KAPLAN SCHWESER

2021 FRM®

Exam Prep

SchweserNotes™

Risk Management and Investment Management; Current Issues in Financial Markets

PART II **BOOK 5**

Contents

LEARNING OBJECTIVES AND READING ASSIGNMENTS

Risk Management and Investment Management

80. Factor Theory

Andrew Ang, *Asset Management: A Systematic Approach to Factor Investing*(New York, NY: Oxford University Press, 2014). Chapter 6

After completing this reading, you should be able to:

a. provide examples of factors that impact asset prices and explain the theory of factor risk premiums. (page 1)
b. discuss the capital asset pricing model (CAPM) including its assumptions and explain how factor risk is addressed in the CAPM. (page 2)
c. explain the 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 3)
d. describe multifactor models and compare and contrast multifactor models to the CAPM. (page 7)
e. explain how stochastic discount factors are created and apply them in the valuation of assets. (page 8)
f. describe efficient market theory and explain how markets can be inefficient. (page 10)

81. Factors

Andrew Ang, *Asset Management: A Systematic Approach to Factor Investing* (New York, NY: Oxford University Press, 2014). Chapter 7

After completing this reading, you should be able to:

a. describe the process of value investing and explain why a value premium may exist. (page 17)
b. explain how different macroeconomic risk factors, including economic growth, inflation, and volatility, affect asset returns and risk premiums. (page 18)
c. assess methods of mitigating volatility risk in a portfolio and describe challenges that arise when managing volatility risk. (page 21)
d. explain how dynamic risk factors can be used in a multifactor model of asset returns, using the Fama-French model as an example. (page 23)
e. compare value and momentum investment strategies, including their return and risk profiles. (page 25)

82. Alpha (and the Low-Risk Anomaly)

Andrew Ang, *Asset Management: A Systematic Approach to Factor Investing* (New York, NY: Oxford University Press, 2014). Chapter 10

After completing this reading, you should be able to:

a. describe and evaluate the low-risk anomaly of asset returns. (page 33)
b. define and calculate alpha, tracking error, the information ratio, and the Sharpe ratio. (page 34)
c. explain the impact of benchmark choice on alpha and describe characteristics of an effective benchmark to measure alpha. (page 35)

d. describe Grinold's fundamental law of active management, including its assumptions and limitations, and calculate the information ratio using this law. (page 36)
e. 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 38)
f. explain how to use style analysis to handle time-varying factor exposures. (page 41)
g. describe issues that arise when measuring alphas for nonlinear strategies. (page 42)
h. compare the volatility anomaly and the beta anomaly and analyze evidence of each anomaly. (page 43)
i. describe potential explanations for the risk anomaly. (page 44)

83. Portfolio Construction

Richard Grinold and Ronald Kahn, *Active Portfolio Management: A Quantitative Approach for Producing Superior Returns and Controlling Risk, 2nd Edition* (New York, NY: McGraw-Hill, 2000). Chapter 14

After completing this reading, you should be able to:
a. distinguish among the inputs to the portfolio construction process. (page 49)
b. evaluate the motivation for and the methods used for refining alphas in the implementation process. (page 50)
c. describe neutralization and the different approaches used for refining alphas to be neutral. (page 51)
d. describe the implications of transaction costs on portfolio construction. (page 52)
e. describe practical issues in portfolio construction, including the determination of an appropriate risk aversion, aversions to specific risks, and proper alpha coverage. (page 53)
f. describe portfolio revisions and rebalancing, and analyze the tradeoffs between alpha, risk, transaction costs, and time horizon. (page 54)
g. determine the optimal no-trade region for rebalancing with transaction costs. (page 54)
h. evaluate the strengths and weaknesses of the following portfolio construction techniques: screens, stratification, linear programming, and quadratic programming. (page 55)
i. describe dispersion, explain its causes, and describe methods for controlling forms of dispersion. (page 57)

84. Portfolio Risk: Analytical Methods

Philippe Jorion, *Value-at-Risk: The New Benchmark for Managing Financial Risk, 3rd Edition* (New York, NY: McGraw-Hill, 2007). Chapter 7

