2017 SchweserNotes™ Part II

FRM® Exam Prep

Risk Management and Investment Management; Current Issues in Financial Markets

eBook 4

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Part II FRM® Exam

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FRM Part II Book 4: Risk Management and Investment Management; Current Issues in Financial Markets

FRM 2017 PART II BOOK 4: RISK MANAGEMENT AND INVESTMENT MANAGEMENT; CURRENT ISSUES IN FINANCIAL MARKETS

Printed in the United States of America.

ISBN: 978-1-4754-5357-7

Reading Assignments and Learning Objectives

The following material is a review of the Risk Management and Investment Management, and Current Issues in Financial Markets principles designed to address the learning objectives set forth by the Global Association of Risk Professionals.

Reading Assignments

Risk Management and Investment Management

Andrew Ang, *Asset Management: A Systematic Approach to Factor Investing* (New York: Oxford University Press, 2014).

62. "Factor Theory," Chapter 6 (page 1)

63. "Factors," Chapter 7 (page 15)

64. "Alpha (and the Low-Risk Anomaly)," Chapter 10 (page 31)

65. "Illiquid Assets," Chapter 13 (page 47)

Richard Grinold and Ronald Kahn, *Active Portfolio Management: A Quantitative Approach for Producing Superior Returns and Controlling Risk, 2nd Edition* (New York: McGraw-Hill, 2000).

66. "Portfolio Construction," Chapter 14 (page 61)

Philippe Jorion, *Value-at-Risk: The New Benchmark for Managing Financial Risk, 3rd Edition* (New York: McGraw Hill, 2007).

67. "Portfolio Risk: Analytical Methods," Chapter 7 (page 73)

68. "VaR and Risk Budgeting in Investment Management," Chapter 17 (page 90)

Robert Litterman and the Quantitative Resources Group, *Modern Investment Management: An Equilibrium Approach* (Hoboken, NJ: John Wiley & Sons, 2003).

69. "Risk Monitoring and Performance Measurement," Chapter 17 (page 106)

Zvi Bodie, Alex Kane, and Alan J. Marcus, *Investments, 10th Edition* (New York: McGraw-Hill, 2013).

70. "Portfolio Performance Evaluation," Chapter 24 (page 117)

G. Constantinides, M. Harris and R. Stulz, eds., *Handbook of the Economics of Finance, Volume 2B* (Oxford: Elsevier, 2013).

71. "Hedge Funds," Chapter 17 (page 139)

Kevin R. Mirabile, *Hedge Fund Investing: A Practical Approach to Understanding Investor Motivation, Manager Profits, and Fund Performance* (Hoboken, NJ: Wiley Finance, 2013).

72. "Performing Due Diligence on Specific Managers and Funds," Chapter 11 (page 151)

Current Issues in Financial Markets

73. Rainer Böhme, Nicolas Christin, Benjamin Edelman, and Tyler Moore, "Bitcoin: Economics, Technology, and Governance," *Journal of Economic Perspectives* 29, no. 2 (Spring 2015): 213–238. (page 165)

74. William C. Dudley, "Market and Funding Liquidity—An Overview," Remarks at the Federal Reserve Bank of Atlanta 2016 Financial Markets Conference, Fernandina Beach, Florida, May 1, 2016. (page 176)

75. "Chapter 2: Market Liquidity—Resilient or Fleeting?" International Monetary Fund, Global Financial Stability Report, October 2015. (page 183)

76. "Algorithmic Trading Briefing Note," Federal Reserve Bank of New York, April 2015. (page 195)

77. Morten Bech, Anamaria Illes, Ulf Lewrick, and Andreas Schrimpf, "Hanging Up the Phone—Electronic Trading in Fixed Income Markets and Its Implications," *BIS Quarterly Review* (March 2016): 79–94. (page 202)

78. Morten Bech and Aytek Malkhozov, "How Have Central Banks Implemented Negative Policy Rates?" *BIS Quarterly Review* (March 2016): 31–44. (page 211)

79. "Corporate Debt in Emerging Economies: A Threat to Financial Stability?" Committee on International Economic Policy and Reform, Brookings Institution, September 2015. (page 219)

Learning Objectives

62. Factor Theory

After completing this reading, you should be able to:

1. Provide examples of factors that impact asset prices, and explain the theory of factor risk premiums. (page 1)
2. Describe the capital asset pricing model (CAPM) including its assumptions, and explain how factor risk is addressed in the CAPM. (page 2)
3. Explain implications of using the CAPM to value assets, including equilibrium and optimal holdings, exposure to factor risk, its treatment of diversification benefits, and shortcomings of the CAPM. (page 2)
4. Describe multifactor models, and compare and contrast multifactor models to the CAPM. (page 6)
5. Explain how stochastic discount factors are created and apply them in the valuation of assets. (page 6)
6. Describe efficient market theory and explain how markets can be inefficient. (page 8)

63. Factors

After completing this reading, you should be able to:

1. Describe the process of value investing, and explain reasons why a value premium may exist. (page 15)
2. Explain how different macroeconomic risk factors, including economic growth, inflation, and volatility affect risk premiums and asset returns. (page 16)
3. Assess methods of mitigating volatility risk in a portfolio, and describe challenges that arise when managing volatility risk. (page 19)
4. Explain how dynamic risk factors can be used in a multifactor model of asset returns, using the Fama-French model as an example. (page 20)
5. Compare value and momentum investment strategies, including their risk and return profiles. (page 22)

64. Alpha (and the Low-Risk Anomaly)

After completing this reading, you should be able to:

1. Describe and evaluate the low-risk anomaly of asset returns. (page 31)
2. Define and calculate alpha, tracking error, the information ratio, and the Sharpe ratio. (page 31)
3. Explain the impact of benchmark choice on alpha, and describe characteristics of an effective benchmark to measure alpha. (page 33)
4. Describe Grinold's fundamental law of active management, including its assumptions and limitations, and calculate the information ratio using this law. (page 34)
5. Apply a factor regression to construct a benchmark with multiple factors, measure a portfolio's sensitivity to those factors and measure alpha against that benchmark. (page 35)
6. Explain how to measure time-varying factor exposures and their use in style analysis. (page 38)
7. Describe issues that arise when measuring alphas for nonlinear strategies. (page 39)
8. Compare the volatility anomaly and beta anomaly, and analyze evidence of each anomaly. (page 40)
9. Describe potential explanations for the risk anomaly. (page 41)

65. Illiquid Assets

After completing this reading, you should be able to:

1. Evaluate the characteristics of illiquid markets. (page 47)
2. Examine the relationship between market imperfections and illiquidity. (page 48)
3. Assess the impact of biases on reported returns for illiquid assets. (page 49)
4. Describe the unsmoothing of returns and its properties. (page 49)
5. Compare illiquidity risk premiums across and within asset categories. (page 51)
6. Evaluate portfolio choice decisions on the inclusion of illiquid assets. (page 55)

66. Portfolio Construction

After completing this reading, you should be able to:

1. Distinguish among the inputs to the portfolio construction process. (page 61)
2. Evaluate the methods and motivation for refining alphas in the implementation process. (page 61)
3. Describe neutralization and methods for refining alphas to be neutral. (page 62)
4. Describe the implications of transaction costs on portfolio construction. (page 63)
5. Assess the impact of practical issues in portfolio construction, such as determination of risk aversion, incorporation of specific risk aversion, and proper alpha coverage. (page 64)
6. Describe portfolio revisions and rebalancing, and evaluate the tradeoffs between alpha, risk, transaction costs, and time horizon. (page 65)
7. Determine the optimal no-trade region for rebalancing with transaction costs. (page 65)
8. Evaluate the strengths and weaknesses of the following portfolio construction techniques: screens, stratification, linear programming, and quadratic programming. (page 66)
9. Describe dispersion, explain its causes, and describe methods for controlling forms of dispersion. (page 67)

67. Portfolio Risk: Analytical Methods

After completing this reading, you should be able to:

1. Define, calculate, and distinguish between the following portfolio VaR measures: individual VaR, incremental VaR, marginal VaR, component VaR, undiversified portfolio VaR, and diversified portfolio VaR. (page 73)
2. Explain the role of correlation on portfolio risk. (page 74)
3. Describe the challenges associated with VaR measurement as portfolio size increases. (page 78)
4. Apply the concept of marginal VaR to guide decisions about portfolio VaR. (page 82)
5. Explain the risk-minimizing position and the risk and return-optimizing position of a portfolio. (page 82)
6. Explain the difference between risk management and portfolio management, and describe how to use marginal VaR in portfolio management. (page 83)

68. VaR and Risk Budgeting in Investment Management

After completing this reading, you should be able to:

1. Define risk budgeting. (page 90)
2. Describe the impact of horizon, turnover and leverage on the risk management process in the investment management industry. (page 90)
3. Describe the investment process of large investors such as pension funds. (page 91)

4. Describe the risk management challenges associated with investments in hedge funds. (page 92)
5. Distinguish among the following types of risk: absolute risk, relative risk, policy-mix risk, active management risk, funding risk, and sponsor risk. (page 92)
6. Apply VaR to check compliance, monitor risk budgets, and reverse engineer sources of risk. (page 95)
7. Explain how VaR can be used in the investment process and the development of investment guidelines. (page 97)
8. Describe the risk budgeting process and calculate risk budgets across asset classes and active managers. (page 98)

69. Risk Monitoring and Performance Measurement

After completing this reading, you should be able to:

1. Define, compare, and contrast VaR and tracking error as risk measures. (page 106)
2. Describe risk planning, including its objectives, effects, and the participants in its development. (page 107)
3. Describe risk budgeting and the role of quantitative methods in risk budgeting. (page 108)
4. Describe risk monitoring and its role in an internal control environment. (page 108)
5. Identify sources of risk consciousness within an organization. (page 108)
6. Describe the objectives and actions of a risk management unit in an investment management firm. (page 109)
7. Describe how risk monitoring can confirm that investment activities are consistent with expectations. (page 110)
8. Explain the importance of liquidity considerations for a portfolio. (page 110)
9. Describe the use of alpha, benchmark, and peer group as inputs in performance measurement tools. (page 112)
10. Describe the objectives of performance measurement. (page 111)

70. Portfolio Performance Evaluation

After completing this reading, you should be able to:

1. Differentiate between time-weighted and dollar-weighted returns of a portfolio and describe their appropriate uses. (page 117)
2. Describe and distinguish between risk-adjusted performance measures, such as Sharpe's measure, Treynor's measure, Jensen's measure (Jensen's alpha), and information ratio. (page 120)
3. Describe the uses for the Modigliani-squared and Treynor's measure in comparing two portfolios, and the graphical representation of these measures. (page 120)
4. Determine the statistical significance of a performance measure using standard error and the t-statistic. (page 127)
5. Explain the difficulties in measuring the performance of hedge funds. (page 128
6. Explain how changes in portfolio risk levels can affect the use of the Sharpe ratio to measure performance. (page 128)
7. Describe techniques to measure the market timing ability of fund managers with a regression and with a call option model, and compute return due to market timing. (page 129)
8. Describe style analysis. (page 131)
9. Describe and apply performance attribution procedures, including the asset allocation decision, sector and security selection decision, and the aggregate contribution. (page 131)

71. Hedge Funds

After completing this reading, you should be able to:

1. Describe the characteristics of hedge funds and the hedge fund industry, and compare hedge funds with mutual funds. (page 139)
2. Explain biases that are commonly found in databases of hedge funds. (page 139)
3. Explain the evolution of the hedge fund industry and describe landmark events that precipitated major changes in the development of the industry. (page 139)
4. Evaluate the role of investors in shaping the hedge fund industry. (page 139)
5. Explain the relationship between risk and alpha in hedge funds. (page 140)
6. Compare and contrast the different hedge fund strategies, describe their return characteristics, and describe the inherent risks of each strategy. (page 141)
7. Describe the historical portfolio construction and performance trend of hedge funds compared to equity indices. (page 144)
8. Describe market events that resulted in a convergence of risk factors for different hedge fund strategies, and explain the impact of such a convergence on portfolio diversification strategies. (page 145)
9. Describe the problem of risk sharing asymmetry between principals and agents in the hedge fund industry. (page 145)
10. Explain the impact of institutional investors on the hedge fund industry and assess reasons for the growing concentration of assets under management (AUM) in the industry. (page 146)

72. Performing Due Diligence on Specific Managers and Funds

After completing this reading, you should be able to:

1. Identify reasons for the failures of funds in the past. (page 151)
2. Explain elements of the due diligence process used to assess investment managers. (page 152)
3. Identify themes and questions investors can consider when evaluating a manager. (page 153)
4. Describe criteria that can be evaluated in assessing a fund's risk management process. (page 155)
5. Explain how due diligence can be performed on a fund's operational environment. (page 156)
6. Explain how a fund's business model risk and its fraud risk can be assessed. (page 158)
7. Describe elements that can be included as part of a due diligence questionnaire. (page 159)

73. Bitcoin: Economics, Technology, and Governance

After completing this reading, you should be able to:

1. Describe the incentives to use virtual currency. (page 165)
2. Identify the limits of Bitcoin and the concerns that may arise from these limits. (page 167)
3. Explain and compare the distinctive risks that Bitcoin presents. (page 169)
4. Describe the measures taken to regulate virtual currencies. (page 171)

74. Market and Funding Liquidity—An Overview

After completing this reading, you should be able to:

1. Compare and contrast market and funding liquidity and describe factors that have impacted both types of liquidity. (page 176)

2. Describe the regulatory and non-regulatory factors that have affected liquidity. (page 177)
3. Describe the link between market and funding liquidity. (page 178)
4. Examine the links between funding liquidity and capital requirements. (page 178)

75. Market Liquidity—Resilient or Fleeting?

After completing this reading, you should be able to:

1. Describe the factors that influence the level of market liquidity and the degree of liquidity resilience in markets. (page 183)
2. Identify drivers and their effects on market liquidity level and resilience. (page 185)
3. Assess the effects that monetary policy has on market liquidity. (page 188)
4. Explain how liquidity spillovers can be amplified and describe what effects this has on the market. (page 190)
5. Describe the recommendations to bolster the level of market liquidity and its resilience. (page 190)

76. Algorithmic Trading Briefing Note

After completing this reading, you should be able to:

1. Identify key risks with algorithmic trading. (page 195)
2. Describe how risks associated with algorithmic trading are monitored and controlled. (page 196)
3. Explain how algorithmic trading activity is captured in banks' risk management frameworks. (page 197)
4. Assess the effectiveness of risk management tools to monitor risks associated with algorithmic trading. (page 197)

77. Hanging Up the Phone—Electronic Trading in Fixed Income Markets and Its Implications

After completing this reading, you should be able to:

1. Describe how the fixed income markets have been evolving. (page 202)
2. Explain the drivers behind the electronification of fixed income markets. (page 204)
3. Identify and describe the implications that electronification has on market quality. (page 205)
4. Compare the qualifications of traditional instruments of liquidity conditions and the new market environment. (page 206)

78. How Have Central Banks Implemented Negative Policy Rates?

After completing this reading, you should be able to:

1. Describe the framework that led to the introduction of negative policy rates. (page 211)
2. Explain the implications of the technical implementation of negative policy rates. (page 212)
3. Identify factors that determine the lower bound for nominal interest rates. (page 213)
4. Identify and compare the risks associated with negative policy rates. (page 214)

79. Corporate Debt in Emerging Economies: A Threat to Financial Stability?

After completing this reading, you should be able to:

1. Describe the general trends of emerging economics over the past decade. (page 219)
2. Examine the risk factors that firms face due to external debt and explain how these risks are transmitted to the financial system. (page 222)

3. Analyze the role of corporate debt in emerging economies using the following case studies:
   - External commercial borrowings in India.
   - Foreign currency lending to Turkish corporates.
   - Corporate bond issuance in Latin America. (page 225)
4. Explain the policy implications related to the risks associated with issuance of corporate debt in emerging economies. (page 233)

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Factor Theory

Topic 62

Exam Focus

In this topic, we introduce factor theory and factor risk. A key point is that it is not the exposure to an asset that is rewarded, but the exposure to the underlying factors. The risk of these factors is being rewarded with risk premiums. Several factor theories are introduced, including the capital asset pricing model (CAPM) and multifactor models. For the exam, understand the key assumptions of the CAPM while recognizing the model's limitations in a real-world setting, and be able to contrast the CAPM with the assumptions of multifactor models. Through multifactor models, we introduce the concept of a stochastic discount factor, which is a random variable used in pricing an asset. Finally, be familiar with the efficient market hypothesis, since it identifies areas of market inefficiencies that can be exploited through active management.

Factors That Impact Asset Prices

LO 62.1: Provide examples of factors that impact asset prices, and explain the theory of factor risk premiums.

In the context of factor investing, it is easiest to think of assets as bundles of **factor risks**, where exposure to the different factor risks earns risk premiums. The underlying **factors** may include the market (which is a tradable investment factor), interest rates, or investing styles (including value/growth, low volatility, or momentum). Factors may also be classified as fundamental macroeconomic factors, such as inflation and economic growth.

Factor theory is based on an analysis of factor risks. Factor risks represent exposures to *bad times*, where these exposures are rewarded with risk premiums. Factor theory is based on three primary principles:

1. *Factors are important, not assets*. It is not exposure to the specific asset that matters, rather the exposure to the underlying risk factors. As a result, investors must look through assets and understand the underlying factor risks.

