly basis using algorithm-based models.

Rational economic man A self-interested, risk-averse individual who has the ability to make judgments using all available information in order to maximize his/her expected utility.

Re-base With reference to index construction, to change the time period used as the base of the index.

Realized volatility Historical volatility, the square root of the realized variance of returns, which is a measure of the range of past price outcomes for the underlying asset.

Rebalancing In the context of asset allocation, a discipline for adjusting the portfolio to align with the strategic asset allocation.

Rebalancing overlay A type of overlay that addresses a portfolio's need to sell certain constituent securities and buy others.

Rebalancing range A range of values for asset class weights defined by trigger points above and below target weights, such that if the portfolio value passes through a trigger point, rebalancing occurs. Also known as a corridor.
Rebate rate The portion of the collateral earnings rate that is repaid to the security borrower by the security lender.
Reduced-form models Models that use economic theory and other factors such as prior research output to describe hypothesized relationships. Can be described as more compact representations of underlying structural models. Evaluate endogenous variables in terms of observable exogenous variables.
Regime The governing set of relationships (between variables) that stem from technological, political, legal, and regulatory environments. Changes in such environments or policy stances can be described as changes in regime.
Regret The feeling that an opportunity has been missed; typically an expression of *hindsight bias*.
Regret-aversion bias An emotional bias in which people tend to avoid making decisions that will result in action out of fear that the decision will turn out poorly.
Relative value volatility arbitrage A volatility trading strategy that aims to source and buy cheap volatility and sell more expensive volatility while netting out the time decay aspects normally associated with options portfolios.
Repo rate The interest rate on a repurchase agreement.
Representativeness bias A belief perseverance bias in which people tend to classify new information based on past experiences and classifications.
Repurchase agreements (repos) In a repurchase agreement, a security owner agrees to sell a security for a specific cash amount, while simultaneously agreeing to repurchase the security at a specified future date (typically one day later) and price.
Request for quote (RFQ) A non-binding quote provided by a market maker or dealer to a potential buyer or seller upon request. Commonly used in fixed income markets these quotes are only valid at the time they are provided.
Reserve portfolio The component of an insurer's general account that is subject to specific regulatory requirements and is intended to ensure the company's ability to meet its policy liabilities. The assets in the reserve portfolio are managed conservatively and must be highly liquid and low risk.
Residence jurisdiction A framework used by a country to determine the basis for taxing income, based on residency.
Residence–residence conflict When two countries claim residence of the same individual, subjecting the individual's income to taxation by both countries.
Residence–source conflict When tax jurisdiction is claimed by an individual's country of residence and the country where some of their assets are sourced; the most common source of double taxation.
Resistance levels Price points on dealers' order boards where one would expect to see a clustering of offers.
Return attribution A set of techniques used to identify the sources of the excess return of a portfolio against its benchmark.
Returns-based attribution An attribution approach that uses only the total portfolio returns over a period to identify the components of the investment process that have generated the returns. The Brinson–Hood–Beebower approach is a returns-based attribution approach.
Returns-based benchmarks Benchmarks constructed by examining a portfolio's sensitivity to a set of factors, such as the returns for various style indexes (e.g., small-cap value, small-cap growth, large-cap value, and large-cap growth).
Returns-based style analysis A top-down style analysis that involves estimating the sensitivities of a portfolio to security market indexes.
Reverse repos Repurchase agreement from the standpoint of the lender.
Revocable trust A trust arrangement wherein the settlor (who originally transfers assets to fund the trust) retains the right to rescind the trust relationship and regain title to the trust assets.
Risk attribution The analysis of the sources of risk.
Risk aversion The degree of an investor's unwillingness to take risk; the inverse of risk tolerance.
Risk budgeting The establishment of objectives for individuals, groups, or divisions of an organization that takes into account the allocation of an acceptable level of risk.
Risk capacity The ability to accept financial risk.
Risk perception The subjective assessment of the risk involved in the outcome of an investment decision.
Risk premium An extra return expected by investors for bearing some specified risk.
Risk reversal A strategy used to profit from the existence of an implied volatility skew and from changes in its shape over time. A combination of long (short) calls and short (long) puts on the same underlying with the same expiration is a long (short) risk reversal.
Risk tolerance The capacity to accept risk; the level of risk an investor (or organization) is willing and able to bear.
Sale and leaseback A transaction wherein the owner of a property sells that property and then immediately leases it back from the buyer at a rate and term acceptable to the new owner and on financial terms consistent with the marketplace.
Sample-size neglect A type of representativeness bias in which financial market participants incorrectly assume that small sample sizes are representative of populations (or "real" data).
Satisfice A combination of "satisfy" and "suffice" describing decisions, actions, and outcomes that may not be optimal, but are adequate.
Scenario analysis A risk assessment technique involving the examination of the performance of a portfolio under specified situations.
Seagull spread An extension of the risk reversal foreign exchange option strategy that limits downside risk.
Securities lending A form of collateralized lending that may be used to generate income for portfolios.
Selective An index construction methodology that targets only those securities with certain characteristics.
Self-attribution bias A bias in which people take personal credit for successes and attribute failures to external factors outside the individual's control.
Self-control bias A bias in which people fail to act in pursuit of their long-term, overarching goals because of a lack of self-discipline.
Separate accounts Accounts holding assets to fund future liabilities from variable life insurance and variable annuities, the products in which customers make investment decisions from a menu of options and themselves bear investment risk.