After completing this reading, you should be able to:
a. define, calculate, and distinguish between the following portfolio VaR measures: diversified and undiversified portfolio VaR, individual VaR, incremental VaR, marginal VaR, and component VaR. (page 63)
b. explain the impact of correlation on portfolio risk. (page 63)
c. apply the concept of marginal VaR to guide decisions about portfolio VaR. (page 72)
d. explain the risk-minimizing position and the risk and return-optimizing position of a portfolio. (page 72)
e. explain the difference between risk management and portfolio management and describe how to use marginal VaR in portfolio management. (page 72)

85. VaR and Risk Budgeting in Investment Management

Philippe Jorion, *Value-at-Risk: The New Benchmark for Managing Financial Risk, 3rd Edition* (New York, NY: McGraw-Hill, 2007). Chapter 17

After completing this reading, you should be able to:

a. define risk budgeting. (page 79)
b. describe the impact of horizon, turnover, and leverage on the risk management process in the investment management industry. (page 80)
c. describe the investment process of large investors such as pension funds. (page 80)
d. describe the risk management challenges associated with investments in hedge funds. (page 81)
e. distinguish among the following types of risk: absolute risk, relative risk, policy-mix risk, active management risk, funding risk, and sponsor risk. (page 81)
f. explain the use of VaR to check manager compliance and monitor risk. (page 85)
g. explain how VaR can be used in the development of investment guidelines and for improving the investment process. (page 87)
h. describe the risk budgeting process and calculate risk budgets across asset classes and active managers. (page 88)

86. Risk Monitoring and Performance Measurement

Robert Litterman and the Quantitative Resources Group, *Modern Investment Management: An Equilibrium Approach* (Hoboken, NJ: John Wiley & Sons, 2003). Chapter 17

After completing this reading, you should be able to:

a. describe the three fundamental dimensions behind risk management, and their relation to VaR and tracking error. (page 95)
b. describe risk planning, including its objectives, effects, and the participants in its development. (page 96)
c. describe risk budgeting and the role of quantitative methods in risk budgeting. (page 97)
d. describe risk monitoring and its role in an internal control environment. (page 97)
e. identify sources of risk consciousness within an organization. (page 98)
f. describe the objectives and actions of a risk management unit in an investment management firm. (page 99)
g. describe how risk monitoring can confirm that investment activities are consistent with expectations. (page 100)
h. describe the Liquidity Duration Statistic and how it can be used to measure liquidity. (page 100)
i. describe the objectives of performance measurement tools. (page 101)
j. describe the use of alpha, benchmarks, and peer groups as inputs in performance measurement tools. (page 102)

87. Portfolio Performance Evaluation

Zvi Bodie, Alex Kane, and Alan J. Marcus, *Investments, 12th Edition* (New York, NY: McGraw-Hill, 2020). Chapter 24

After completing this reading, you should be able to:

a. differentiate between the time-weighted and dollar-weighted returns of a portfolio and describe their appropriate uses. (page 107)
b. describe risk-adjusted performance measures, such as Sharpe's measure, Treynor's measure, Jensen's measure (Jensen's alpha), and the information ratio, and identify the circumstances

under which the use of each measure is most relevant. (page 111)
c. describe the uses for the Modigliani-squared and Treynor's measure in comparing two portfolios and the graphical representation of these measures. (page 111)
d. determine the statistical significance of a performance measure using standard error and the t-statistic. (page 118)
e. describe style analysis. (page 121)
f. explain the difficulties in measuring the performance of actively managed portfolios. (page 119)
g. describe performance manipulation and the problems associated with using conventional performance measures. (page 119)
h. 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 120)
i. describe and apply performance attribution procedures, including the asset allocation decision, sector and security selection decision, and the aggregate contribution. (page 121)

88. Hedge Funds

George M. Constantinides, Milton Harris, and René M. Stulz, eds., *Handbook of the Economics of Finance, Volume 2B* (Oxford, UK: Elsevier, 2013). Chapter 17