2. *Assets represent bundles of factors*. Assets typically represent bundles of risk factors, although some assets, like equities and government bonds, can be thought of as factors themselves. Other assets, including corporate bonds, private equity, and hedge funds, contain many factors, such as equity risk, interest rate risk, volatility risk, and default risk. Assets' risk premiums reflect these risk factors.

3. *Investors have differing optimal risk exposures.* Investors each have different optimal exposures to risk factors. One of the important factors is volatility. Higher volatility results in higher asset risks during bad times. One important recent example of bad times was the 2007–2009 financial crisis. In return for bearing factor risks, investors require compensation through a risk premium (e.g., a volatility premium for volatility risk) during normal times. Economic growth represents another factor to which investors want different exposures.

Bad times could represent economic bad times, including high inflation and low economic growth. They could also represent bad times for investing, including poorly performing investments or markets. Factors are all unique and each represents exposure to a different set of bad times.

Capital Asset Pricing Model

LO 62.2: Describe the capital asset pricing model (CAPM) including its assumptions, and explain how factor risk is addressed in the CAPM.

The **capital asset pricing model** (CAPM) describes how an asset behaves not in isolation, but in relation to other assets and to the market. The CAPM views not the asset's own volatility as the relevant measure, but its covariance with the market portfolio, as measured by the asset's *beta*.

The CAPM assumes that the only relevant factor is the market portfolio, and risk premiums are determined solely by beta. As mentioned, risk premiums are important because they compensate investors for losses during bad times. Risk here is determined by the assets' movements relative to each other, and not by the assets in isolation.

LO 62.3: Explain implications of using the CAPM to value assets, including equilibrium and optimal holdings, exposure to factor risk, its treatment of diversification benefits, and shortcomings of the CAPM.

Implications of Using the CAPM

The CAPM holds six important lessons.

Lesson 1: Hold the factor, not the individual asset.

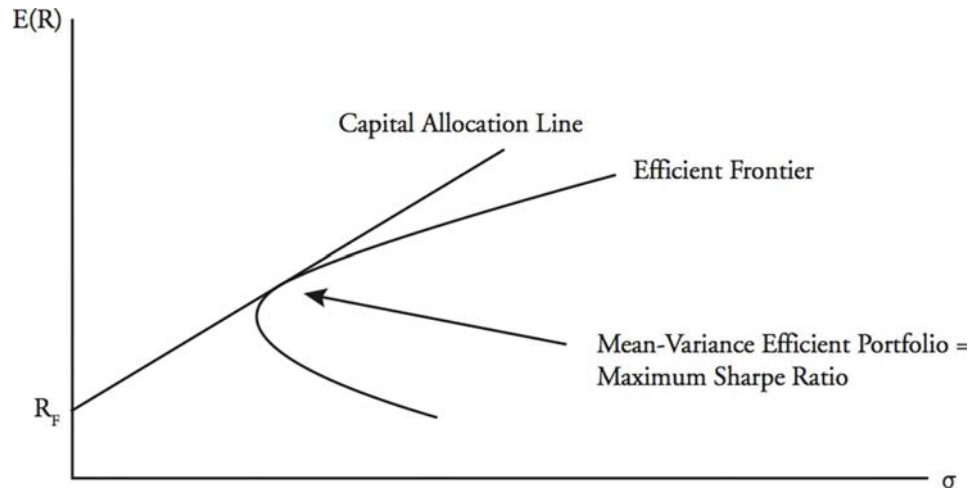
In a CAPM world, stocks are held in proportion to their market capitalization, where the sole factor is the market portfolio. The market portfolio can be constructed by holding many assets, which helps diversify away *idiosyncratic (firm-specific) risk*, leaving only *systematic (market) risk*. Individual stocks have risk premiums, which compensate investors for being exposed to the market factor. Market risk affects all investors exposed to the market portfolio.

According to the CAPM, investors do not wish to hold assets in isolation, because diversification improves the risk-return profile of a portfolio. The concept is simple: diversification helps ensure that bad returns from one asset will be offset by the returns of

other assets that perform well. This also improves Sharpe ratios (i.e., risk premium divided by total risk). Investors continue to diversify until they are left with the market portfolio, which represents the optimal diversified portfolio.

Mean-variance efficient portfolio. Portfolio diversification and Sharpe ratios can be graphically represented by the mean-variance **efficient frontier**. When investors hold portfolios that combine the risky asset and the risk-free asset, the various risk-return combinations are represented by the **capital allocation line** (CAL). The risky asset in this case is the *mean-variance efficient* (MVE) *market portfolio*, which is efficient because it represents the maximum Sharpe ratio given investors' preferences. The specific combination of the risk-free asset and MVE portfolio depends on investors' risk aversions.

Figure 1: Capital Allocation Line



Equilibrium. In equilibrium, demand for an asset equals supply, and since under the CAPM all investors hold the risky MVE market portfolio, the market is the factor. For equilibrium to happen, someone must hold the MVE portfolio as the risky asset. If no investor held the risky asset, the risky asset must be overpriced, and its expected return must be too low. This situation cannot represent an equilibrium state. Since under CAPM the expected payoff of an asset remains constant, the asset's expected return must increase as its price falls. In equilibrium, the risk factor is the market, and it has a risk premium. The market factor is a function of investor risk aversions and utilities, and risk premiums will not disappear since investors cannot use arbitrage to remove systematic risk.

Lesson 2: Investors have their own optimal factor risk exposures.

Every investor holds the same risky MVE market portfolio, but the proportion in which they hold it differs. Investors hold different combinations of the risk-free asset and the risky portfolio, representing various positions along the CAL.

Lesson 3: The average investor is fully invested in the market.

An investor with an average risk aversion would hold 100% of the risky MVE market portfolio, which represents the tangency point of the MVE frontier and the CAL. The average investor's risk aversion is, therefore, the risk aversion of the market.

Lesson 4: Exposure to factor risk must be rewarded.

When all investors invest in the same risky MVE portfolio, the CAL for an investor is called the **capital market line** (CML) in equilibrium. The risk premium of the CML depends on an investor's risk aversion and the volatility of the market portfolio:

$$E(R_M) - R_F = \bar{\gamma} \times \sigma_M^2$$

where $E(R_M) - R_F$ is the market risk premium, $\bar{\gamma}$ is the average investor's risk aversion, and σ_M^2 is the market portfolio's variance. During volatile market times (e.g., the 2007–2009 financial crisis), equity prices typically fall and expected returns increase. In the CAPM world, the risk premium is proportional to the market variance. Because market variance removes all idiosyncratic risk, the remaining systematic risk should be rewarded through the risk premium. When the average investor's risk aversion increases, the market risk premium should also increase.

Lesson 5: Risk is measured as beta exposure.

An individual asset's risk is measured as factor exposure to the asset, and higher factor exposures to the asset indicate higher expected returns (assuming the risk premium is positive). The risk premium of an individual asset is derived under the CAPM formula using beta pricing to construct the **security market line** (SML). The formula states that:

$$E(R_i) - R_F = \frac{\text{cov}(R_i, R_M)}{\text{var}(R_M)} \times [E(R_M) - R_F] = \beta_i \times [E(R_M) - R_F]$$

where R_i is the individual stock's return, R_F is the risk-free rate, and **beta** is a function of the market variance and the asset's co-movement with the market: [$\beta_i = \text{cov}(R_i, R_M) / \text{var}(R_M)$]. Higher co-movements denote higher betas, which correspond to higher risk premiums. Whereas previously we looked at systematic risk and diversification, beta looks at idiosyncratic risk and the lack of diversification.

Higher betas imply lower diversification benefits. Investors tend to find high betas (high sensitivities to market returns) unattractive, and, therefore, want to be compensated with higher expected returns. On the other hand, low beta assets are valuable because they do comparatively well when markets perform poorly, offering significant diversification benefits. During the financial crisis, certain assets (safe havens like gold and government bonds) became so attractive that they had negative expected returns. This meant investors actually paid to hold these assets!

Lesson 6: Valuable assets have low risk premiums.

The CAPM risk premium represents the reward investors receive for holding the asset in bad times. Since the market portfolio is the risk factor, bad times indicate low market returns. Assets that have losses during periods of low market returns have high betas, which

indicates they are risky and, therefore, should have high risk premiums. Low beta assets have positive payoffs when the market performs poorly, making them valuable to investors. As a result, investors do not require high risk premiums to hold these assets.

Shortcomings of the CAPM

The CAPM makes several simplifying assumptions that are necessary to make the model work; however, many of these assumptions are considered overly simplistic or not reflective of the real world. The assumptions of the CAPM break down especially in illiquid, inefficient markets where information may be costly and not available to all investors. We look at seven of these assumptions:

1. *Investors only have financial wealth.* Investors have unique income streams and liabilities. Liabilities are often denominated in real terms, and income streams are risky because incomes decline during periods of low economic growth. As a result, both inflation and income growth are important factors. In general, investors have many factors that contribute to wealth, including human capital (or labor income risk).

2. *Investors have mean-variance utility.* Mean-variance utility assumes a symmetric treatment of risk. In reality, investors have an asymmetric view of risk, disliking losses more than they like gains, which deviates from the CAPM assumptions. Therefore, in the real world, stocks exhibit different levels of downside risks. Those with higher downside risks should offer higher returns.

3. *Investors have a single period investment horizon.* While not a main assumption of the CAPM, a single period restriction does not hold in the real world. In the CAPM, all investors hold the market portfolio, which does not require rebalancing. However, the optimal strategy for long-term investors is to rebalance, which is a multi-period strategy.

4. *Investors have homogeneous (identical) expectations.* The assumption that all investors share the same expectations is not realistic in the real world, because investors have heterogeneous (differing) expectations. This can produce significant departures from the CAPM.

5. *Markets are frictionless (no taxes or transaction costs).* We all know that taxes and transaction costs affect investor returns; therefore, the CAPM assumption of frictionless markets does not hold in the real world. For illiquid securities, transaction costs can be very high, further heightening the deviations from the CAPM. In addition, investors have heterogeneous beliefs, but they may not be able to fully act on differing expectations if there are trading restrictions (e.g., a prohibition on short selling). When this happens, stock prices reflect only the expectations of those who believe stock prices will rise, causing asymmetries in the market. This is a deviation from the CAPM.

6. *All investors are price takers.* In the real world, investors are often price setters and not price takers. Large (institutional) investors frequently trade on special knowledge, and large trades will often move the market.

7. *Information is free and available to everyone.* In reality, information itself can be a factor. Information is often costly and unavailable to certain investors, which is a deviation from the CAPM.

Multifactor Models

LO 62.4: Describe multifactor models, and compare and contrast multifactor models to the CAPM.

As mentioned, the CAPM is a single-factor model that looks at the market as the only factor and defines bad times as low returns to the market portfolio. By contrast, **multifactor models** incorporate other risk factors, including low economic growth, low GDP growth, or low consumption. One of the earliest multifactor models was **arbitrage pricing theory** (APT), which describes expected returns as a linear function of exposures to common (i.e., macroeconomic) risk factors.

The lessons from multifactor models are similar to the lessons from the CAPM:

1. *Diversification is beneficial.* In the CAPM, the market removes (diversifies away) idiosyncratic risk. In multifactor models, it is the tradable version of a factor that removes this risk.

2. *Investors have optimal exposures.* Each investor has an optimal exposure to the market portfolio (in the CAPM) or to factor risks (in multifactor models).

3. *The average investor holds the market portfolio.* This is true under both the CAPM and multifactor models.

4. *Exposure to factor risk must be rewarded.* In the CAPM, the market factor is priced in equilibrium. In multifactor models, each factor has a risk premium, assuming no arbitrage or equilibrium.

5. *Risk is measured by a beta factor.* In the CAPM, an asset's risk is measured by its beta. In multifactor models, an asset's risk is measured by its factor exposures (i.e., factor betas).

6. *Valuable assets have low risk premiums.* Assets that have a positive payoff in bad times are attractive, and, therefore, have low risk premiums. In the CAPM, bad times are explicitly defined as low market returns.

Pricing Kernels

LO 62.5: Explain how stochastic discount factors are created and apply them in the valuation of assets.

Multifactor models define bad times over multiple factors. They use the concept of a **pricing kernel**, also known as the **stochastic discount factor** (SDF), which represents a random variable used in pricing an asset. The SDF represents an index of bad times, where the bad times are indexed by a multitude of different factors and states. The SDF is denoted as m in the multifactor model, where m is a single variable that captures all bad times for any given a and b constants:

$$m = a + b \times R_m$$

The CAPM is a special case of this model, where *m* moves linearly with the market return. However, modeling returns as linear is a shortcoming of the CAPM, which can be improved upon by using the pricing kernel which allows for the assumption of nonlinearity.

We can expand this model to include various factor exposures (f_1, f_2, etc.) where SDF depends on a vector of these factors, where all the *k* factors represent different bad times:

$$m = a + b_1 f_1 + b_2 f_2 + \ldots + b_k f_k$$

With multifactor pricing kernels, bad times can be defined as periods when an additional $1 income becomes very valuable. Looking at bad times this way interprets SDF as a *marginal utility*. Periods of high marginal utility could arise from the loss of a job (resulting in low income, where the value of an extra dollar is high), low GDP growth, low consumption (resulting in current consumption below past consumption), or generally low economic growth.

Pricing Kernels vs. Discount Rate Models

In a traditional discount rate model, the price of an asset is determined by discounting its future cash flows at the appropriate discount rate:

$$P_i = E\left[\frac{\text{payoff}_i}{1 + E(R_i)}\right]$$

The discount rate is determined through the CAPM as:

$$E(R_i) = R_F + \beta_i \times [E(R_M) - R_F]$$

The SDF model can also be used to predict an asset's price, where we use the SDF as the relevant factor:

$$P_i = E[m \times \text{payoff}_i]$$

This equation helps explain the name "stochastic discount factor," since the payoffs are discounted using *m* as the relevant factor. The SDF is called a "pricing kernel," using the term kernel from statistics where we estimate *m* using the kernel estimator. Because the kernel is used to derive asset pricing, it is called a pricing kernel.

If we divide both sides of the equation by the asset's current price, P_i, the equation gives us a constant payoff formula, which we can then use to derive the risk-free asset:

$$\frac{P_i}{P_i} = E\left[m \times \frac{payoff_i}{P_i}\right]$$

$$1 = E[m \times (1 + R_i)]$$

$$\frac{1}{1 + R_F} = E[m \times 1], \text{ when payoffs are constant}$$

We can also model an asset's risk premium similar to the CAPM, where [$\beta_{i,m}$ = cov(R_i, m) / var(m)]:

$$E(R_i) - R_F = \frac{cov(R_i, m)}{var(m)} \times \left(-\frac{var(m)}{E(m)}\right) = \beta_{i,m} \times \lambda_m$$

Beta is multiplied by the price of the "bad times" risk, determined as:

$$\lambda_m = -\frac{var(m)}{E(m)}$$

This equation represents the inverse of factor risk (denoted by the negative sign). In short, assets that have a positive payoff in bad times are valuable to hold, leading to high prices and low expected returns.

The equation for expected return can also be modeled as having exposure to the risk-free rate and multiple betas in the SDF model. Each beta represents a different macroeconomic factor, such as inflation, economic growth, the market portfolio, or investment strategy:

$$E(R_i) = R_F + \beta_{i,1} \times E(f_1) + \beta_{i,2} \times E(f_2) + \ldots + \beta_{i,k} \times E(f_k)$$

Efficient Market Theory

LO 62.6: Describe efficient market theory and explain how markets can be inefficient.

The APT was one of the earliest forms of the **efficient market theory**. The APT is a multifactor model where market participants—including active managers and arbitrageurs—move an asset's expected return toward a value that represents an equilibrium risk-return tradeoff. The APT uses systematic factors that cannot be removed through arbitrage. As a result, investors demand to be compensated for this risk in the form of a risk premium.

Another efficient market theory was developed by Sanford Grossman and Joseph Stiglitz (1980).[1] In their theory, markets are near-efficient and information is costless. Market efficiency is in part caused by active managers searching for areas of inefficiency, making markets more efficient in the process. We can expect to find these areas of inefficiency in illiquid market segments where information does not move freely and where these inefficiencies make it difficult to earn large profits. Note, however, that the assumption of costless information creates a circular argument: if there is no cost to information and prices already reflect all information, there wouldn't be a need to collect information. However, if no one collects information, then it cannot be fully reflected in asset prices.

Market efficiency is also described in the **efficient market hypothesis** (EMH). The EMH implies that speculative trading is costly, and active managers cannot generally beat the market. The average investor, who holds the market portfolio, can beat the market simply by saving on transaction costs. Even if markets cannot be perfectly efficient, the EMH is still useful because it can help investors identify areas of market inefficiency that can be exploited through active management.

The EMH has been refined to improve upon the CAPM's shortcomings by allowing for imperfect information and various costs, including transaction, financing, and agency costs. Behavioral biases also represent inefficiencies, which have similar effects as frictions. Behavioral biases can be described either through a rational or behavioral explanation approach.