Separate property regime A marital property regime under which each spouse is able to own and control property as an individual.

Settlor (or grantor) An entity that transfers assets to a trustee, to be held and managed for the benefit of the trust beneficiaries.

Shari'a The law of Islam. In addition to the law of the land, some follow guidance provided by Shari'a or Islamic law.

Sharpe ratio The average return in excess of the risk-free rate divided by the standard deviation of return; a measure of the average excess return earned per unit of standard deviation of return. Also known as the *reward-to-variability ratio*.

Short-biased A hedge fund strategy in which the manager uses a less extreme version of dedicated short-selling. It involves searching for opportunities to sell expensively priced equities, but short exposure may be balanced with some modest value-oriented, or index-oriented, long exposure.

Short sale against the box Shorting a security that is held long.

Shortfall probability The probability of failing to meet a specific liability or goal.

Shrinkage estimation Estimation that involves taking a weighted average of a historical estimate of a parameter and some other parameter estimate, where the weights reflect the analyst's relative belief in the estimates.

Single-manager fund A fund in which one portfolio manager or team of portfolio managers invests in one strategy or style.

Situational influences External factors, such as environmental or cultural elements, that shape our behavior.

Smart beta Involves the use of simple, transparent, rules-based strategies as a basis for investment decisions.

Smart order routers (SOR) Smart systems used to electronically route small orders to the best markets for execution based on order type and prevailing market conditions.

Social proof A bias in which individuals tend to follow the beliefs of a group.

Soft-catalyst event-driven approach An event-driven approach in which investments are made proactively in anticipation of a corporate event (mergers and acquisitions, bankruptcies, share issuances, buybacks, capital restructurings, re-organizations, accounting changes) that has yet to occur.

Sole ownership Owned by one person; assets held in sole ownership are typically considered part of a decedent's estate. The transfer of their ownership is dictated by the decedent's will through the probate process.

Source jurisdiction A framework used by a country to determine the basis for taxing income or transfers. A country that taxes income as a source within its borders imposes source jurisdiction.

Source–source conflict When two countries claim source jurisdiction of the same asset; both countries may claim that the income is derived from their jurisdiction.

Special dividends A dividend paid by a company that does not pay dividends on a regular schedule, or a dividend that supplements regular cash dividends with an extra payment.

Spread curve The fitted curve of credit spreads for each bond of an issuer plotted against either the maturity or duration of each of those bonds.

Spread duration A measure used in determining a portfolio's sensitivity to changes in credit spreads.

Standards of conduct Behaviors required by a group; established benchmarks that clarify or enhance a group's code of ethics.

Static hedge A hedge that is not sensitive to changes in the price of the asset hedged.