After completing this reading, you should be able to:
a. describe the characteristics of hedge funds and the hedge fund industry and compare hedge funds with mutual funds. (page 129)
b. explain biases that are commonly found in databases of hedge funds. (page 130)
c. explain the evolution of the hedge fund industry and describe landmark events that precipitated major changes in the development of the industry. (page 130)
d. 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 131)
e. explain the relationship between risk and alpha in hedge funds. (page 131)
f. compare and contrast the different hedge fund strategies, describe their return characteristics, and describe the inherent risks of each strategy. (page 132)
g. describe the historical portfolio construction and performance trends of hedge funds compared to those of equity indices. (page 135)
h. describe market events that resulted in a convergence of risk factors for different hedge fund strategies and explain the impact of such convergences on portfolio diversification strategies. (page 136)
i. describe the problem of risk sharing asymmetry between principals and agents in the hedge fund industry. (page 137)

89. Performing Due Diligence on Specific Managers and Funds

Kevin R. Mirabile, *Hedge Fund Investing: A Practical Approach to Understanding Investor Motivation, Manager Profits, and Fund Performance, 2nd Edition* (Hoboken, NJ: Wiley Finance, 2016). Chapter 12

After completing this reading, you should be able to:
a. identify reasons for the failures of hedge funds in the past. (page 141)
b. explain elements of the due diligence process used to assess investment managers. (page 142)
c. identify themes and questions investors can consider when evaluating a hedge fund manager. (page 143)
d. describe criteria that can be evaluated in assessing a hedge fund's risk management process.

(page 145)
e. explain how due diligence can be performed on a hedge fund's operational environment. (page 147)
f. explain how a hedge fund's business model risk and its fraud risk can be assessed. (page 149)
g. describe elements that can be included as part of a due diligence questionnaire. (page 151)

90. Finding Bernie Madoff: Detecting Fraud by Investment Managers

Stephen G. Dimmock and William C. Gerken: *Finding Bernie Madoff: Detecting Fraud by Investment Managers* (2011).

After completing this reading, you should be able to:
a. explain the use and efficacy of information disclosures made by investment advisors in predicting fraud. (page 157)
b. describe the barriers and the costs incurred in implementing fraud prediction methods. (page 159)
c. discuss ways to improve investors' ability to use disclosed data to predict fraud. (page 160)

Current Issues in Financial Markets

91. Rates

Andreas Schrimpf and Vladyslav Sushko, "Beyond LIBOR: A Primer on the New Benchmark Rates," *BIS Quarterly Review*, March 5, 2019.

After completing this reading, you should be able to:
a. describe the features comprising an ideal benchmark. (page 165)
b. examine the issues that led to the replacement of LIBOR as the reference rate. (page 166)
c. examine the risks inherent in basing risk-free rates (RFR's) on transactions in the repo market. (page 169)

92. Machine Learning: A Revolution in Risk Management and Compliance?

Bart van Liebergen, "Machine Learning: A Revolution in Risk Management and Compliance?" Institute of International Finance, April 2017.

After completing this reading, you should be able to:
a. describe the process of machine learning and compare machine learning approaches. (page 173)
b. describe the application of machine learning approaches within the financial services sector and the types of problems to which they can be applied. (page 175)
c. analyze the application of machine learning in three use cases:
- credit risk and revenue modeling.
- fraud.
- surveillance of conduct and market abuse in trading. (page 176)

93. Artificial Intelligence and Machine Learning in Financial Services

"Artificial Intelligence and Machine Learning in Financial Services," Financial Stability Board, Nov. 1, 2017.

After completing this reading, you should be able to:
a. describe the drivers that have contributed to the growing use of FinTech and the supply and demand factors that have spurred adoption of AI and machine learning in financial services. (page 183)

b. describe the use of AI and machine learning in the following cases:
- customer-focused uses.
- operations-focused uses.
- trading and portfolio management in financial markets.
- uses for regulatory compliance. (page 184)

c. describe the possible effects and potential benefits and risks of AI and machine learning on financial markets and how they may affect financial stability. (page 186)

94. Climate Change: Physical Risk and Equity Prices

Chapter 5: Climate Change: Physical Risk and Equity Prices, Global Financial Stability Report, International Monetary Fund (IMF), April 2020.