Under the *rational explanation* approach, losses during bad times are compensated by high returns. It is important to clearly define what bad times constitutes, and whether these bad times are actually bad for investors. For example, an investor who shorted the market would benefit, rather than incur losses, in a "bad times" scenario.

Under the *behavioral explanation* approach, it is agents' reactions (under/overreaction) to news that generates high returns. Perfectly rational investors are not prone to these biases, and they provide their own capital to take advantage of mispricing caused by biases. However, the markets may have barriers to the entry of capital that make it difficult to take advantage of mispricings, including structural barriers (e.g., certain investors are unable to take advantage of an opportunity) and regulatory barriers (e.g., minimum credit rating requirement of asset holdings). Structural barriers allow for behavioral biases to persist for a long time.

Ultimately, it is not the type of bias that matters, but whether the investor is different from the average investor who is subject to both rational and behavioral constraints, and whether return opportunities are expected to persist.

1. Sanford J. Grossman and Joseph E. Stiglitz, "On the Impossibility of Efficient Markets," *American Economic Review* 70 (1980): 393–498.

KEY CONCEPTS

LO 62.1

Exposure to different factor risks earns risk premiums. Underlying factors may include the market, interest rates, investing styles, inflation, and economic growth. Factor risks represent exposures to bad times, and this exposure must be compensated for with risk premiums. There are three important principles of factor risk:

1. It is not exposure to the specific asset that matters, rather the exposure to the underlying risk factors.
2. Assets represent bundles of factors, and assets' risk premiums reflect these risk factors.
3. Investors each have different optimal exposures to risk factors, including volatility.

LO 62.2

The capital asset pricing model (CAPM) is a single-factor model that describes how an asset behaves in relation to other assets and to the market. The CAPM incorporates an asset's covariance with the market portfolio, measured by the asset's beta. In the CAPM world, the only relevant factor is the market portfolio, and risk premiums are determined solely by beta.

LO 62.3

The CAPM has six important lessons:

1. Hold the factor, not the individual asset.
2. Investors have their own optimal factor risk exposures.
3. The average investor is fully invested in the market.
4. Exposure to factor risk must be rewarded.
5. Risk is measured as beta exposure.
6. Valuable assets have low risk premiums.

The CAPM has six main shortcomings (i.e., unrealistic simplifying assumptions):

1. Investors only have financial wealth.
2. Investors have mean-variance utility.
3. Investors have a single period investment horizon.
4. Investors have homogeneous (identical) expectations.

5. Markets are frictionless (no taxes or transaction costs).

6. All investors are price takers.

LO 62.4

There are six lessons from the multifactor models:

1. Diversification is beneficial.

2. Investors have optimal exposures, to factor risks in multifactor models.

3. The average investor holds the market portfolio.

4. Exposure to factor risks must be rewarded through risk premiums.

5. Risk is measured by factor betas.

6. Valuable assets have low risk premiums.

LO 62.5

Multifactor models define bad times over multiple factors using a pricing kernel, also known as the stochastic discount factor (SDF). The SDF represents an index of bad times. The SDF is denoted as *m* in the multifactor model, representing a single variable that captures all bad times for any given *a* and *b* constants:

$$m = a + b \times R_m$$

The SDF model can also be set up using multiple factor exposures where factors represent different bad times.

The SDF model can be used to predict an asset's price, where SDF is the relevant factor *m*:

$$P_i = E[m \times payoff_i]$$

The asset's risk premium can be modeled using beta.

The risk premium equation can be set up using multiple factor exposures where factors represent different macroeconomic factors, including inflation, economic growth, the market portfolio, or investment strategy.

LO 62.6

Arbitrage pricing theory (APT) uses systematic factors that cannot be removed through arbitrage, and for which investors must be compensated for through risk premiums.

Another efficient market theory developed suggests that markets are near-efficient and information is costless. Active managers search for areas of inefficiency in illiquid market segments, making markets more efficient in the process.

The efficient market hypothesis (EMH) states that speculative trading is expensive, and active managers cannot beat the market on average. The EMH is useful because it helps investors identify areas of market inefficiency that active management can exploit. The EMH has been refined to allow for imperfect information, various costs (transaction, financing, and agency), and behavioral biases.

Under the rational explanation of behavioral biases, losses during bad times are compensated for by high returns. Under the behavioral explanation, it is agents' under- or overreactions to news that generates high returns. Market barriers may make it difficult to take advantage of mispricings.

Concept Checkers

1. Which of the following concepts would least likely meet the definition of a factor?
   A. Market.
   B. Volatility.
   C. Hedge funds.
   D. Momentum investing style.

2. According to the capital asset pricing model (CAPM), in equilibrium, all investors hold the mean-variance efficient portfolio. Which of the following investor types is an exception to this assumption?
   A. Infinitely risk-averse investors.
   B. Infinitely risk-tolerant investors.
   C. Investors who hold some of the risk-free asset.
   D. Investors who hold the market portfolio.

3. Assets that have losses during periods of low market returns have:
   A. low betas and low risk premiums.
   B. high betas and low risk premiums.
   C. low betas and high risk premiums.
   D. high betas and high risk premiums.

4. Which of the following statements best describes the relationship between asset payoffs and "bad times" events (high inflation, low economic growth, or both)?
   A. The higher the expected payoff of an asset in bad times, the higher the asset's expected return.
   B. The higher the expected payoff of an asset in bad times, the lower the asset's expected return.
   C. The expected payoff of an asset in bad times is unrelated to the asset's expected return, because it depends on investor preferences.
   D. The expected payoff of an asset in bad times is unrelated to the asset's expected return, because arbitrageurs eliminate any expected return potential.

5. Which of the following statements least likely represents a limitation of the capital asset pricing model (CAPM)?
   A. All investors are price takers.
   B. Information is costless to obtain.
   C. All investors have the same expectations.
   D. There are uniform taxes and transaction costs.

Concept Checker Answers

1. C Assets, including corporate bonds, private equity, and hedge funds, are not considered factors themselves, but contain many factors, such as equity risk, interest rate risk, volatility risk, and default risk.

   Some assets, like equities and government bonds, can be thought of as factors themselves. Factors may also include the market (a tradable investment factor), interest rates, or investing styles (including value/growth, low volatility, or momentum).

2. A According to the CAPM, all investors hold a combination of the risky mean-variance efficient market portfolio and the risk-free asset. All investors hold the same market portfolio (therefore the mean-variance efficient portfolio is the market portfolio), and it is only the quantity of holdings that differs among investors. The only exception to this assumption is an *infinitely* risk-averse investor, who would only hold the risk-free asset.

3. D Assets that have losses during periods of low market returns have *high* betas (high sensitivity to market movements), which indicates they are risky and, therefore, should have *high* risk premiums. Low beta assets have positive payoffs when the market performs poorly, making them valuable to investors. As a result, investors do not require high risk premiums to hold these assets.

4. B The higher the expected payoff of an asset in bad times, the lower the asset's expected return. Assets that have a positive payoff in bad times are valuable to hold, leading to high prices and, therefore, low expected returns.

5. D The CAPM does not assume *uniform* taxes and transaction costs; it assumes there are *no* taxes or transaction costs (i.e., frictionless markets). The other limiting assumptions of the CAPM include:

   1. Investors only have financial wealth.
   2. Investors have mean-variance utility.
   3. Investors have a single period investment horizon.
   4. Investors have homogeneous (identical) expectations.
   5. All investors are price takers.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Factors

Topic 63

Exam Focus

Macroeconomic factors have been linked to asset returns. The most important macro factors that affect returns are economic growth, inflation, and volatility. Volatility risk can be mitigated by investing in low-volatility assets or buying volatility protection in the derivatives market (e.g., buying put options). The capital asset pricing model (CAPM) is a single-factor model that relates asset returns to market risk. The Fama-French model is a multifactor model that adds a size factor and a value factor to the original CAPM market factor to explain stock returns. A momentum factor can also help explain asset returns. The momentum strategy far outpaces the size and value-growth strategies in terms of returns. However, momentum strategies are prone to crashes. For the exam, understand the risk and return profiles of each factor. Also, be aware of rational and behavioral explanations for each factor.

Value Investing

LO 63.1: Describe the process of value investing, and explain reasons why a value premium may exist.

Risk premiums are driven by **factors**. Economy-wide (i.e., fundamental-based) factors such as inflation, volatility, productivity, economic growth, and demographics drive risk premiums. Additionally, factors related to tradeable investment styles such as momentum investing, value investing, and investing based on firm size drive returns.

A company's **book value** (i.e., net worth) per share is equal to total assets minus total liabilities divided by shares outstanding. It indicates, on a per-share basis, what a company would be worth if it liquidated its assets and paid off its liabilities. Value stocks have high book-to-market ratios while growth stocks have low book-to-market ratios, where "market" indicates the company's stock price. An investment strategy that is long value stocks and short growth stocks is called a **value-growth strategy**.

Historically, value stocks have significantly outperformed growth stocks. One dollar invested in a value-growth strategy in 1965 would be worth more than $6 around 2012, with a peak value of nearly $8 in 2006 and 2007. During the more than 40-year period, value stock returns experienced a sharp downturn during the tech boom, during the late 1990s, during the financial crisis in 2007–2009, and again in 2011. Overall, however, value investing appears to work. Are returns higher than growth investing returns due to a systematic factor? Alternatively, is there a value risk premium? Risk factors offer premiums to investors to compensate them for bearing losses in bad times, like the late 1990s and 2007–2009. Rational and behavioral explanations for the value premium will be discussed in detail in LO 63.5.

Macroeconomic Factors

LO 63.2: Explain how different macroeconomic risk factors, including economic growth, inflation, and volatility affect risk premiums and asset returns.

Macroeconomic factors, such as increasing inflation or slowing economic growth, affect all investors to varying degrees. Most, though not all, investors are hurt by rising inflation, slowing economic growth, or both. But it is not the level of the factor that matters, it is the shock (i.e., unanticipated changes) to a factor. For example, asset prices generally fall when inflation unexpectedly increases. Economic growth, inflation, and volatility are the three most important macro factors that affect asset prices.

Economic Growth

Risky assets like equities generally perform poorly during periods of low economic growth. Less-risky assets like bonds, and especially government bonds, tend to perform well during periods of slow growth. For the investor who can weather a downturn easily, she should invest in equities because returns will be greater over the long run. Periods of stronger growth generally last longer than downturns. For the investor who cannot bear large losses during a period of slow growth, she should invest in bonds. Her portfolio will likely perform better during the downturn but worse in the long run.

Figure 1 reports the returns of large and small stocks, as well as government, investment grade, and junk (high-yield) bonds during expansions and retractions as defined by the National Bureau of Economic Research (NBER). Returns are from Ibbotson Morningstar and cover the period 1952 through 2011. During periods of recession, government and investment grade bonds outperform equities and high-yield bonds, yielding 12.3% and 12.6%, respectively. During expansion periods, equities outperform bonds with large stocks yielding 12.4% and small stocks yielding 16.8%. High-yield bond returns appear indifferent to changes in economic growth, yielding 7.4% in recessions and 7.7% in expansions.

Figure 1 also reports returns based on quarter-on-quarter real GDP growth and quarter-on-quarter consumption growth (i.e., real personal consumption expenditures). The patterns are similar to those exhibited by NBER expansion/recession data. Equities outperform in periods of high real GDP growth and high consumption growth, while bonds outperform in periods of low real GDP growth and low consumption growth. High-yield bonds perform slightly better in high-growth periods.

Figure 1: Investment Returns During Expansions and Recessions

				Corporate Bonds	
	Large Stocks	*Small Stocks*	*Government Bonds*	*Investment Grade*	*High Yield*
Returns					
Full Sample	11.3%	15.3%	7.0%	7.0%	7.6%
Business Cycles					
Recessions	5.6%	7.8%	12.3%	12.6%	7.4%
Expansions	12.4%	16.8%	5.9%	6.0%	7.7%
Real GDP					
Low	8.8%	12.2%	10.0%	9.7%	7.0%
High	13.8%	18.4%	3.9%	4.4%	8.2%
Consumption					
Low	5.6%	5.6%	9.6%	9.1%	7.1%
High	17.1%	25.0%	4.4%	5.0%	8.2%
Inflation					
Low	14.7%	17.6%	8.6%	8.8%	9.2%
High	8.0%	13.0%	5.4%	5.3%	6.0%

In terms of volatility, both stocks and bonds are more volatile during downturns and periods of low growth. For example, large stock return volatility was 23.7% during recessions and 14.0% during expansions. Government bonds perform best during recessions but are also more volatile during these periods (15.5% volatility during recessions and 9.3% volatility during expansions).

Inflation

High inflation is generally bad for both stock and bond prices and returns. Figure 1 indicates that all categories perform better in low inflation versus high inflation periods. Volatilities are also higher in high inflation periods. Large and small stocks return 14.7% and 17.6%, respectively, during low inflation periods, and 8.0% and 13.0% during high inflation periods. Bond yields of 8.6%, 8.8%, and 9.2% (government, investment grade, and high-yield bonds, respectively) during low inflation periods exceeded returns during high inflation periods by approximately 3.0%. Bonds are fixed payment securities. As such, it is clear that bonds should perform poorly in high inflation times. Inflation lowers real bond returns. It is less clear that stocks perform poorly in high inflation times since they represent ownership of real, productive companies, not a claim to a stream of fixed cash flows.

Volatility

Volatility is an important risk factor for many asset classes. The CBOE Volatility Index (VIX) represents equity market volatility. The correlation between the VIX and stock returns has historically indicated a negative relationship (correlation coefficient of –0.39 between 1986 and 2011). This means that stock returns tend to drop when the VIX (equity volatility) increases.

The financial leverage of companies increases during periods of increased volatility because debt stays approximately the same while the market value of equity falls. The negative relationship between stock returns and volatility is called the **leverage effect**. As financial leverage increases, equities become riskier and volatility increases. Additionally, higher volatility increases the required rates of return on equities, pushing stock prices down. Thus, there are two paths to lower stock returns resulting from higher volatility:

1. When market volatility increases, the leverage effect suggests a negative relationship between stock returns and volatility.

2. When market volatility increases, discount rates increase and stock prices decline so that future stock returns can be higher (to compensate for the higher volatility). The capital asset pricing model (CAPM) supports this second path.

Other Macroeconomic Factors

Other macroeconomic factors, including productivity risk, demographic risk, and political risk, also affect asset returns. **Productivity shocks** affect firm output. In periods of falling productivity, stock prices fall (like in the 1960s and 1970s). In periods of improving productivity (like the 1980s and 1990s computer revolution) productivity shocks are positive and stock prices generally increase. The correlation between productivity shocks and stock returns is relatively high (approximately 50%).

New models, called *dynamic stochastic general equilibrium* (DSGE) macro models, indicate that economic variables change over time due to the actions of agents (i.e., consumers, firms, governments, and central banks), technologies (and their impact on how firms produce goods and services), and the way that agents interact (i.e., markets). A benchmark model created by Smets and Wouters (2007)[1] specifies seven shocks that impact the business cycle. They are: (1) productivity, (2) investment, (3) preferences, (4) inflation, (5) monetary policy, (6) government spending, and (7) labor supply.

Like productivity shocks, **demographic risk**, which can be interpreted as a shock to labor output, is a shock to firm production. Economic *overlapping generation* (OLG) models include demographic risk as a factor affecting investor returns. In these models, generations overlap. Young, middle-age, and retired workers exist in a system. Workers earn income and save during the young and middle-age stages. Retired workers disinvest. As a cohort progresses through life, they join others already in the cohort but born at an earlier time. According to several OLG models, events that shock the composition of the cohort, like World Wars I and II, infectious diseases, like the Spanish Flu of 1918, and the baby boom, which followed World War II, impact returns. For example, one model predicts that stock prices will fall when baby boomers retire as they liquidate assets to fund consumption. This would occur if there are relatively fewer young and middle-age investors to offset the asset liquidation of retirees. If there are a greater number of young and middle-age workers, relative to retirees, the impact will be lessened (or even overcome). Another study shows that risk aversion increases with age and that as the average age of the population increases, the equity risk premium should also increase. Note that it is important to use cross-country data in demographic studies.

1. Frank Smets and Rafael Wouters, "Shocks and Frictions in US Business Cycles: A Bayesian Dynamic Stochastic General Equilibrium Approach," *American Economic Review* 97, no. 3 (2007): 586–606.

Political (or sovereign) risk, once thought only important in emerging markets, increases risk premiums. The financial crisis of 2007–2009 made clear that political risk affects both developed and undeveloped countries.

Managing Volatility Risk

LO 63.3: Assess methods of mitigating volatility risk in a portfolio, and describe challenges that arise when managing volatility risk.

Volatility can be mitigated by investing in less volatile assets. As one would expect, bond returns are less impacted by volatility in equity markets (than equity returns). However, bonds are not necessarily a safe haven. Correlation between changes in the VIX and bond returns was 0.12 (between 1986 and 2011). This means bonds perform better than stocks (with a correlation coefficient of –0.39) when the VIX is rising, but the relationship is not highly positively correlated. For example, during the recent financial crisis, volatility was a factor that caused risky assets, bonds and stocks included, to fall simultaneously. The VIX can also capture uncertainty. Some research indicates that uncertainty risk is different from volatility risk, but the two risks are highly correlated.