Status quo bias An emotional bias in which people do nothing (i.e., maintain the "status quo") instead of making a change.

Stock lending Securities lending involving the transfer of equities.

Stop-losses A trading order that sets a selling price below the current market price with a goal of protecting profits or preventing further losses.

Stops Stop-loss orders involve leaving bids or offers away from the current market price to be filled if the market reaches those levels.

Straddle An option combination in which one buys *both* puts and calls, with the same exercise price and same expiration date, on the same underlying asset. In contrast to this long straddle, if someone *writes* both options, it is a short straddle.

Strangle A variation on a straddle in which the put and call have different exercise prices; if the put and call are held long, it is a long strangle; if they are held short, it is a short strangle.

Strategic asset allocation 1) The process of allocating money to IPS-permissible asset classes that integrates the investor's return objectives, risk tolerance, and investment constraints with long-run capital market expectations. 2) The result of the above process, also known as the policy portfolio.

Strategic buyers Buyers who have a strategic motive (e.g., realization of synergies) for seeking to buy a company.

Stratified sampling A sampling method that guarantees that subpopulations of interest are represented in the sample. Also called *representative sampling* or *cell approach*.

Structural models Models that specify functional relationships among variables based on economic theory. The functional form and parameters of these models are derived from the underlying theory. They may include unobservable parameters.

Structural risk Risk that arises from portfolio design, particularly the choice of the portfolio allocations.

Stub trading An equity market-neutral strategy that capitalizes on misalignment in prices and entails buying and selling stock of a parent company and its subsidiaries, typically weighted by the percentage ownership of the parent company in the subsidiaries.

Support levels Price points on dealers' order boards where one would expect to see a clustering of bids.

Surplus The difference between the value of assets and the present value of liabilities. With respect to an insurance company, the net difference between the total assets and total liabilities (equivalent to policyholders' surplus for a mutual insurance company and stockholders' equity for a stock company).

Surplus capital Capital that is in excess of primary capital.

Surplus portfolio The component of an insurer's general account that is intended to realize higher expected returns than the reserve portfolio and so can assume some liquidity risk. Surplus portfolio assets are often managed aggressively with exposure to alternative assets.

Survival probability The probability an individual survives in a given year; used to determine expected cash flow required in retirement.

Survivorship bias Bias that arises in a data series when managers with poor track records exit the business and are dropped from the database whereas managers with good records remain; when a data series of a given date reflects only entitites that have survived to that date.

Synthetic long forward position The combination of a long call and a short put with identical strike price and expiration, traded at the same time on the same underlying.

Synthetic short forward position The combination of a short call and a long put at the same strike price and maturity (traded at the same time on the same underlying).

Tactical asset allocation Asset allocation that involves making short-term adjustments to asset class weights based on short-term predictions of relative performance among asset classes.

Tail risk The risk that there are more actual events in the tail of a probability distribution than would be predicted by probability models.

Tax avoidance Developing strategies that minimize tax, while conforming to both the spirit and the letter of the tax codes of jurisdictions with taxing authority.

Tax evasion The practice of circumventing tax obligations by illegal means such as misreporting or not reporting relevant information to tax authorities.

Taylor rule A rule linking a central bank's target short-term interest rate to the rate of growth of the economy and inflation.

Temporary life insurance A type of life insurance that covers a certain period of time, specified at purchase. Commonly referred to as "term" life insurance.

Term deposits Interest-bearing accounts that have a specified maturity date. This category includes savings accounts and certificates of deposit (CDs).

Term structure of volatility The plot of implied volatility (y-axis) against option maturity (x-axis) for options with the same strike price on the same underlying. Typically, implied volatility is not constant across different maturities – rather, it is often in contango, meaning that the implied volatilities for longer-term options are higher than for near-term ones.

Territorial tax system A framework used by a country to determine the basis for taxing income or transfers. A country that taxes income as a source within its borders imposes source jurisdiction.

Testamentary gratuitous transfer The bequeathing or transfer of assets upon one's death. From a recipient's perspective, it is called an inheritance.

Testator A person who makes a will.