After completing this reading, you should be able to:

a. from the perspective of physical risk, describe the channels through which climate change can affect financial stability. (page 191)

b. explain how climate change and climate risk have affected equity prices and equity valuations. (page 192)

c. discuss how country characteristics such as insurance penetration and economic development impact the extent to which climatic disasters affect equity prices. (page 194)

95. The Green Swan – Central Banking and Financial Stability in the Age of Climate Change

Patrick Bolton, Morgan Despres, Luiz Awazu, Pereira Da Silva, Frédéric Samama, and Romain Svartzman, "The Green Swan – Central Banking and Financial Stability in the Age of Climate Change", Bank for International Settlements (BIS), January 2020. (Chapter 1–Chapter 3 only)

After completing this reading, you should be able to:

a. describe the concept of "green swan", how it differs from "black swan" and why climate change is considered a "green swan" event. (page 199)

b. explain why climate change is a threat to price stability. (page 200)

c. explain why climate change is a threat to financial stability by describing the ways physical and transition risks can materialize. (page 201)

d. discuss the measures that should be considered by members of the financial safety net under the risk, time horizon and system resilience approaches as well as the limitations of these measures. (page 203)

96. When Selling Becomes Viral: Disruptions in Debt Markets in the COVID-19 Crisis and the Fed's Response

Valentin Haddad, Alan Moreira, and Tyler Mui, "When Selling Becomes Viral: Disruptions in Debt Markets in the COVID-19 Crisis and the Fed's Response."

After completing this reading, you should be able to:

a. describe the evolution of bond and CDS prices during March-April 2020. (page 207)

b. compare the developments in debt markets during the Great Financial Crisis of 2008-2009 and during the COVID-19 crisis. (page 209)

c. explain the effects of frictions and arbitrage limitations on price movements in debt markets during March-April 2020. (page 209)

d. explain the Fed's interventions in debt markets during March-April 2020 as well as the rationale for and effects of these interventions. (page 212)

97. Global Financial Stability Overview: Markets in the Time of COVID-19

Chapter 1: Global Financial Stability Overview: Markets in the Time of COVID-19, Global Financial Stability Report, International Monetary Fund (IMF), April 2020.

After completing this reading, you should be able to:

a. describe the developments in financial and commodity markets during March-April 2020. (page 219)

b. discuss the global financial vulnerabilities intensified by the slowdown in economic activity and tightened financial conditions following the COVID-19 outbreak. (page 223)

c. explain the various monetary and financial policy responses to COVID-19 as well as the future steps that should be taken. (page 226)

98. Financial Crime in Times of COVID-19 – AML and Cyber Resilience Measures

"Financial Crime in Times of COVID-19 – AML and Cyber Resilience Measures," Financial Stability Institute, May 2020.

After completing this reading, you should be able to:

a. explain the increase of cyber threats faced by financial institutions because of the Covid-19 crisis. (page 235)

b. explain the cyber resilience measures taken by international and national financial authorities in response to the increased cyber threats since the outbreak of Covid-19. (page 236)

c. explain the anti-money laundering (AML) and anti-terrorism financing (ATF) measures taken by international and national financial authorities in response to the increased ML and TF risks since the outbreak of Covid-19. (page 238)

99. Replacing LIBOR

Stephen Cecchetti and Kim Schoenholtz, "Replacing LIBOR," September 2019.

After completing this reading, you should be able to:

a. explain the key issues that could cause systemic disruption when LIBOR ends. (page 243)

b. explain the current state of the transition and the challenges that lie ahead. (page 244)

c. describe the government institutions' role in the transition. (page 245)

100. Cyber Risk and the U.S. Financial System: A Pre-Mortem Analysis

"Cyber Risk and the U.S. Financial System: A Pre-Mortem Analysis," Federal Reserve Bank of New York Staff Reports, June 2020.