Other investment approaches also perform poorly in periods of increased volatility. A number of strategies have a large exposure to volatility risk. For example, currency strategies perform poorly during periods of high volatility. For investors who want to avoid volatility, they can buy put options (i.e., protection against volatility). Out-of-the-money puts, which pay off during periods of high volatility, provide hedges against volatility risk.

In sum, there are two basic approaches to mitigating volatility risk. They are:

- Invest in less volatile assets like bonds, understanding that they too can perform poorly during extreme circumstances such as the 2007–2009 financial crisis.
- Buy volatility protection in the derivatives market (e.g., buy out-of-the-money put options).

Volatility Premiums

Typically, an investor buys an asset, like a stock, and the long position produces a positive expected return. In other words, on average, assets have positive premiums. However, volatility has a negative premium. To collect the volatility premium, one must sell volatility protection (e.g., sell out-of-the money put options). Realized volatilities are lower on average (by approximately 2%–3%) than VIX implied volatilities. This means that, on average, options are expensive and investors can collect volatility premiums by shorting volatility strategies.

During normal economic periods, selling volatility provides high, stable payoffs. However, when there is a crash, like the 2007–2009 financial crisis, sellers of volatility suffer large, negative returns. A volatility (swap) index constructed by Merrill Lynch indicates steadily (with minor blips) increasing cumulative returns between January 1989 and December 2007, until the financial crisis. Between September and November 2008, losses were nearly 70%. Considering the data leading up to the crisis (through December 2007), selling volatility looked like easy money. Considering the whole sample period, including the crisis,

the data indicates negative skewness of –8.26. Without the crisis (i.e., only considering the data up to December 2007) the negative skewness was a mere –0.37.

Professor's Note: Selling volatility is like selling insurance. If you sell auto insurance, you collect stable premiums over time but occasionally face a large payout due to a car accident. The same is true for selling out-of-the-money put options. The seller collects option premiums for years, then a disaster happens, like the 2007–2009 financial crisis, and the seller faces massive losses. Option purchasers know in advance what they can lose, the option premium, but sellers do not. Thus, during a market crash, losses could be massive for volatility sellers. Only investors who can tolerate periods of high volatility, which often coincide with losses (sometimes very large losses), should sell volatility.

Academics have estimated a relationship between the expected market risk premium $[E(R_M) - R_F]$ and volatility. The equation is shown as follows:

$$E(R_M) - R_F = \bar{\gamma} \times \sigma_M^2$$

where σ_M^2 is equal to the variance of the market return and $\bar{\gamma}$ represents the average investor's risk aversion. While the coefficient $\bar{\gamma}$ is positive in theory, various studies have estimated it as either positive, negative, or zero. Again, though, whether positive or negative, only those investors who can withstand massive losses during periods of high volatility should sell volatility.

Dynamic Risk Factors

LO 63.4: Explain how dynamic risk factors can be used in a multifactor model of asset returns, using the Fama-French model as an example.

The **capital asset pricing model** (CAPM) is a single-factor model. In the CAPM, the single risk factor is market risk. Stocks that have high exposure to the CAPM market factor perform well when the market performs well and poorly when the market performs poorly. Over the long run, stocks with high betas (i.e., a high market risk factor) should have higher returns than the market return. Returns are higher for high beta stocks to compensate investors for losses during bad periods.

The market portfolio can be readily traded via low-cost index funds, stock futures, and exchange-traded funds (ETFs). In general, macro factors, like political, inflation, and growth risks, are not directly traded (volatility risk is the exception). As a result, dynamic factors can be easily employed in portfolios. The best known example of a tradeable multifactor model is called the **Fama and French model**, introduced in 1993.[2]

2. Eugene F. Fama and Kenneth R. French, "Common Risk Factors in the Returns on Stocks and Bonds," *Journal of Financial Economics* 33 (1993): 3–56.

Professor's Note: In the academic finance literature "style factors," "investment factors," and "dynamic factors" are used interchangeably. Practitioners also refer to these factors as "smart beta" or "alternative beta." Fama and French were the first to develop a multifactor model that captured these effects.

The Fama-French model (called the Fama-French three-factor model) explains asset returns based on three dynamic factors. The model includes:

- The traditional CAPM market risk factor (MKT).
- A factor that captures the **size effect** (SMB).
- A factor that captures the **value/growth effect** (HML).

The Fama-French three-factor model is expressed as follows:

$$E(R_i) = R_F + \beta_{i,MKT} \times E(R_M - R_F) + \beta_{i,SMB} \times E(SMB) + \beta_{i,HML} \times E(HML)$$

Following the market factor, the second factor in the model is SMB. The SMB factor refers to the difference between the returns on small stocks (small market capitalization) versus big stocks (large market capitalization). In other words, the risk factor is small stock returns minus big stock returns, thus SMB. Historically, small-cap stocks have outperformed large-cap stocks. This factor captures the higher performance of small companies relative to large companies. Note, however, that the average stock only has market exposure. Every stock cannot be large, and every stock cannot be small.

The third factor in the model is HML. This factor captures the return differential of high book-to-market stocks versus low-book-to-market stocks. The ratios are calculated as book value divided by market capitalization. Recall that a value strategy consists of buying low-priced stocks (i.e., taking a long position in low-priced stocks) and selling high-priced stocks (i.e., shorting high-priced stocks), normalized by book value. Growth stocks have high stock prices relative to book values, and value stocks have low stock prices relative to book values. Historically, value stocks have outperformed growth stocks. Thus, the Fama-French factors are constructed to capture size (SMB) and value (HML) premiums (known as **factor-mimicking portfolios**).

A value investor, who buys stocks that are perceived as trading below their fundamental value, would have a positive HML beta. Relative to the CAPM expected return, the value investor's return adjusts upward by $\beta_{i,HML} \times E(HML)$. Thus, the overall risk premium increases above the single-factor CAPM risk premium. Likewise, the overall risk premium is adjusted down by $\beta_{i,HML} \times E(HML)$ for growth stocks. This is because growth stocks have negative HML betas, so expected returns are adjusted downward.

In the CAPM, both the average stock beta and the market beta equal one. In the Fama-French model, the HML and SMB betas are centered on zero. The average investor earns the market return as the average stock (or portfolio of stocks) does not have a value or size tilt. This means the investor must specifically choose a value play or a size play, to benefit from the HML and SMB factors. Also, the CAPM and Fama-French models assume betas are constant, but empirical research indicates they vary and increase during bad times.

Value and Momentum Investment Strategies

LO 63.5: Compare value and momentum investment strategies, including their risk and return profiles.

The fact that small stocks tend to outperform big stocks, after adjusting for the firm's beta, was discovered by Banz (1981)[3] and similarly by Reinganum (1981).[4] Following the publication of this finding, the effect disappeared. In other words, if you examine the returns to an SMB strategy from 1965 to 2011, returns to the strategy peak in the early 1980s, with no evidence of a small stock premium in subsequent years. The two possible explanations for the disappearing size effect are as follows:

- *Data mining*. Fischer Black (1993)[5] suggested data mining following the publication of the Fama and French study. If a finding is discovered with *in-sample data* (i.e., in the data used in the original study) but is not substantiated in further studies using *out-of-sample data*, then data mining provides a possible explanation for the result.
- *Investor actions*. Upon the publication of the Banz and Reinganum studies, investors, acting rationally, bid up the prices of small-cap stocks until the SMB effect was removed. This is consistent with the efficient market hypothesis (EMH) in which investors exploit anomalies until they can no longer profit from them. If this is true, then size should be removed as a risk factor in the Fama-French model.

Note that small stocks do tend to have higher returns (i.e., weak size effect), partially because they are less liquid than large-cap stocks. Also, the value and momentum effects, discussed next, are stronger for small stocks. However, the ability to capture small-cap excess returns over the market (on a risk-adjusted basis) is no longer present.

Value Investing

Unlike the disappearing size premium, the value risk premium has provided investors with higher risk-adjusted returns for more than 50 years. Value strategies have suffered periods of loss, including the 1990s recession, the dot com bull market of the late 1990s, and the 2007–2009 financial crisis. The notion of value investing dates back to when Graham and Dodd (1934)[6] published *Security Analysis* with a focus on finding stocks that had prices lower than their fundamental values.

There are generally two explanations for the value premium, one rational and the other behavioral.

Rational Theories of the Value Premium

Value stocks move with each other and co-vary with growth stocks in the rational story about the reason a value premium exists. They perform well together and poorly together.

3. Rolf W. Banz, "The Relationship Between Return and Market Value of Common Stocks," *Journal of Financial Economics* 9 (1981): 3–18.
4. Marc R. Reinganum, "Misspecification of Capital Asset Pricing: Empirical Anomalies Based on Earnings' Yields and Market Values," *Journal of Financial Economics* 9, no. 1 (1981): 19–46.
5. Fischer Black, "Beta and Return," *Journal of Portfolio Management* 20, no. 1 (1993): 8–18.
6. Benjamin Graham and David Dodd, *Security Analysis* (New York: McGraw-Hill, 1934).

Value is risky and, as such, value stocks sometimes perform poorly. The value premium is compensation for these periods of poor performance, for losing money during bad times. Value did perform poorly during the bull market in the late 1990s. This means rational stories must define "bad times" and that value earns a premium on average, not all of the time. Also, not all value risk can be diversified away. The remaining value risk is captured in the value premium.

Labor income risk, investment growth, "luxury" consumption, long-run consumption risk, and housing risk are factors that have been used to explain the value premium. Value stock betas often increase during bad times defined by these risks, causing value stocks to be particularly risky. Macro-based and CAPM risk factors turn out to be the same factors that affect value firms.

Consider the difference between growth and value firms. Growth firms are more adaptable and can adjust when times change because the bulk of their capital is human capital. Value firms are more "old school" with capital in the form of fixed assets that cannot be redeployed when times change. Thus, value firms have *high and asymmetric adjustment costs*. This makes value stocks fundamentally more risky than growth stocks.

The average investor holds the market portfolio. Some investors choose a value tilt and others a growth tilt. The decision boils down to how well the investor can withstand bad times. Given the factors defined above as bad for value (i.e., labor income risk, investment growth, etc.), the investor must ask himself, "Are these times bad for me (versus bad in general)?" If, for example, an investor can manage well during times of low investment growth, that is not a bad time for that investor relative to the average investor. The investor, who has a comparative advantage in holding value stocks, can bear value risk and, therefore, can earn the value premium.

Behavioral Theories of the Value Premium

Behavioral theories of the value premium revolve around two basic ideas: (1) overextrapolation and overreaction and (2) loss aversion and mental accounting.

Overextrapolation and overreaction. Investors have a tendency to assume that past growth rates will continue in the future. This is called **overextrapolation**. For example, a technology company may have a period of tremendous growth as it developed new products that are in high demand. Many investors may assume that this company will continue this growth into the future. Investors often bid up the prices of growth stocks beyond their intrinsic values due to unwarranted optimism. Prices fall when the high expected growth doesn't materialize, leading to lower returns than those earned on value stocks.

Loss aversion and mental accounting. Investors dislike losses more than they like gains (i.e., **loss aversion**), and they tend to view investment gains and losses on a case-by-case basis rather than on a portfolio basis (known as *mental accounting*). Barberis and Huang (2001)[7] use this notion to explain the value premium. They argue that the reason value stocks have high book-to-market values is that they have undergone a period of very poor performance. Loss-averse investors view the stock as risker and, therefore, require a higher rate of return.

7. Nicholas Barberis and Ming Huang, "Mental Accounting, Loss Aversion, and Individual Stock Returns," *Journal of Finance* 56, no. 4 (2001): 1247–92.

Professor's Note: The extrapolation/overreaction behavioral explanation of the value premium is different from the rational one in that in the behavioral explanation, value stocks are not riskier, they are just cheap relative to growth stocks. Investors tend to underestimate the growth prospects of value stocks and overestimate the growth prospects of growth stocks. This bids up the prices of growth stocks and bids down the prices of value stocks, allowing value stocks to outperform on average. Investors must determine if they tend to overextrapolate or not. Investors who act like other average, non-over or under-reacting investors should hold the market portfolio. Investors who overextrapolate will lean toward growth stocks, and those who underreact will lean toward value stocks.

Why are there not enough value investors in the market to push up prices and remove the value premium, as described in the section on the small-cap effect? Maybe investors find value investing difficult, although it is easy to sort stocks on a book-to-market basis using internet screening tools. Perhaps investment horizons must be too long to engage in value investing. The book-to-market value effect described here requires at least a three month to six month horizon. It is possible that not enough institutions have a long enough investment horizon to adopt a value investing approach.

Value investing exists in all asset classes. Strategies include:

- *Riding the yield curve* in fixed income (i.e., capturing the duration premium).
- *Roll return* in commodities (i.e., an upward or downward sloping futures curve determines the sign of the return).
- *Carry* in foreign exchange (e.g., long positions in currencies with high interest rates and short positions in currencies with low interest rates). In this case, high yields are akin to low prices in equity value strategies.

Retail investors can implement value strategies via low-cost index products. Large, institutional investors can, at least theoretically, cheaply implement value strategies across markets.

Momentum Investing

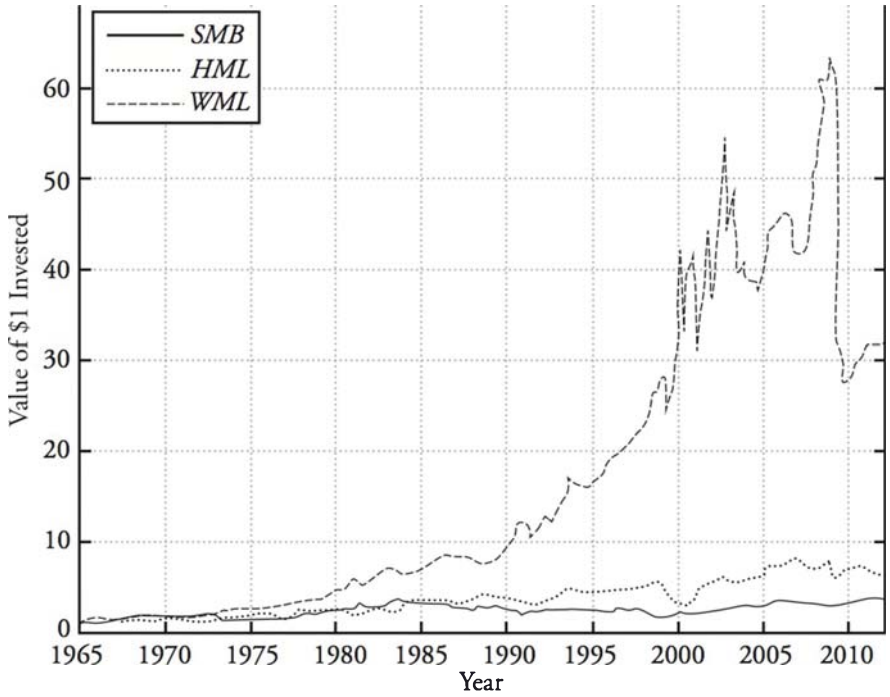
In 1993, the same year Fama and French captured the size and value/growth effects, Jagadeesh and Titman[8] identified a **momentum effect.** Momentum strategies (also called **trend investing**) consist of buying stocks that have gone up over a period (e.g., six months or so) and short stocks that have fallen over the same period (i.e., buy past "winners" and sell past "losers"). The momentum factor, WML, stands for "winners minus losers." It is also sometimes denoted UMD for "up minus down," buying stocks that have gone up in price and selling stocks that have gone down in price. A momentum premium is observed in fixed income (government and corporate bonds), international equities, commodities, real estate, and specific industries and sectors.

The returns to momentum investing exceed size and value investing premiums by a wide margin. Figure 2 illustrates the differences in returns across the three strategies. One dollar invested in the WML premium in January 1965 reached a high of more than $60 before following precipitously (below $30) during the 2007–2009 financial crisis. Correlation

8. Narasimhan Jegadeesh and Sheridan Titman, "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency," *Journal of Finance* 48, no. 1 (1993): 65–91.

between the value premium and the momentum premium was only approximately –0.16 during this period. This means that value returns are not opposite momentum returns.

Figure 2: Returns for SMB, HML, and WML strategies



Value and momentum strategies are, however, opposite each other in the following sense. Value investing is inherently stabilizing. It is a *negative feedback strategy* where stocks that have fallen in value eventually are priced low enough to become value investments, pushing prices back up. Momentum is inherently destabilizing. It is a *positive feedback strategy* where stocks that have been increasing in value are attractive to investors, so investors buy them, and prices increase even more. Momentum investing can lead to crashes (e.g., the more than 50% drop during the 2007–2009 financial crisis). Notice that value and growth returns did not fall in quite so dramatic a fashion. An investor following a momentum strategy should still rebalance his portfolio.