Thematic investing An investment approach that focuses on companies within a specific sector or following a specific theme, such as energy efficiency or climate change.

Theta The daily change in an option's price, all else equal. Theta measures the sensitivity of the option's price to the passage of time, known as time decay.

Time deposits Interest-bearing accounts that have a specified maturity date. This category includes savings accounts and certificates of deposit (CDs).

Time-series estimation Estimators that are based on lagged values of the variable being forecast; often consist of lagged values of other selected variables.

Time-series momentum A managed futures trend following strategy in which managers go long assets that are rising in price and go short assets that are falling in price. The manager trades on an absolute basis, so be net long or net short depending on the current price trend of an asset. This approach works best when an asset's own past returns are a good predictor of its future returns.

Time-to-cash table See *liquidity classification schedule.*

Time value The difference between the market price of an option and its intrinsic value, determined by the uncertainty of the underlying over the remaining life of the option.

Top-down approach A credit strategy approach that involves formulating a view on major macroeconomic trends and then selecting the bonds that the investor expects to perform best in the expected environment.

Total factor productivity A variable which accounts for that part of Y not directly accounted for by the levels of the production factors (K and L).

Total return equity swap A swap contract that involves a series of exchanges of the total return on a specified asset or equity index in return for specified fixed or floating rate payments.

Total return payer Party responsible for paying the reference obligation cash flows and return to the receiver, but will also be compensated by the receiver for any depreciation in the index or default losses incurred on the portfolio.

Total return receiver Party receives both the cash flows from the underlying index as well as any appreciation in the index over the period in exchange for paying Libor plus a pre-determined spread.

Total return swap A swap in which one party agrees to pay the total return on a security. Often used as a credit derivative, in which the underlying is a bond.

Tracking error The standard deviation of the differences between a portfolio's returns and its benchmark's returns; a synonym of active risk. Also called *tracking risk*.

Tracking risk The standard deviation of the differences between a portfolio's returns and its benchmark's returns; a synonym of active risk. Also called *tracking error*.

Trade urgency A reference to how quickly or slowly an order is executed over the trading time horizon.

Transactions-based attribution An attribution approach that captures the impact of intra-day trades and exogenous events such as a significant class action settlement.

Transfer coefficient The ability to translate portfolio insights into investment decisions without constraint.

Trigger points In the context of portfolio rebalancing, the endpoints of a rebalancing range (corridor).

Unsmoothing An adjustment to the reported return series if serial correlation is detected. Various approaches are available to unsmooth a return series.

Upside capture ratio A measure of capture when the benchmark return is positive in a given period; upside capture greater (less) than 100% generally suggests out (under) performance relative to the benchmark.

Utility The level of relative satisfaction received from the consumption of goods and services.

Utility theory Theory whereby people maximize the present value of utility subject to a present value budget constraint.

Variance notional The notional amount of a variance swap; it equals vega notional divided by two times the volatility strike price [i.e., (vega notional)/(2 × volatility strike)].

Vega The change in an option's price for a change in volatility of the underlying, all else equal.

Vega notional The trade size for a variance swap, which represents the average profit and loss of the variance swap for a 1% change in volatility from the strike.

Vesting A term indicating that employees only become eligible to receive a pension after meeting certain criteria, typically a minimum number of years of service.

Volatility clustering The tendency for large (small) swings in prices to be followed by large (small) swings of random direction.

Volatility skew The skewed plot (of implied volatility (y-axis) against strike price (x-axis) for options on the same underlying with the same expiration) that occurs when the implied volatility increases for OTM puts and decreases for OTM calls, as the strike price moves away from the current price.

Volatility smile The U-shaped plot (of implied volatility (y-axis) against strike price (x-axis) for options on the same underlying with the same expiration) that occurs when the implied volatilities priced into both OTM puts and calls trade at a premium to implied volatilities of ATM options.

Will A document associated with estate planning that outlines the rights others will have over one's property after death. Also called *testament*.

Z-spread The yield spread that must be added to each point of the implied spot yield curve to make the present value of a bond's cash flows equal its current market price. Also known as zero-volatility spread.