After completing this reading, you should be able to:

a. explain the direct costs of and the spillovers caused by a cyber-attack. (page 249)

b. explain how cyber shocks can get amplified through financial networks. (page 250)

c. discuss the policy responses that can be implemented against cyber events. (page 251)

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Ang, Chapter 6.

READING 80: FACTOR THEORY

Ang, Chapter 6

EXAM FOCUS

In this reading, 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.

MODULE 80.1: FACTORS THAT IMPACT ASSET PRICES AND THE CAPM

LO 80.a: 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.

LO 80.b: Discuss 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 80.c: Explain the 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.

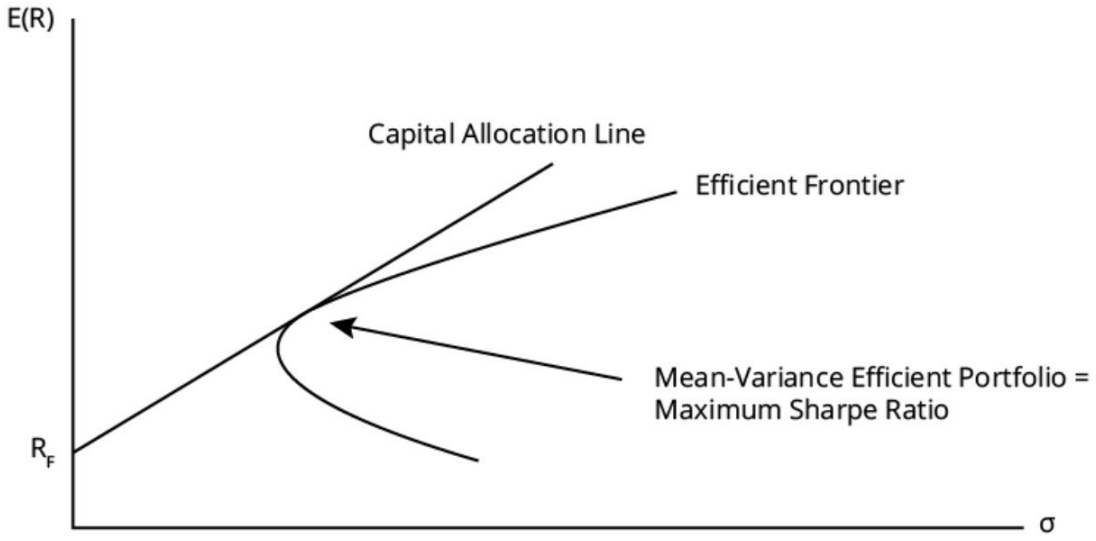
Lesson 1: Hold the factor, not the individual asset.

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 80.1: 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:

$$\mathrm{E}\left(\mathrm{R}_{\mathrm{M}}\right)-\mathrm{R}_{\mathrm{F}}=\bar{\gamma}\times\sigma_{\mathrm{M}}^{2}$$

where $E(R_M) - R_F$ is the market risk premium, γ is the average investor's risk aversion, and σ^2_M 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:

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

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: [$\beta_i = cov(R_i, R_M) / var(R_M)$]. 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.

MODULE QUIZ 80.1

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.

MODULE 80.2: MULTIFACTOR MODELS, PRICING KERNELS, AND EFFICIENT MARKET THEORY

Multifactor Models

LO 80.d: 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 80.e: 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:

$$m = a + b_1f_1 + b_2f_2 + \ldots + b_kf_k$$

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:

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

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

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

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:

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

Efficient Market Theory

LO 80.f: 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.

MODULE QUIZ 80.2

1. Market efficiency can be described with the efficient market hypothesis (EMH). Regarding the definition of EMH and the rational and behavioral explanations for this approach, the EMH suggests that:
   A. speculative trading is costless.
   B. active managers cannot generally beat the market.
   C. under the behavioral explanation, losses during bad times are compensated for by high returns.
   D. under the rational explanation, it is agents' under- or overreactions to news that generates high returns.