Momentum is often added to the Fama-French model as follows:

$$E(R_i) = R_F + \beta_{i,MKT} \times E(R_M - R_F) + \beta_{i,SMB} \times E(SMB) + \beta_{i,HML} \times E(HML) + \beta_{i,WML} \times E(WML)$$

As mentioned, momentum can be riskier than value or size investing in that it is more prone to crashes. There have been 11 momentum crashes on record: seven during the 1930s Great Depression, three during the financial crisis starting in 2007, and one in 2001. During the 2007–2009 crisis, financial stocks were hit hard. Losers tend to keep losing, and they likely would have, but the government bailout put a floor on stock prices. Momentum investors were short these stocks. When the government bailed out financial firms and other firms that were hit hard, momentum investors experienced large losses as the market rebounded. During the Great Depression, policymakers also influenced asset prices, causing losses to momentum investors.

Momentum risk includes:

- Tendency toward crashes.
- Monetary policy and government risk (i.e., the government gets in the way of the natural progression of asset prices).
- Macro factors such as the business cycle, the state of the stock market, and liquidity risk.

Behavioral explanations suggest that investor biases explain momentum. Investors overreact (a delayed overreaction) to good news about firms. This causes prices to drift upward. Alternatively, investors may underreact to good news, causing prices to increase less than they should have given the good news. As investors acquire more information, prices go up in the next period. Thus, behavioral explanations for the momentum premium fall into two, difficult-to-distinguish camps:

1. *Overreaction to good news*. In some cases overconfident, informed investors, like retail investors and hedge fund managers, observe positive signals in stock performance. They attribute the performance to their own skill. The overconfidence leads to overreaction, pushing prices up above their fundamental values.

2. *Underreaction to good news*. In this case, "news watchers" ignore information in the history of stock prices and other investors trade only on history (i.e., past price signals) and ignore fundamental information about the firm. In both cases, information is only partially incorporated into stock prices, causing an underreaction.

Whether there is momentum that results from overreaction or from underreaction, prices eventually revert to their fundamental values over the long run. An investor considering momentum investing must assess whether he leans toward overreaction or underreaction. Also, the investor must know that he can tolerate large losses during "crash" periods, historically concentrated around periods when policymakers (e.g., central banks) interrupt momentum, changing the course that asset prices would naturally take. In sum, assets are exposed to factor risks like value and momentum. Factor premiums compensate investors for losses during bad times.

Key Concepts

LO 63.1

A value-growth investment strategy is long value stocks and short growth stocks. Value stocks have high book-to-market ratios, and growth stocks have low book-to-market ratios. Historically, value stocks have significantly outperformed growth stocks.

Risk premiums, including a value premium, exist to compensate investors for losses experienced during bad times. There are rational and behavioral explanations for why a value premium may exist. Value stocks are risky, thus the value premium compensates investors for losses during bad times (rational explanation). Investors undervalue the growth prospects of value stocks and overextrapolate past growth into future prospects, overvaluing growth stocks. Value stocks are underpriced relative to their fundamental values, and growth stocks are overvalued, leading to a value premium (behavioral explanation).

LO 63.2

Macroeconomic factors, like inflation and economic growth, affect all investors to varying degrees. Economic growth, inflation, and volatility are the three most important macro factors that affect asset prices. It is unanticipated changes to a risk factor that affect asset prices, not the level of the factor. In other words, it is not the level of inflation, but an unanticipated increase or decrease in inflation that causes stock and bond prices to rise or fall.

- Risky assets generally perform poorly during periods of low economic growth.
- Stocks and bonds generally perform poorly in periods of high inflation.
- Stock returns drop when volatility (measured by the VIX) increases.

Other macroeconomic factors, like shocks to productivity, demographic risks, and sovereign risks, also affect asset returns.

LO 63.3

Volatility increases in periods of economic stress. There are two basic approaches to mitigating volatility risk:

- Invest in less-volatile assets like bonds. One challenge to managing volatility is that asset prices, including less volatile assets, tend to perform poorly during periods of economic stress (e.g., 2007–2009).
- Buy volatility protection in the derivatives market (e.g., buy out-of-the-money put options). Sellers of volatility protection (i.e., those selling put options) collect volatility premiums.

LO 63.4

The Fama-French model explains asset returns based on three dynamic factors. The factors are:

- The traditional CAPM market risk factor.
- A factor that captures the size effect (SMB or small cap minus big cap). Historically, small-cap stocks outperform large-cap stocks. The strategy is long small-cap stocks and short large-cap stocks.
- A factor that captures the value/growth effect (HML or high book-to-market value minus low book-to-market value). Value stocks tend to outperform growth stocks. The value-growth strategy is long value stocks and short growth stocks.

LO 63.5

A value strategy is long value stocks and short growth stocks. A momentum strategy is long "winners" (i.e., stocks that have gone up in value over the last six months or so) and short "losers" (i.e., stocks that have gone down in value over the last six months or so). A momentum strategy has vastly outperformed both value-growth and size strategies since 1965. However, momentum strategies are subject to crashes. Rational and behavioral explanations can be used to describe both value and momentum risk premiums.

Concept Checkers

1. A low book-to-market value ratio is indicative of a:
   A. value stock.
   B. growth stock.
   C. small-cap stock.
   D. large-cap stock.

2. Which of the following asset classes has approximately the same returns in high economic growth periods and low economic growth periods?
   A. Small-cap stocks.
   B. Large-cap stocks.
   C. Government bonds.
   D. High-yield bonds.

3. Which of the following investment options provides a means of mitigating volatility risk?
   A. Buying put options.
   B. Selling put options.
   C. Buying equities.
   D. Buying call options.

4. Which of the following is not a factor in the Fama-French three-factor model?
   A. The capital asset pricing model market risk factor.
   B. The small capitalization minus big capitalization risk factor.
   C. The winners minus losers risk factor.
   D. The high book-to-market value minus low book-to-market value risk factor.

5. Which of the following investment strategies stabilizes asset prices?
   A. A value investment strategy.
   B. A momentum investment strategy.
   C. A size investment strategy.
   D. Value, momentum, and size strategies all stabilize asset prices.

Concept Checker Answers

1. **B** A company's book value per share is equal to total assets minus total liabilities all divided by shares outstanding. It indicates, on a per-share basis, what a company would be worth if it liquidated its assets and paid off its liabilities. Value stocks have high book-to-market ratios while growth stocks have low book-to-market ratios.

2. **D** During periods of recession, government and investment-grade bonds outperform equities and high-yield bonds. During expansion periods, equities outperform bonds. High-yield bond returns appear indifferent to changes in economic growth, yielding 7.4% in recessions and 7.7% in expansions.

3. **A** There are two basic approaches to mitigating volatility risk. They are investing in less volatile assets like bonds (instead of stocks) or buying volatility protection in the derivatives market, such as buying out-of-the-money put options.

4. **C** The Fama-French model includes the following three risk factors:
   - The traditional capital asset pricing model market risk factor.
   - A factor that captures the size effect (SMB).
   - A factor that captures the value/growth effect (HML).

   The winners minus losers (WML) momentum factor was discovered by Jagadeesh and Titman.

5. **A** Value and momentum are opposite each other in that value investing is inherently stabilizing. It is a *negative feedback strategy* where stocks that have fallen in value eventually are priced low enough to become value investments, pushing prices back up. Momentum is inherently destabilizing. It is a *positive feedback strategy* where stocks that have been increasing in value are attractive to investors, so investors buy them, and prices increase even more.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Alpha (and the Low-Risk Anomaly)

Topic 64

Exam Focus

Investors are interested in generating alpha, which is the return earned in excess of a benchmark. It was traditionally thought that higher risk produced higher returns. However, in practice, strategies focused on lower volatility have actually been found to produce higher returns than higher-volatility investments. For the exam, be able to explain the impact of benchmark section on alpha. Also, understand how to apply factor regression to construct a benchmark with multiple factors, and how to measure alpha against that benchmark. Finally, be familiar with the potential explanations for return anomalies with regard to low risk.

Low-Risk Anomaly

LO 64.1: Describe and evaluate the low-risk anomaly of asset returns.

The capital asset pricing model (CAPM) from traditional finance states that there should be a positive relationship between risk and return. Higher risk, as measured by beta, should have a higher return. The **low-risk anomaly** appears to suggest the exact opposite. This anomaly finds that firms with lower betas and lower volatility have higher returns over time. For example, over a five-year period from 2011–2016, the cumulative return for a low volatility fund (iShares Edge MSCI Minimum Volatility USA ETF) was 68.75% relative to the cumulative return of 65.27% for the S&P 500 Index ETF.

Alpha, Tracking Error, the Information Ratio, and the Sharpe Ratio

LO 64.2: Define and calculate alpha, tracking error, the information ratio, and the Sharpe ratio.

Professor's Note: We will demonstrate the calculations for these measures along with other performance measures later in this book (Topic 70).

Alpha is often interpreted as a measure of investor skill, but it is really just a statement of average performance in excess of a benchmark. Excess return (R_t^{ex}) can be seen as the difference between the return of an asset (R_t) and the return of the asset's benchmark (R_t^B).

$$R_t^{ex} = R_t - R_t^B$$

Excess return is also sometimes called **active return**. This phrase assumes that the benchmark is passive and can be achieved without investment knowledge or human intervention. The S&P 500 Index and the Russell 1000 Index are commonly used large-cap benchmarks. If the benchmark is passive, then any additional return that the investor achieves is from doing something different from the benchmark, which by definition is active.

We compute alpha (α) by finding the average excess return for T observations.

$$\alpha = \frac{1}{T}\sum_{t=1}^{T} R_t^{ex}$$

To fully understand the concept of alpha, we also need to understand tracking error and the information ratio. **Tracking error** is the standard deviation of excess returns. It measures the dispersion of the investor's returns relative to their benchmark.

$$\text{tracking error} = \bar{\sigma} = \text{standard devation}(R_t^{ex})$$

When a professional investment manager uses active strategies, there is often a constraint placed on the amount of tracking error permitted. Larger tracking errors indicate that the manager has more freedom in decision making.

One easy way to monitor alpha is to standardize it using tracking error. The ratio of alpha to tracking error is known as the **information ratio** (IR), and it is a good way to monitor risk-adjusted returns for active asset managers. Active investment choices can be ranked based on their IR scores.

$$IR = \frac{\alpha}{\bar{\sigma}}$$

Sometimes the benchmark for an asset manager is the risk-free rate (R_F). In this case, alpha is measured as the return earned on an investment (R_t) in excess of the risk-free rate.

$$\alpha = R_t - R_F$$

When the risk-free rate is the appropriate benchmark, the best way to measure risk-adjusted returns is to use the **Sharpe ratio**. This measure has alpha in the numerator and the standard deviation of the asset in the denominator.

$$\text{Sharpe ratio} = \frac{\bar{R}_t - \bar{R}_F}{\sigma}$$

Benchmark Selection for Alpha

LO 64.3: Explain the impact of benchmark choice on alpha, and describe characteristics of an effective benchmark to measure alpha.

The choice of benchmark has a significant impact on the calculated alpha for an investment. Strictly benchmarking to an identifiable index, like the S&P 500 Index, assumes that an asset has a beta of 1.0. What if the true beta is some value other than 1.0? Consider an investment that has a beta of 0.73 and tracking error of 6.16%. The alpha for this investment could be estimated by regressing the excess return of the fund ($R_t - R_F$) against the excess return of the benchmark ($R_t^{SP500} - R_F$). In the following regression equation, you see a calculated alpha of 3.44% and a placeholder for error term (ε_t) because we never know, in advance, how an individual observation will deviate from our model at any point in time.

$$R_t - R_F = 0.0344 + 0.73(R_t^{SP500} - R_F) + \varepsilon_t$$

We can rearrange this formula to isolate only the expected return on our investment. Doing so, we find that our customized benchmark should actually be invested 27% in the risk-free rate and 73% in the S&P 500 Index. Using a benchmark that recognizes the investment's beta as 0.73, we calculate an alpha of 3.44%, which translates into an IR of 0.5584 (= 0.0344 / 0.0616).

$$R_t = 0.0344 + 0.27(R_F) + 0.73(R_t^{SP500}) + \varepsilon_t$$

If this same investor were to wrongly regress their investment against only the S&P 500 Index, then they would calculate an alpha of 1.50%, which is incorrect because it assumes a beta of 1.0 when the actual beta is 0.73.

$$R_t = 0.015 + R_t^{SP500} + \varepsilon_t$$

Using the wrong benchmark would produce an IR of 0.2435 (= 0.0150 / 0.0616). This suggests that using an incorrect benchmark will understate both the expected alpha and the IR. Inaccurate information may cause an investor to pass on an investment that they otherwise should have accepted.

This illustration leads an investor to wonder: what is the best way to choose a benchmark? An appropriate benchmark can be selected by applying a few different complementary standards. First, the benchmark should be *well-defined*. It should be hosted by an independent index provider, which makes it both verifiable and free of ambiguity. The S&P 500 Index and the Russell 1000 Index are both examples of well-defined large-cap indices. Second, an index should be *tradeable*. If the benchmark is not a basket of tradeable securities that could be directly invested in as an alternative, then the benchmark is not a very good comparison. Third, a benchmark must be *replicable*. This is closely related to the tradability standard. There are some benchmarks, like absolute return benchmarks, that are

not feasible for an investor to replicate. If it cannot be replicated, then the tracking error will be very high. Fourth, the benchmark must be *adjusted for risk*. In the example above, you can see that the alpha and the IR will be calculated too low if the risk level of the benchmark is too high for the investment in question.

Fundamental Law of Active Management

LO 64.4: Describe Grinold's fundamental law of active management, including its assumptions and limitations, and calculate the information ratio using this law.

Portfolio managers create value, and potentially create alpha, by making bets that deviate from their benchmark. Richard Grinold formalized this intuitive relationship in the **fundamental law of active management.**[1] This fundamental law does not provide a tool for searching for high IR plays, but it does present a good mechanism for systematically evaluating investment strategies. The law states that:

$$IR \approx IC \times \sqrt{BR}$$

The formula for Grinold's fundamental law shows that the information ratio (IR) is approximately equal to the product of the information coefficient (IC) and the square root of the breadth (BR) of an investor's strategy. The **information coefficient** is essentially the correlation between an investment's predicted and actual value. This is an explicit evaluation of an investor's forecasting skill. A higher IC score means that the predictions had a higher correlation (high-quality predictions). **Breadth** is simply the number of investments deployed.

Consider an example of an investor who requires an IR of 0.50. If this investor wants to time the market using an index and plans to only make four investments during the year, then he would need an IC of 0.25 as shown:

$$0.5 = 0.25 \times \sqrt{4}$$

What would happen if this same investor instead decided to deploy a stock selection strategy based on either value or momentum plays? These two strategies both involve taking a high number of bets every year. If they placed 200 bets in a given year, then they would only need an IC of 0.035 instead of 0.25. A lower IC means lower-quality predictions.

$$0.5 = 0.035 \times \sqrt{200}$$

Grinold's fundamental law teaches us about a central tradeoff in active management. Investors need to either play smart (a high IC shows high-quality predictions) or play often (a high BR shows a lot of trade activity). Essentially, investors can be very good at making forecasts and place a small number of bets, or they will need to simply place a lot of bets.

1. Richard C. Grinold, "The Fundamental Law of Active Management," *Journal of Portfolio Management* 15, no. 3 (1989): 30–37.

Grinold's framework ignores downside risk and makes a critical assumption that all forecasts are independent of one another. The Norwegian sovereign wealth fund has used Grinold's fundamental law in practice. Their philosophy is to take a high number of bets using a large list of entirely independent asset managers. This helps to keep forecasts independent and allows them to have reduced reliance on forecasting prowess while still endeavoring to achieve their benchmark IR goals.

In practice, it has also been noted that as assets under management go up, the IC tends to decline. This affects mutual funds, hedge funds, private equity firms, pension funds, and sovereign wealth funds alike. This is one reason why some mutual funds close to new investors and turn away new assets once they reach an internally set size.

Factor Regression and Portfolio Sensitivity

LO 64.5: Apply a factor regression to construct a benchmark with multiple factors, measure a portfolio's sensitivity to those factors, and measure alpha against that benchmark.

Consider the CAPM formula, where $E(R_i)$ is the expected return for asset *i* for a given level of beta exposure, and $E(R_M)$ is the expected return on the market:

$$E(R_i) = R_F + \beta[E(R_M) - R_F]$$

If an investment has a beta of 1.3, then the following formulas demonstrate the algebraic evolution of this expression:

$$E(R_i) = R_F + 1.3[E(R_M) - R_F]$$
$$E(R_i) = R_F + 1.3E(R_M) - 1.3(R_F)$$
$$E(R_i) = -0.3R_F + 1.3E(R_M)$$

In this example, the expected return on a $1 investment in asset *i* should be equal to a portfolio with a short position in the risk-free rate of $0.30 and a long position in the market of $1.30. Any return earned in excess of this unique blend will exceed our expectations and is, therefore, considered to be *alpha*. Using regression, the alpha is approximated as:

$$R_{i,t} - R_F = \alpha + \beta(R_M - R_F) + \varepsilon_{i,t}$$

This exact process was conducted on Berkshire Hathaway stock over the period of January 1990 to May 2012 relative to S&P 500 Index. The results are shown in Figure 1. The monthly alpha coefficient is statistically significant at a 95% confidence level due to the absolute value of the *t*-statistic being greater than 2.0. Most regressions do not produce a statistically significant alpha.