KEY CONCEPTS

LO 80.a

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 80.b

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 80.c

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 80.d

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 80.e

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 80.f

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.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 80.1

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). (LO 80.a)

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. (LO 80.c)

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. (LO 80.c)

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. (LO 80.c)

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.

   (LO 80.c)

Module Quiz 80.2

1. **B** The EMH implies that speculative trading is costly, and active managers cannot generally beat the market. 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. (LO 80.f)

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

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Ang, Chapter 7.

READING 81: FACTORS

Ang, Chapter 7

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.

MODULE 81.1: VALUE INVESTING AND MACROECONOMIC FACTORS

Value Investing

LO 81.a: Describe the process of value investing and explain 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 81.e.

Macroeconomic Factors

LO 81.b: Explain how different macroeconomic risk factors, including economic growth, inflation, and volatility, affect asset returns and risk premiums.

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 81.1 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 81.1 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 81.1: Investment Returns During Expansions and Recessions

	Large Stocks	Small Stocks	Government Bonds	Corporate 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 81.1 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.

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.

MODULE QUIZ 81.1

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.

MODULE 81.2: MANAGING VOLATILITY RISK AND DYNAMIC RISK FACTORS

Managing Volatility Risk

LO 81.c: 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 81.d: 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]

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.

MODULE QUIZ 81.2

1. 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.
2. 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.

MODULE 81.3: VALUE AND MOMENTUM INVESTMENT STRATEGIES

LO 81.e: Compare value and momentum investment strategies, including their return and risk 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. 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 previously 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.

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.

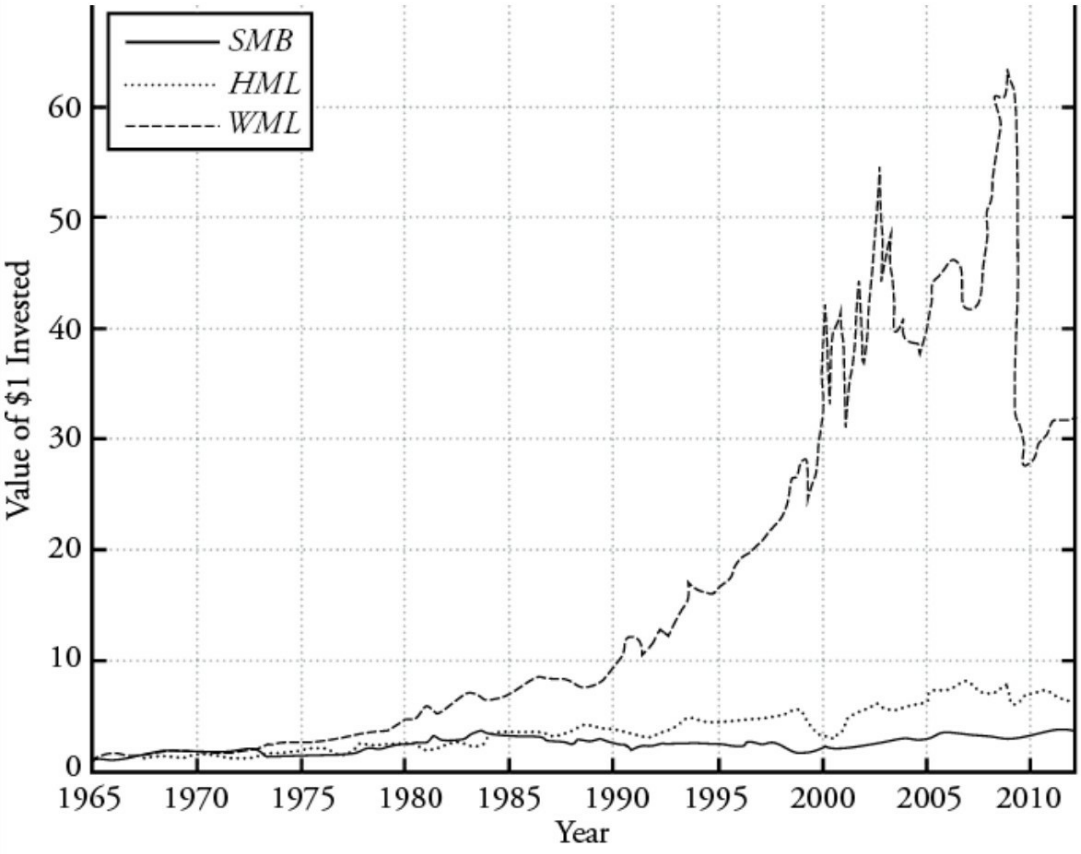
Retail investors can implement value strategies via low-cost index products. Large, institutional investors can, at least theoretically, cheaply implement value strategies across markets.

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 81.2 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 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 81.2: 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.

MODULE QUIZ 81.3

1. 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.

KEY CONCEPTS

LO 81.a

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 81.b

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 81.c

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 81.d

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 81.e

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.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 81.1

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. (LO 81.a)

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. (LO 81.b)

Module Quiz 81.2

1. **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. (LO 81.c)

2. **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. (LO 81.d)

Module Quiz 81.3

1. **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. (LO 81.e)

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[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.

[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.

[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).

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

[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.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Ang, Chapter 10.

READING 82: ALPHA (AND THE LOW-RISK ANOMALY)

Ang, Chapter 10

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.

MODULE 82.1: LOW-RISK ANOMALY, ALPHA, AND THE FUNDAMENTAL LAW

Low-Risk Anomaly

LO 82.a: 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 82.b: 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 (Reading 87).

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.

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

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.

$$\text{Sharpe ratio} = \frac{\overline{R_t} - \overline{R_F}}{\sigma}$$

Benchmark Selection for Alpha

LO 82.c: 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 $\left(R_t^{SP500} - R_F\right)$. 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.

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

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).

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

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 previous example, 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 82.d: 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:

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

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.

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.

MODULE QUIZ 82.1

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.

MODULE 82.2: FACTOR REGRESSION AND PORTFOLIO SENSITIVITY

LO 82.e: 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 82.1. 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 82.1: 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)

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 period of January 1990–May 2012 yields the results displayed in Figure 82.2.

Figure 82.2: 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 82.2 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:

$R_B = 0.33(\text{T-bills}) + 0.67 \times (\text{market portfolio}) - 0.5(\text{small caps}) + 0.5(\text{large caps}) + 0.38(\text{value stocks}) - 0.38(\text{growth stocks})$

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 82.3 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 82.3: 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.

MODULE QUIZ 82.2

1. 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.

MODULE 82.3: TIME-VARYING FACTORS, VOLATILITY AND BETA ANOMALIES, AND ANOMALY EXPLANATIONS

Measurement of Time-Varying Factors

LO 82.f: Explain how to use style analysis to handle time-varying factor exposures.

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 82.4 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 82.4: 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 82.g: 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 82.h: Compare the volatility anomaly and the 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.

LO 82.i: 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.

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.

MODULE QUIZ 82.3

1. 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.

KEY CONCEPTS

LO 82.a

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 82.b

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.

$$\text{Sharpe ratio} = \frac{\overline{\text{R}}_\text{t} - \overline{\text{R}}_\text{F}}{\sigma}$$

LO 82.c

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 82.d

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 82.e

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 82.f

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 82.g

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 82.h

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 82.i

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.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 82.1

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. (LO 82.a)

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. (LO 82.c)

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. (LO 82.d)

Module Quiz 82.2

1. **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. (LO 82.e)

Module Quiz 82.3

1. **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. (LO 82.i)

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

[2] Berkshire Hathaway Annual Letter to Shareholders, 2010.

[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.

[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.

[8] Harrison Hong and David Sraer, “Speculative Betas,” NBER Working Paper 18548, November 2012.

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Grinold and Kahn, Chapter 14.