Figure 1: Regression of Excess Returns

	Coefficient	*t-Statistic*
Alpha	0.72%	2.02
Beta	0.51	6.51
Adjusted R^2	0.14	

This regression implies the following CAPM equation:

$$R_B = 0.49R_F + 0.51R_M$$

According to these regression results, a customized benchmark of 49% in the risk-free asset and 51% in the market would produce an expected alpha of 0.72% per month for Berkshire Hathaway. That is 8.6% (0.72% × 12) of annualized expected alpha! Since alpha is the excess return above the actual return, R_i, you can think of alpha using the following formula:

$$\alpha = R_i - [0.49R_F + 0.51E(R_M)]$$

Professor's Note: For Berkshire, it is important to note that their market capitalization has grown from less than $10 billion in the early 1990s to over $220 billion in 2012. In his Annual Letter to Shareholders for 2010, Warren Buffet told shareholders that "the bountiful years, we want to emphasize, will never return. The huge sums of capital we currently manage eliminate any chance of exceptional performance".[2] Thus, Berkshire Hathaway has acknowledged the law of declining marginal returns due to scale.

In 1993, Eugene Fama and Kenneth French extended the traditional CAPM-based regression to include additional factors. They controlled for the **size effect** (small companies tend to outperform large companies) and for the **value/growth effect** (value stocks tend to perform better than growth stocks). They formally labeled the size premium as SMB, which stands for "small minus big" (the return on small stocks minus the return on big stocks), and they represented the value premium with HML, which stands for "high minus low" (high book-to-market stocks minus low book-to-market stocks). The factors for SMB and HML are long-short factors. The "small minus big" factor can be visualized as:

SMB = $1 in small caps (long position) – $1 in large caps (short position)

In a similar manner, we can visualize "high minus low" as:

HML = $1 in value stocks (long position) – $1 in growth stocks (short position)

2. Berkshire Hathaway Annual Letter to Shareholders, 2010.

The **Fama and French three-factor model** is constructed as follows:

$$R_i - R_F = \alpha + \beta_{i,MKT} \times (R_M - R_F) + \beta_{i,SMB} \times (SMB) + \beta_{i,HML} \times (HML)$$

The SMB beta will be positive if there is co-movement with small stocks, and it will be negative if there is co-movement with large stocks. If a given asset does not co-move with either small or large companies (i.e., a medium company focus), then its beta coefficient will be zero. Likewise, the HML beta will be positive if the assets have a value focus, and it will be negative if the assets have a growth focus. Applying the Fama-French model to Berkshire Hathaway over the time period of January 1990–May 2012 yields the results displayed in Figure 2.

Figure 2: Fama-French Three-Factor Model Results

	Coefficient	*t-Statistic*
Alpha (α)	0.65%	1.96
Market beta ($\beta_{i,MKT}$)	0.67	8.94
SMB beta ($\beta_{i,SMB}$)	–0.50	–4.92
HML beta ($\beta_{i,HML}$)	0.38	3.52
Adjusted R^2	0.27	

The results in Figure 2 show several interesting aspects. First, the alpha declined slightly but is still very high. Second, the market beta rose from 0.51 to 0.67. Third, the SMB beta is negative, which suggests a large company bias. Fourth, the HML beta is positive, which suggests a value focus for the fund. The adjusted R^2 also rose from 0.14 to 0.27, which suggests that SMB and HML do add value. Based on the results, the custom benchmark implied by the Fama-French three-factor model for Berkshire Hathaway is shown as follows:

R_B = 0.33(T-bills) + 0.67 × (market portfolio)

–0.5(small caps) + 0.5(large caps)

+ 0.38(value stocks) – 0.38(growth stocks)

All of the factor weights in this formula sum to 1.0, but adding the SMB and HML factors add explanatory ability to the regression equation. A test could also be added to account for the **momentum effect**, which is the theory that upward trending stocks will continue their upward movement while downward moving stocks will continue their downward trend. Thus, a fourth factor can be added to the Fama-French model. This fourth factor could be labeled as UMD, which stands for "up minus down" (upward trending stocks minus downward trending stocks). A positive UMD beta would suggest a focus on upward trending stocks, while a negative UMD beta would suggest a focus on downward trending stocks. As with the SMB and HML betas, a beta of zero suggests no relationship. Figure 3 shows the UMD factor added to the previous results. Using this data, it can be discerned that Berkshire Hathaway does not have exposure to momentum investing.

Figure 3: Fama-French Three-Factor Model Results With UMD Factor

	Coefficient	*t-Statistic*
Alpha (α)	0.68%	2.05
Market beta ($\beta_{i,MKT}$)	0.66	8.26
SMB beta ($\beta_{i,SMB}$)	–0.50	–4.86
HML beta ($\beta_{i,HML}$)	0.36	3.33
UMD beta ($\beta_{i,UMD}$)	–0.04	–0.66
Adjusted R^2	0.27	

One core challenge with using the Fama-French model is replication of indices. Fama and French have created an SMB index and an HML index to increase explanatory power, but there is no way to directly trade an SMB or HML portfolio. These indices are conceptual and not directly tradeable. It is important to include only tradeable factors because the factors chosen will greatly influence the calculated alpha.

Measurement of Time-Varying Factors

LO 64.6: Explain how to measure time-varying factor exposures and their use in style analysis.

Style analysis is a form of factor benchmarking where the factor exposures evolve over time. To illustrate time-varying factors, consider four investments: (1) LSV Value Equity (LSVEX), (2) Fidelity Magellan (FMAGX), (3) Goldman Sachs Capital Growth (GSCGX), and (4) Berkshire Hathaway (BRK). Figure 4 shows the regression data from monthly returns on all four funds using the Fama-French three-factor model plus the UMD factor. The key difference between this information and data already presented is that the time period has been adjusted to January 2001 through December 2011.

Figure 4: Regression of Excess Returns for Multiple Funds

	LSVEX	*FMAGX*	*GSCGX*	*BRK*
Alpha (α)	0.00%	–0.27%	–0.14%	0.22%
t-stat	0.01	–2.23	–1.33	0.57
Market beta ($\beta_{i,MKT}$)	0.94	1.12	1.04	0.36
t-stat	36.9	38.6	42.2	3.77
SMB beta ($\beta_{i,SMB}$)	0.01	–0.07	–0.12	–0.15
t-stat	0.21	–1.44	–3.05	–0.97
HML beta ($\beta_{i,HML}$)	0.51	–0.05	–0.17	0.34
t-stat	14.6	–1.36	–4.95	2.57
UMD beta ($\beta_{i,UMD}$)	0.2	0.02	0.00	–0.06
t-stat	1.07	1.00	–0.17	–0.77

This data presents a different story about these funds than earlier. The only calculated alpha that is statistically significant is for Fidelity Magellan, but it is a –3.24% (= –0.27% × 12) in annualized terms. This was not good news for Fidelity investors, although it is time

constrained to a period that ended in 2011. Berkshire's alpha is nicely positive, but for this time period, it is not significant. According to the HML beta factors, LSV Value Equity is indeed a value-focused investment. The data also shows that FMAGX is a leveraged play on the market with a 1.12 market beta. The UMD beta confirms that none of these four funds are momentum plays.

Style analysis tries to solve some of the problems with standard multifactor regression. Unlike Fama and French's untradeable SMB and HML indices, style analysis uses tradeable assets. For example, consider three funds: (1) SPDR S&P 500 ETF (SPY), (2) SPDR S&P 500 Value ETF (SPYV), and (3) SPDR S&P 500 Growth ETF (SPYG). These three exchange-traded funds (ETFs) are hosted by State Street Global Advisors and they all belong to the SPDR (pronounced "spider") family of ETFs. Style analysis also adjusts for the fact that factor loadings (betas) change over time. A possible multifactor regression could be estimated for next period's expected asset return (R_{t+1}) as follows:

$$R_{t+1} = \alpha_t + \beta_{SPY,t}SPY_{t+1} + \beta_{SPYV,t}SPYV_{t+1} + \beta_{SPYG,t}SPYG_{t+1} + \varepsilon_{t+1}$$

This formula has an imposed restriction that all factor loadings (i.e., factor weights) must sum to one:

$$1 = \beta_{SPY,t} + \beta_{SPYV,t} + \beta_{SPYG,t}$$

The time-varying portion of this equation comes into play with the respective factor loadings. This process uses estimates that incorporate information up to time *t*. Every new month (t + 1) requires a new regression to adjust the factor loadings. This means that the beta factors will change over time to reflect changes in the real world.

Issues with Alpha Measurement for Nonlinear Strategies

LO 64.7: Describe issues that arise when measuring alphas for nonlinear strategies.

Alpha is computed using regression, which operates in a linear framework. There are nonlinear strategies, such as uncovered long put options, that can make it appear that alpha exists when it actually does not. An uncovered long put option has a payoff profile that is L-shaped (nonlinear), but applying traditional regression tools will yield a positive alpha, which does not exist in reality. This situation is encountered when payoffs are quadratic terms, like R_t^2 or are option-like terms, such as $\max(R_t, 0)$. This can be a significant problem for hedge funds, because merger arbitrage, pairs trading, and convertible bond arbitrage strategies all have nonlinear payoffs.

One reason that nonlinear strategies yield a false positive alpha is because the distribution of returns is not a normal distribution. Certain nonlinear strategies will also exhibit negative skewness in their distribution. This will increase loss potential in the left-hand tail and make the middle of the distribution appear thicker. Skewness is not factored into the calculation of alpha, which is an issue for nonlinear payoff strategies.

Volatility and Beta Anomalies

LO 64.8: Compare the volatility anomaly and beta anomaly, and analyze evidence of each anomaly.

Using data from 1926–1971, Haugen and Heins (1975)[3] found that "over the long run, stock portfolios with lesser variance in monthly returns have experienced greater average returns than 'riskier' counterparts." Ang, Hodrick, Xing, and Zhang (2006)[4] tested whether increased volatility, as measured by standard deviation, has a positive relationship with returns and Sharpe ratios. They organized their data, which comprised monthly return data from September 1963–December 2011, into quintiles and controlled for numerous variables including leverage, volume, bid-ask spreads, dispersion in analyst's forecasts, and momentum. They observed a **volatility anomaly** which shows that as standard deviation increased, both the average returns and the Sharpe ratios decreased. For the lowest three quintiles, the average return was above 10%, but declined to 6.8% for quintile 4 and to 0.1% for the quintile with the highest volatility. Likewise, Sharpe ratios declined from 0.8 for the lowest volatility quintile to 0.0 for the highest volatility quintile. It was found that the most volatile stocks produce the lower returns, while the least volatile stocks performed the best.

When the capital asset pricing model (CAPM) was first tested in the 1970s, a positive relationship was found between beta and expected returns. Numerous academics have since retested this relationship with interesting results. Ang et al. (2006) found that stocks with high betas tend to have lower-risk-adjusted returns. Organizing monthly return data from September 1963–December 2011 into quintiles, they found that the Sharpe ratio fell from 0.9 for stocks with the lowest betas to 0.4 for stocks with the highest betas. This **beta anomaly** does not suggest that stocks with higher betas have low return because they do not. It means they have lower Sharpe ratios (risk-adjusted performance) because higher betas are paired with higher volatility as measured by standard deviation, which is the denominator in the Sharpe ratio.

Interestingly, CAPM does *not* predict that lagged betas (measured over previous periods) should produce higher returns. It does predict that investors should find a contemporaneous relationship between beta and expected returns. This means that stocks with higher betas should also have higher returns during the same time period when the beta was measured. This is a confirming, not a predictive, metric. Following this logic, if investors could reliably predict future betas, then they could more accurately predict future expected returns. The trouble is that historical betas are not good predictors of future betas. Buss and Vilkov (2012)[5] estimated future betas using implied volatility measures in option pricing models and found some improvement over using historical betas. The beta anomaly is less a mystery as it is a challenge to find a reliable way of predicting future betas to improve the risk perspective of beta.

3. Robert A. Haugen and A. James Heins, "Risk and the Rate of Return on Financial Assets: Some Old Wine in New Bottles," *Journal of Financial and Quantitative Analysis* 10, no. 5 (1975): 775–84.
4. Andrew Ang, Robert J. Hodrick, Yuhang Xing, and Xiaoyan Zhang, "High Idiosyncratic Volatility and Low Returns: International and Further U.S. Evidence," *Journal of Financial Economics* 91 (2009): 1–23.
5. Adrian Buss and Grigory Vilkov, "Measuring Equity Risk With Option-Implied Correlations," *The Review of Financial Studies* 25, no. 10 (2012): 3113–40.

Potential Explanations for the Risk Anomaly

LO 64.9: Describe potential explanations for the risk anomaly.

A comprehensive explanation for the risk anomaly is elusive. It has been speculated that the true explanation is some combination of data mining, investor leverage constraints, institutional manager constraints, and preference theory.

Some academics have wondered if the risk anomaly is the result of *data mining*. Ang et al. (2006) found that the risk anomaly appears during both recessions and expansions. Frazzini and Pedersen (2014)[6] found that low beta portfolios have high Sharpe ratios in U.S. stocks, international stocks, Treasury bonds, and corporate bonds. Cao and Han (2013)[7] also found evidence of the risk anomaly in option and commodity markets. The argument of data mining is not well supported.

Another possible explanation is the prevalence of *leverage constrained investors*. This is sometimes an occurrence with institutional investors, but it is very much a constraint of retail investors. Since certain investors are leverage constrained, meaning that they cannot borrow funds for investing, they choose to invest in stocks with built-in leverage in the form of high betas. The additional demand for high-beta stocks will bid up their respective prices until the assets are overvalued and they deliver a decreased risk-adjusted return with regard to lower beta stocks. This same theory works to lower the prices of low beta stocks and, therefore, results in higher risk-adjusted returns due to lower entry prices.

Institutional managers also have *constraints* that could help to explain the risk anomaly. Consider a scenario with two competing portfolios. Portfolio A has positive alpha because the portfolio is undervalued, while Portfolio B has a negative alpha because it is overvalued. In a perfect world, an investor would buy (go long) Portfolio A and short sell Portfolio B to capture the perceived alphas. Many institutional investors will have constraints against short selling. Most also have tracking error constraints that only permit a specified deviation from their benchmark. Under either of these constraints, an institutional investor would not be able to capture the alpha that they think exists. One solution for the tracking error constraint is to change the benchmark or the tracking error tolerance bands, but this can be a difficult process requiring formal approval from the investment committee of the fund.

Sometimes investors simply have a *preference* for high-volatility and high-beta stocks. This could occur because their capital market expectations are very bullish, so they want to amplify their returns. The end result is that investors buy the higher-beta investments and bid up their prices to the point where future returns will be much lower. There will always be a group of investors that desire to shun "safe" and "boring" lower-volatility stocks. The good news is that this creates less emotionally driven entry points for long-term investors who desire lower volatility.

6. Andrea Frazzini and Lasse Heje Pederson, "Betting Against Beta," *The Journal of Financial Economics* 111, no. 1 (2014): 1–25.
7. Jie Cao and Bing Han, "Cross Section of Option Returns and Idiosyncratic Stock Volatility," *The Journal of Financial Economics* 108, no. 1 (2013): 231–49.

Investors holding heterogeneous preferences (disagreeing on investment potential) and having investment constraints could explain a portion of the risk anomaly. Hong and Sraer (2012)[8] found that when disagreement is low and investors are long-only constrained, then the CAPM holds the best. When disagreement is high, some investments become overpriced and future returns are decreased. Significant disagreement can lead to an inverse relationship between beta and returns.

8. Harrison Hong and David Sraer, "Speculative Betas," NBER Working Paper 18548, November 2012.

Key Concepts

LO 64.1

The capital asset pricing model (CAPM) states that there should be a positive relationship between risk and return. Higher risk, as measured by beta, should have a higher return. The low-risk anomaly appears to suggest the exact opposite. This anomaly finds that firms with lower betas and lower volatility have higher returns over time.

LO 64.2

Alpha is the average performance of an investor in excess of their benchmark. Excess return is often called active return, and the standard deviation of the active return is known as tracking error.

The ratio of active return to tracking error is called the information ratio, which is one way to easily rank competing investment alternatives.

$$\text{IR} = \frac{\alpha}{\bar{\sigma}}$$

If an investor is using the risk-free rate as their benchmark, then their alpha is any return earned in excess of the risk-free rate, and the best risk-adjusted return measurement is the Sharpe ratio.

$$\text{Sharpe ratio} = \frac{\bar{R}_t - \bar{R}_F}{\sigma}$$

LO 64.3

A benchmark is very important for investment comparisons. If the benchmark is riskier than the investment in question, then both the alpha and the information ratio will be too low. The best combination for a benchmark is for it to be well-defined, tradeable, replicable, and adjusted for the risk of the underlying pool of investments.

LO 64.4

Grinold's fundamental law of active management suggests a tradeoff between the number of investment bets placed (breadth) and the required degree of forecasting accuracy (information coefficient).

$$\text{IR} \approx \text{IC} \times \sqrt{\text{BR}}$$

An investor either needs to place a large number of bets and not be very concerned with forecasting accuracy, or he needs to be very good at forecasting if he places only a small number of bets.

LO 64.5

The traditional capital asset pricing model only accounts for co-movement with a market index. Multifactor models, like the Fama and French three-factor model, add other explanatory factors in an attempt to better predict the alpha for an asset. Multifactor models have been shown to enhance the informational value of regression output. The Fama-French three-factor model is expressed as:

$$R_i - R_F = \alpha + \beta_{i,MKT} \times (R_M - R_F) + \beta_{i,SMB} \times (SMB) + \beta_{i,HML} \times (HML)$$

This model adds a size premium (SMB) and a value premium (HML) to the CAPM single-factor model. A momentum effect (UMD) could also be added to help explain excess returns. This factor suggests that upward trending stocks will continue their upward movement while downward moving stocks will continue their downward trend.

LO 64.6

Style analysis is a form of factor benchmarking where the factor exposures evolve over time. The traditional Fama-French three-factor model can be improved by using indices that are tradeable, such as the SPDR S&P Value ETF (SPYV), and incorporating time-varying factors that change over time.

LO 64.7

Alpha is computed using regression, which operates in a linear framework. There are nonlinear strategies that can make it appear that alpha exists when it actually does not. This situation is encountered when payoffs are quadratic terms or option-like terms. This may be a significant problem for hedge funds because merger arbitrage, pairs trading, and convertible bond arbitrage strategies all have nonlinear payoffs.

LO 64.8

The volatility anomaly and the beta anomaly both agree that stocks with higher risk, as measured by either high standard deviation or high beta, produce lower risk-adjusted returns than stocks with lower risk.

LO 64.9

A comprehensive explanation for the risk anomaly is elusive. It has been speculated that the true explanation is some combination of data mining, investor leverage constraints, institutional manager constraints, and preference theory.

Concept Checkers

1. Which of the following statements is correct concerning the relationship between the low-risk anomaly and the capital asset pricing model (CAPM)?
   A. The low-risk anomaly provides support for the CAPM.
   B. The notion that the low-risk anomaly violates the CAPM has not been proven empirically.
   C. The low-risk anomaly violates the CAPM and suggests that low-beta stocks will outperform high-beta stocks.
   D. Both CAPM and the low-risk anomaly point to a positive relationship between risk and reward.

2. Which of the following statements is not a characteristic of an appropriate benchmark? An appropriate benchmark should be:
   A. tradeable.
   B. replicable.
   C. well-defined.
   D. equally applied to all risky assets irrespective of their risk exposure.

3. Grinold's fundamental law of active management suggests that:
   A. investors should focus on increasing only their predictive ability relative to stock price movements.
   B. sector allocation is the most important factor in active management.
   C. a small number of investment bets decreases the chances of making a mistake and, therefore, increases the expected investment performance.
   D. to maximize the information ratio, active investors need to either have high-quality predictions or place a large number of investment bets in a given year.

4. Why would an investor include multiple factors in a regression study?
   I. To attempt to improve the adjusted R^2 measure.
   II. To reduce the *t*-stat value on the respective regression coefficients.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

5. Which of the following characteristics is a potential explanation for the risk anomaly?
   A. Investor preferences.
   B. The presence of highly leveraged retail investors.
   C. Lack of short selling constraints for institutional investors.
   D. Lack of tracking error constraints for institutional investors.

Concept Checker Answers

1. **C** The low-risk anomaly violates the CAPM and suggests that low beta stocks will outperform high-beta stocks. This has been empirically proven with several studies. The CAPM points to a positive relationship between risk and reward, but the low-risk anomaly suggests an inverse relationship.

2. **D** An appropriate benchmark should be well-defined, replicable, tradeable, and risk-adjusted. If the benchmark is not on the same risk scale as the assets under review, then there is an unfair comparison.

3. **D** Grinold's fundamental law of active management focuses on the tradeoff of high quality predictions relative to placing a large number of investment bets. Investors can focus on either action to maximize their information ratio, which is a measure of risk-adjusted performance. While sector allocation is a very important component of the asset allocation decision, Grinold focused only on the quality of predictions and the number of investment bets made.

4. **A** An investor should consider adding multiple factors to the regression analysis to potentially *improve* the adjusted R^2 measurement, potentially *increase* the tests of statistical significance, and to search for a benchmark that is more representative of a portfolio's investment style.

5. **A** Potential explanations for the risk anomaly include: the preferences of investors, leverage constraints on retail investors that drive them to buy pre-leveraged investments in the form of high-beta stocks, and institutional investor constraints like prohibitions against short selling and tracking error tolerance bands.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Illiquid Assets

Topic 65

Exam Focus

This topic examines illiquid asset market characteristics and the relationship between illiquidity and market imperfections. Reported return biases are discussed as well as the illiquidity risk premium within and across asset classes. For the exam, understand that all markets, even highly liquid markets such as commercial paper, can be illiquid at some points in time. Also, know the three biases that impact reported returns of illiquid asset classes (survivorship bias, sample selection bias, and infrequent sampling). Finally, understand the factors that influence the decision to include illiquid asset classes in a portfolio.

Illiquid Asset Markets

LO 65.1: Evaluate the characteristics of illiquid markets.

There are several characteristics that describe illiquid asset markets, including:

1. Most asset classes are illiquid, at least to some degree.
2. Markets for illiquid assets are large.
3. Illiquid assets comprise the bulk of most investors' portfolios.
4. Liquidity dries up even in liquid asset markets.

Most Asset Classes Are Illiquid

All markets, even large-cap equity markets, are somewhat illiquid. It is clear, however, that some assets (e.g., real estate) are less liquid than others (e.g., public equities). Illiquid assets trade infrequently, in small amounts, and generally exhibit low turnover. For example, there are mere seconds between transactions in public equity markets with an annualized turnover rate greater than 100%. In contrast, over-the-counter (OTC) equities typically trade within a day, but sometimes a week or more may pass between trades, with annualized turnover of 25% to 35%. Corporate bonds trade daily, and municipal bonds typically trade semiannually. At the far end of the liquidity spectrum is institutional infrastructure with an average investment commitment of 50 to 60 years (up to 99 years), and art, with 40 to 70 years between transactions. There is negligible turnover in infrastructure. Turnover in residential real estate is about 5% per year, while turnover in institutional real estate is approximately 7%. Time between real estate transactions can range from months to decades.

Markets for Illiquid Assets Are Large

The size of the U.S. residential mortgage market was $16 trillion in 2012. The institutional real estate market was measured at $9 trillion. In contrast, the market capitalization of the NYSE and Nasdaq combined was approximately $17 trillion. The total wealth held in illiquid assets exceeds the total wealth in traditional, liquid stock, and bond markets.

Investor Holdings of Illiquid Assets

The home is often an individual's most valuable asset. As a result, illiquid assets represent approximately 90% of total wealth, not counting human capital, the largest and least liquid asset for many individual investors. High net worth individuals in the United States even typically allocate 10% of portfolios to fine art and jewelry, known as treasure assets. High net worth individuals in foreign countries hold an average of 20% in treasure assets. Institutional investors have also increased allocations to illiquid assets over the last 20 years. University endowments have increased allocations of illiquid assets to approximately 25%, up from 5% in the early 1990s. Pension funds have increased allocations to approximately 20%, up from 5% in 1995. In general, investors hold sizeable amounts of illiquid assets.

Liquidity Can Dry Up

In stressed economic periods, such as during the 2007–2009 financial crisis, liquidity can dry up. For example, money markets froze (i.e., repurchase agreement and commercial paper markets) during the crisis as investors were unwilling to trade at any price. Residential and commercial mortgage-backed securities markets, structured credit markets, and the auction rate securities market, a market for floating rate municipal bonds, also became illiquid during the crisis. The auction rate securities market is still frozen, more than six years later. Major liquidity crises have occurred at least once every 10 years across the globe, in conjunction with downturns and financial distress.

Market Imperfections

LO 65.2: Examine the relationship between market imperfections and illiquidity.

Many economic theories assume that markets are perfect. This means that market participants are rational and pursue utility maximization, that there are no transactions costs, regulation or taxes, that assets are perfectly divisible, that there is perfect competition in markets, and that all market participants receive information simultaneously. The reality, though, is that markets are imperfect.

Imperfections that encourage illiquidity include:

- **Market participation costs.** There are costs associated with entering markets, including the time, money, and energy required to understand a new market. In many illiquid markets, only certain types of investors have the expertise, capital, and experience to participate. This is called a **clientele effect**. There will be less liquidity in markets that are suited to a limited number of investors and/or where there are barriers to entry in terms of required experience, capital, or expertise.

- **Transaction costs.** Transaction costs include taxes and commissions. For many illiquid assets, like private equity, there are additional costs, including costs associated with performing due diligence. Investors must pay attorneys, accountants, and investment bankers. These costs can impede investment.

When acknowledging the existence of transaction costs (i.e., acknowledging that markets are imperfect), some academic studies assume that as long as an investor can pay the transaction costs (and sometimes these costs are large), then any investor can transact (i.e., any asset can be liquid if one can pay the transaction cost). However, this is not always true. For example, there are:

- **Difficulties finding a counterparty (i.e., search frictions).** For example, it may be difficult to find someone to understand/purchase a complicated structured credit product. It may also be difficult to find buyers with sufficient capital to purchase an office tower or a skyscraper in a city like New York. No matter how high the transaction cost, it may take weeks, months, or years to transact in some situations.
- **Asymmetric information.** Some investors have more information than others. If an investor fears that the counterparty knows more than he does, he will be less willing to trade, which increasing illiquidity. When asymmetric information is extreme, people assume all products are lemons. Because no one wants to buy a lemon, markets break down. Often liquidity freezes are the result of asymmetric information. Because investors are looking for non-predatory counterparties who are not seeking to take advantage of asymmetric information, information itself can be a form of search friction.
- **Price impacts.** Large trades can move markets, which, in turn, can result in liquidity issues for the asset or asset class.
- **Funding constraints.** Many illiquid assets are financed largely with debt. For example, even at the individual level, housing purchases are highly leveraged. As a result, if access to credit is compromised, investors cannot transact.

Illiquid Asset Return Biases

LO 65.3: Assess the impact of biases on reported returns for illiquid assets.

LO 65.4: Describe the unsmoothing of returns and its properties.

In general, investors should be skeptical of reported returns in illiquid asset markets. The reason is that reported returns are generally overstated. There are reporting biases that result in inflated returns. Three main biases that impact returns of illiquid assets are:

- Survivorship bias.
- Selection bias.
- Infrequent trading.

Survivorship Bias

There are no requirements for certain types of funds (e.g., private equity, hedge funds, buyout funds, and so on) to report returns to database providers. As such, poorly performing funds have a tendency to stop reporting. Additionally, funds may never begin reporting because returns are not high enough to appeal to investors. This results in **reporting biases**. In addition, many poorly performing funds ultimately fail. Performance studies generally include only those funds that were successful enough to survive over the entire period of

analysis, leaving out the returns of funds that no longer exist. Both of these factors result in reported returns that are too high. This is called **survivorship bias**. Non-surviving funds have below average returns and surviving funds have above average returns, but it is the surviving fund returns that are reported. Studies show mutual fund returns are 1% to 2% lower than reported and returns may be as much as 4% lower for illiquid asset markets. While the solution to survivorship bias seems obvious (to observe the entire universe of funds), it is impossible to do in illiquid asset markets.

Sample Selection Bias

Asset values and returns tend to be reported when they are high. For example, houses and office buildings typically are sold when values are high. Often, a seller will wait until property values recover before selling. These higher selling prices are then used to calculate returns. This results in **sample selection bias**.

The problem with selection bias is especially prevalent in private equity markets. Buyout funds take companies public when stock prices are high. Venture capitalists sell companies when values are high. Distressed companies are often not liquidated and left as shell companies (these are sometimes called zombie companies). It is difficult to tell, based on old data without any recent transactions, if a company is alive or whether it is a zombie.

Impacts of sample selection bias include:

- Higher reported alphas relative to true alphas because only high prices are recorded. For example, one study estimates an alpha of more than 90% for venture capital log returns. However, alpha falls to –7% after correcting for sample selection bias. Another study estimates returns are decreased 2% to 5% per month if you correct for the bias.
- Lower reported betas than true betas because there are fewer (only high) prices recorded, flattening the security market line (SML). The effect is smaller for real estate returns because volatility is lower than in private equity and studies often include downturns such as what happened in real estate in the early 1990s and the early 2000s.
- Lower reported variance of returns than the true variance of returns because only high returns are counted (i.e., underestimated risk).

In sum, sample selection bias results in overestimated expected returns and underestimated risk as measured by beta and the standard deviation of returns (i.e., volatility).

Infrequent Trading

Illiquid assets, by definition, trade infrequently. **Infrequent trading** results in underestimated risk. Betas, return volatilities, and correlations are too low when they are computed using the reported returns of infrequently traded assets. Returns for these infrequently traded assets are smoothed. For example, if one compares quarterly returns to the daily returns of the same asset, quarterly returns will appear (and actually be) less volatile. Prices will often be higher or lower in a given investment horizon, than it appears when examining quarterly returns. The computed standard deviation of returns often will be lower when examining quarterly returns compared to daily returns. Also, correlations with other asset classes (e.g., liquid assets such as large-cap stocks) will be artificially low because return volatility is muted by infrequent trades.

It is possible to unsmooth or de-smooth returns using **filtering algorithms**. Filtering algorithms generally remove noise from signals. However, unsmoothing adds noise back to reported returns to uncover the true, noisier returns. Unsmoothing returns affects risk and return estimates, and could have a dramatic effect on returns. For example, reported real estate returns during the 1990s downturn were –5.3%. The corresponding unsmoothed returns were –22.6%. The National Council of Real Estate Investment Fiduciaries (NCREIF) returns reached –8.3% in December 2008. Unsmoothed returns during the same quarter were –36.3%. The standard deviation of the raw returns was 2.25% during the same quarter compared to 6.26% for unsmoothed returns. For comparison, stock return volatility was approximately 7.5% per quarter. Correlations between the S&P 500 Index and NCREIF returns increased from 9.2% to 15.8% when returns were unsmoothed.

Illiquidity Risk Premiums

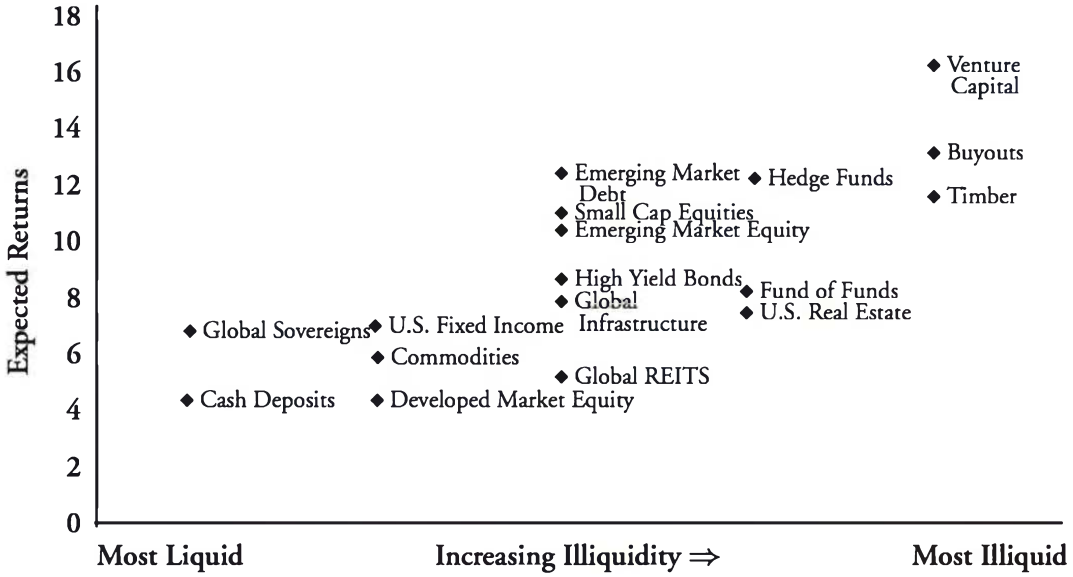
LO 65.5: Compare illiquidity risk premiums across and within asset categories.

Illiquidity Risk Premiums Across Asset Classes

As part of the analysis in Antti Ilmanen's 2011 book *Expected Returns*[1], we can relate liquidity to expected returns as shown in Figure 1. Note, however, that we cannot completely pigeonhole asset classes based on illiquidity (e.g., some private equity funds are more liquid than some hedge funds or infrastructure investments). Also note that, in this analysis, returns are computed over the period 1990 to 2009 and the illiquidity estimates are just estimates (i.e., they represent Ilmanen's opinions). Ilmanen's work does imply a positive relationship between the illiquidity of an asset class and its expected return. Venture capital is considered the least liquid and has the highest expected return, between 16% and 17%. Buyout funds and timber are also illiquid but command lower expected returns, approximately 13% and close to 12%, respectively. Hedge funds are more liquid and are expected to earn a little more than 12%. Real estate is on par with hedge funds in terms of liquidity but commands a lower return of nearly 8%. Equities are much more liquid and earned a bit more than 4% over the period. Cash is the most liquid and it too earned a little over 4% during the period.

1 Ilmanen, A. (2011). *Expected Returns: An Investor's Guide to Harvesting Market Rewards*. Chichester, West Sussex, U.K.: Wiley.

Figure 1: Liquidity vs. Expected Returns



It is the conventional view that there is a premium for illiquidity. However, this may not be true. First, there are illiquidity biases. As discussed previously, reported returns of illiquid assets are too high (i.e., overstated if using raw, unsmoothed data) and risk and correlation estimates are too low.

Second, illiquid asset classes such as private equity, buyout funds, and physical assets like timber contain significant risks beyond liquidity risk. After adjusting for these risks, illiquid asset classes are much less attractive. According to one study, after adjusting for risk, most investors are better off investing in the S&P 500 than in a portfolio of private equity.

Third, there is no "market index" for illiquid assets. Private equity, hedge fund, and real estate indices are not investable, so no investor is actually earning the index return. For example, the NCREIF includes thousands of properties. Because individuals do not typically own thousands of properties, they are much more subject to idiosyncratic risks and are less diversified within the asset class.

Fourth, you must rely on manager skill in illiquid asset classes. There is no way, as there is with tradeable, cheap bond and equity index funds, to separate factor risk (i.e., systematic risk) from the talents of fund managers. As noted, there is no way to earn index returns. If an investor cannot earn index returns in illiquid asset class markets, he has no way of separating passive returns from alpha generated by active managers.

These factors imply that it may not be possible to generate substantial illiquidity risk premiums across illiquid asset classes. However, there is evidence of large illiquidity risk premiums within asset classes.

Illiquidity Risk Premiums Within Asset Classes

Less liquid assets generally have higher returns than more liquid assets, within asset classes. Currently, there is no formal theory about why illiquidity risk premiums exist within asset

classes but not between. It might be that investors simply overpay for illiquid asset classes, chasing the illusion of higher returns. It may also be that firms do not manage portfolios as a cohesive whole, but instead put asset classes in different silos. Mispricing (i.e., the lack of a premium across classes) may be due to slow-moving capital across classes, limits to arbitrage, and institutional constraints (e.g., the fixed-income desk doesn't talk to the equity traders, and so on).

Illiquidity Effects in U.S. Treasury Markets

On-the-run (i.e., newly issued) Treasury bills (T-bills) are more liquid and have lower yields than off-the-run (seasoned) T-bills. The difference is called the on-the-run/off-the-run bond spread. During the 2007–2009 financial crisis, same maturity T-bonds and T-notes traded with different yields. While prices should have been the same, T-bond prices were more than 5% lower than T-note prices. Given that the U.S. Treasury market is one of the largest and most liquid in the world, it is surprising to observe large illiquidity effects.

Illiquidity Effects in Corporate Bond Markets

Larger bid-ask spreads and infrequent trading led to higher yields in corporate bond markets. Studies indicate that illiquidity risk explains 7% of the variation in investment grade bond yields and 22% of the variation in junk bond yields. Also, as bid-ask spreads increase, yield spreads increase by more than double the amount (e.g., a one-basis point increase in the bid-ask spread results in a more than two-basis point increase in the yield spread).

Illiquidity Effects in Equity Markets

There are several variables related to illiquidity that are shown to impact equity returns. Studies indicate that less liquid stocks earn higher returns than more liquid stocks. Illiquidity factors that impact equity returns are:

- Bid-ask spreads.
- Volume.
- Turnover.
- Volume measured by whether the trade was initiated by buyers or sellers.
- Ratio of absolute returns to dollar volume, called the "Amihud measure."
- Price impact of large trades.
- Informed trading measures (i.e., adverse selection).
- Quote size.
- Quote depth.
- Frequency of trades.
- Number of "zero" returns (in liquid markets returns are usually not zero).
- Return autocorrelations (which are a measure of stale prices).

All of these factors are characteristics of illiquidity that are unique to each stock. There are also illiquidity risk betas that are covariances of stock returns with illiquidity factors. Researchers estimate illiquidity risk premiums at 1% to 8% depending on the illiquidity measure used. Research also indicates that risk premiums have declined, although studies find a 1% risk premium for listed equities compared to a 20% risk premium for OTC stocks.

Secondary Markets for Private Equity and Hedge Funds

Private equity funds trade companies with each other, providing needed liquidity. In 2005, these secondary buyouts represented about 15% of all private-equity buyout deals. This does allow funds to get out of specific deals, may give limited partners (LPs) some cash in the process, and may allow LPs to better understand the values of portfolio companies. However, secondary buyouts do not allow limited partners to get out of the private equity fund itself.

LPs can exit private equity funds in secondary markets. However, these markets are immature, small, and more opaque. Firms participating in these markets on the buy side were called vultures in the 1990s. Buyers took advantage of distressed sellers, getting discounts of 30% to 50%. Discounts fell below 20% in the early 2000s, but shot up again during the 2007–2009 financial crisis.

Harvard University saw its endowment fall by more than $8 billion, or 22%, between July 1, 2008, and October 31, 2008. Harvard relies on the endowment for some of its operating funds. Endowment fund managers attempted to sell stakes in private equity to free up cash for operations and faced discounts of 50%.

Because hedge fund investors can typically redeem their investments at predetermined dates, discounts on secondary market transactions are much smaller than in private equity investments. During the recent financial crisis, hedge fund discounts were 6% to 8% on average. Some funds traded at a premium, even during the crisis, due to strong demand (i.e., the funds were closed to new investors). Large asset owners like sovereign funds and pension funds can supply liquidity in hedge fund and private equity markets, buying stakes at reduced prices and harvesting illiquidity risk premiums.

In sum, there are four ways that investors can harvest illiquidity premiums:

1. Allocating a portion of the portfolio to illiquid asset classes like real estate. This is **passive allocation to illiquid asset classes**.

2. Choosing more illiquid assets within an asset class. This means engaging in **liquidity security selection**.

3. Acting as a **market maker** for individual securities. For example, Dimensional Funds Advisors (DFA) is a liquidity provider that buys stock at a discount from those wanting to sell quickly and sells small-cap stocks at a premium to investors demanding shares. The firm avoids adverse selection problems by choosing counterparties who fully disclose information about stocks. The firm is trustworthy in its dealings and does not manipulate prices or engage in front running. Sovereign wealth funds, large pension funds, and other large asset owners can also act as market makers, providing liquidity while buying at discounts and selling at premiums.

4. Engaging in **dynamic factor strategies** at the aggregate portfolio level. This means taking long positions in illiquid assets and short positions in liquid assets to harvest the illiquidity risk premium. Investors rebalance to take advantage of the liquidity differences as less liquid assets become more liquid. Rebalancing the portfolio is the simplest way to provide liquidity. As long as buyers buy when others want to sell and sell when others want to buy, rebalancing is countercyclical. Of the four ways investors can harvest the illiquidity premium, this is the easiest to implement and can have the greatest effect on portfolio returns.

Portfolio Allocation to Illiquid Assets

LO 65.6: Evaluate portfolio choice decisions on the inclusion of illiquid assets.

In determining the portfolio allocation to illiquid asset classes, or any asset class for that matter, investors must consider their personal circumstances. The illiquid asset allocation decision is influenced by different investment horizons, the lack of tradeable indices, the need to hire talented active portfolio managers, and the need to monitor those managers. Portfolio choice models that include illiquid assets must consider two important aspects of illiquidity that impact investors:

1. Long time horizons between trades (i.e., infrequent trading).

2. Large transaction costs.

Asset Allocation to Illiquid Asset Classes with Transaction Costs

The primary issue with asset allocation models that include transaction costs is that they assume an asset will always trade if the counterparty pays the transaction cost. However, this is not true in private equity, infrastructure, real estate, and timber markets. It is not (or may not) be possible to find a buyer in a short period of time. Counterparties, if identified, must perform due diligence, which takes time. In some cases, the counterparty, upon completion of due diligence, chooses not to buy the asset. In periods of stress, even liquid asset classes face liquidity freezes and it becomes impossible to find buyers at any price.

Asset Allocation to Illiquid Asset Classes with Infrequent Trading

As anyone trying to sell in a period of illiquidity knows, one cannot "eat" illiquid assets. Consider the example of Harvard University, briefly described earlier. The only way the university could generate cash for operations in a period of significant losses and illiquidity across what some would consider some of the most liquid assets (i.e., commercial paper and repurchase agreements), Harvard would have had to sell at huge discounts. Only liquid assets can be consumed. As a result, illiquidity has a major effect on investors' portfolio choices. Illiquidity causes the following with respect to portfolio choice:

- **Reduces optimal holdings**. The less frequently a liquidity event is expected to occur, the lower the allocation to the illiquid asset class.
- Rebalancing illiquid assets (i.e., when there is infrequent trading in the asset class) causes allocations to **vary significantly**. The investor must wait until the liquidity event arrives. As such, the allocation prior to a liquidity event (or during nonrebalancing periods) can vary from too high to too low relative to the optimal allocation.

- Investors cannot hedge against declining values when an asset cannot be traded. As a result, **illiquid asset investors must consume less** than liquid asset investors to offset the risk.
- **There are no illiquidity "arbitrages."** To construct an arbitrage, an asset must be continuously traded. Illiquid assets are not continuously traded.
- Due to infrequent trading, illiquid asset investors must **demand an illiquidity risk premium.** The more frequently the asset is traded, the lower the premium. For example, one study indicates that private equity investments generate returns 6% higher than public markets to compensate investors for illiquidity.

The inclusion of illiquid assets in a portfolio is not as simple or desirable as it might seem. The following points should be considered:

1. Studies show that illiquid assets do not deliver higher risk-adjusted returns.

2. Investors are subject to agency problems because one must rely on the talents and skills of the manager. It is difficult to monitor external managers (e.g., private equity managers).

3. In many firms, illiquid assets are managed separately from the rest of the portfolio.

4. Illiquid asset investors face high idiosyncratic risks. There is no "market" portfolio of illiquid assets. Recall the example of the NCREIF versus the individual investor. It is not possible for most investors to hold thousands of properties, and small numbers of properties can lead to undiversified, property specific risks (but also returns, making illiquid assets compelling to investors). Illiquid assets are compelling because:
   - Illiquid asset markets are less efficient than stock and bond markets.
   - There are large information asymmetries in illiquid asset markets.
   - High transaction costs keep many investors out of the market.
   - Management skill is crucial and alpha opportunities are widely dispersed.

   All of these factors suggest there are great opportunities for the skilled investor to profit from investments in illiquid assets. Investors must have the skills and resources to find, evaluate, and monitor illiquid asset opportunities. Endowments like Harvard, Yale, and Stanford have the skills and resources. Unskilled investors, even those endowments at less sophisticated, skilled, and connected schools, can lose big in illiquid asset markets.

Key Concepts

LO 65.1

There are four main characteristics that describe illiquid asset markets, including:

1. Most asset classes are illiquid, at least to some degree.
2. Markets for illiquid assets are large.
3. Illiquid assets comprise the bulk of most investors' portfolios.
4. Liquidity dries up even in liquid asset markets.

LO 65.2

Market imperfections encourage illiquidity in asset markets. Specifically, market participation costs (i.e., clientele effects) and transaction costs give rise to illiquidity. Some academic models assume that all assets can be traded if one will pay the required (sometimes very high) transaction cost. However, this is not necessarily true in illiquid asset markets. There are search frictions (i.e., difficulties finding a counterparty and information asymmetries), price impacts, and funding constraints that may prevent trades from occurring, no matter how high the transaction cost.

LO 65.3

In general, investors should be skeptical of reported returns in illiquid asset markets as they are generally overstated. There are reporting biases that result in artificially inflated returns. The three main biases that impact reported illiquid asset returns are:

1. Survivorship bias: Poor performing funds often quit reporting results. Also, many poor performing funds ultimately fail. Finally, some poor performing funds never begin reporting returns because performance is weak. All of these factors lead to survivorship bias. Survivorship bias leads to an overstatement of stated returns relative to true returns.
2. Selection bias: Asset values and returns tend to be reported when they are high. For example, houses and office buildings typically are sold when values are high. These higher selling prices are used to calculate returns. This results in sample selection bias, which again leads to overstated returns.
3. Infrequent trading: Illiquid assets, by definition, trade infrequently. Infrequent trading results in underestimated risk. Betas, return volatilities, and correlations are too low when they are computed using the reported returns of infrequently traded assets.

LO 65.4

Unsmoothing adds noise back to reported returns to uncover the true, noisier returns. This process affects risk and return estimates and could have a dramatic effect on returns.

LO 65.5

There is little evidence that there are large illiquidity risk premiums across asset classes. However, there are large illiquidity risk premiums within asset classes.

There are four primary ways that investors can harvest illiquidity premiums:

1. Allocating a portion of the portfolio to illiquid asset classes like real estate. This is passive allocation to illiquid asset classes.

2. Choosing more illiquid assets within an asset class. This means engaging in liquidity security selection.

3. Acting as a market maker for individual securities.

4. Engaging in dynamic factor strategies at the aggregate portfolio level. This means taking long positions in illiquid assets and short positions in liquid assets to harvest the illiquidity risk premium. Of the four ways investors can harvest illiquidity premiums, this is the easiest to implement and can have the greatest effect on portfolio returns.

LO 65.6

There are several points to consider when deciding to allocate portfolio resources to illiquid assets:

1. Studies show that illiquid assets do not deliver higher risk-adjusted returns.

2. Investors are subject to agency problems because one must rely on the talents and skills of portfolio managers. It is difficult to monitor external managers.

3. In many firms, illiquid assets are managed separately from the rest of the portfolio.

4. Illiquid asset investors face high idiosyncratic risks. There is no "market" portfolio of illiquid assets. Illiquid assets are compelling because illiquid asset markets are less efficient than stock and bond markets, there are large information asymmetries in illiquid asset markets, high transaction costs keep many investors out of the market, management skill is crucial, and alpha opportunities are widely dispersed.

Concept Checkers

1. Global liquidity crises generally occur because:
   A. governments choose not to engage in monetary policy actions to stimulate economies.
   B. financial distress causes markets to freeze.
   C. markets for illiquid assets shrink, causing liquidity issues to infect traditional asset classes.
   D. transaction costs increase as developing economies get stronger.

2. When an investor has difficulty finding a counterparty for a complicated credit product like a structured debt instrument, this is known as:
   A. market participation costs.
   B. agency costs.
   C. search frictions.
   D. selection bias.

3. Blue Sky Funds, a private equity fund, has suffered low returns for the last five years. As a result, the find has decided to quit reporting returns. The fund did report returns each year for the last 10 years when performance was strong. This problem of reporting leads to:
   A. survivorship bias.
   B. sample selection bias.
   C. infrequent trading bias.
   D. attrition bias.

4. Which of the following variables is not an illiquidity factor that affects equity returns?
   A. Measures of adverse selection.
   B. The number of recorded positive returns.
   C. Turnover.
   D. Volume.

5. Rick Faircloth, a general partner and portfolio manager with Faircloth Funds, is considering ways in which his company can profit from illiquidity risk premiums. He has studied several alternative methods for harvesting illiquidity risk premiums. Which of the following strategies might Faircloth implement that will likely have the greatest effect on portfolio returns?
   A. Acting as a market maker for individual securities.
   B. Choosing the most illiquid assets within an asset class, even if the asset class is generally considered to be liquid.
   C. Allocating a portion of a portfolio to illiquid asset classes.
   D. Using dynamic factor strategies at the aggregate portfolio level.

Concept Checker Answers

1. **B** In stressed economic periods, such as during the 2007–2009 financial crisis, liquidity can dry up. Major liquidity crises have occurred at least once every ten years across the globe, in conjunction with downturns and financial distress.

2. **C** Difficulties finding a counterparty are called search frictions. For example, it may be difficult to find someone to understand/purchase a complicated structured credit product. It may also be difficult to find buyers with sufficient capital to purchase multimillion dollar office towers in major metropolitan areas. No matter how high the transaction costs, it may take weeks, months, or years to transact in some situations. Asymmetric information can also be a type of search friction as investors search for non-predatory counterparties with which to transact.

3. **A** There are no requirements for certain types of funds, like private equity funds, to report returns. As such, poorly performing funds have a tendency to stop reporting. Additionally, many poorly performing funds ultimately fail. Performance studies generally include only those funds that were successful enough to survive over the entire period of analysis, leaving out the returns of funds that no longer exist. Both of these factors result in reported returns that are too high. This is called survivorship bias.

4. **B** There are several variables related to illiquidity that are shown to impact equity returns. They are bid-ask spreads, volume, turnover, volume measured by whether the trade was initiated by buyers or sellers, the ratio of absolute returns to dollar volume, the price impact of large trades, informed trading measures (i.e., adverse selection), quote size and depth, the frequency of trades, the number of zero returns, and return autocorrelations. It is not the number of recorded positive returns, but the number of recorded zero returns, that are relevant.

5. **D** There are four primary ways that investors can harvest illiquidity premiums:

    1. Allocating a portion of the portfolio to illiquid asset classes like real estate (i.e., passive allocation to illiquid asset classes).

    2. Choosing more illiquid assets within an asset class (i.e., liquidity security selection).

    3. Acting as a market maker for individual securities.

    4. Engaging in dynamic factor strategies at the aggregate portfolio level. This means taking long positions in illiquid assets and short positions in liquid assets to harvest the illiquidity risk premium. Of the four ways investors can harvest illiquidity risk premiums, this is the easiest to implement and can have the greatest effect on portfolio returns.