READING 83: PORTFOLIO CONSTRUCTION

Grinold and Kahn, Chapter 14

EXAM FOCUS

This reading addresses techniques for optimal portfolio construction. We will discuss important inputs into the portfolio construction process as well as ways to refine the alpha inputs as an alternative to imposing constraints directly into the portfolio optimization calculations. The role of transaction costs in determining optimal rebalancing is also explained. For the exam, pay attention to the discussions of refining alphas and the implications of transaction costs for both rebalancing and dispersion of returns across separately managed portfolios. Also, be prepared to compare and contrast the various methods of portfolio construction: screening, stratification, linear programming, and quadratic programming.

MODULE 83.1: THE PORTFOLIO CONSTRUCTION PROCESS AND TRANSACTION COSTS

The Portfolio Construction Process

LO 83.a: Distinguish among the inputs to the portfolio construction process.

The process of constructing an optimal investment portfolio requires several inputs:

- *Current portfolio*: The assets and their weights in the current portfolio. Relative to the other inputs, the current portfolio input can be measured with the most certainty.
- *Alphas*: The expected excess returns of portfolio stocks (relative to their expected returns). This input is subject to forecast error and bias.
- *Covariances*: Estimates of covariances are subject to estimation error.
- *Transaction costs*: Transaction costs are estimated and increase as more frequent portfolio changes are made.
- *Active risk aversion*: Refers to the strength of the preference for lower volatility of the difference between actively managed portfolio returns and benchmark portfolio returns.

LO 83.b: Evaluate the motivation for and the methods used for refining alphas in the implementation process.

A portfolio can be optimized, based on the inputs, using mean-variance analysis. In most cases there are significant constraints imposed on the asset weights, either by client or manager requirements. A client (or regulations) may prohibit short sales. A manager may impose an upper limit on active risk or on maximum deviations from benchmark weights. As more constraints are introduced, simple

mean-variance analysis, maximizing active return minus a penalty for active risk, can become quite complex.

An alternative approach is to adjust the manager's estimated alphas (an input into a mean-variance optimization analysis) in ways that effectively impose the various constraints. Consider an account for which short selling is prohibited. Rather than performing an optimization that constrains asset weights to be non-negative, we can use the optimization equations (in reverse) to solve for the set of alphas that would produce non-negative weights in an unconstrained mean-variance optimization. The optimal weights are moved toward benchmark weights. This method allows us to focus on the effects of a specific constraint on alphas, the key input for active portfolio construction.

Before we examine refining alphas to satisfy other constraints, such as a constraint on the beta of the active portfolio, we consider two techniques that are often employed after refining alphas for various client or manager imposed constraints: **scaling** and **trimming**.

An often used equation for **alpha** is:

alpha = (volatility) × (information coefficient) × (score)

Where *volatility* refers to residual risk, the *information coefficient* (IC) measures the linear relationship between the manager's forecasted asset alphas and actual asset returns, and *score* is expected to be approximately normally distributed with a mean of 0 and a standard deviation of 1. Considering that volatility (residual risk) and information coefficient (IC) are relatively constant, we can see that the standard deviation (scale) of portfolio alphas is proportional to the standard deviation of the score variable. Alphas will have a mean of zero and a scale approximately equal to volatility × information coefficient when score follows a standard normal distribution. With an information coefficient of 0.10 and residual risk of 30%, the scale of the alphas will be 0.10 × 30% = 3%; the alphas will have a mean of zero and a standard deviation of 3%.

If we compare the scale (standard deviation) of the refined alphas from our earlier discussion of a prohibition on short sales to the scale of the original unconstrained alphas, we can calculate the decrease in the information coefficient that results from the decrease in the scale of the alphas due to the imposition of the constraint. If the adjusted alphas do not have the appropriate scale, they can be rescaled.

Another refinement to manager alphas is to reduce large positive or negative alpha values, a process called trimming. The threshold for "large" values might be three times the scale of the alphas. For large alpha values, the reasons supporting these values are re-examined. Any alphas found to be the result of questionable data are set to zero. Additionally, the remaining large alphas may be reduced to some maximum value, typically some multiple of the scale of the alphas.

LO 83.c: Describe neutralization and the different approaches used for refining alphas to be neutral.

Neutralization is the process of removing biases and undesirable bets from alpha. There are several types of neutralization: benchmark, cash, and risk-factor. In all cases, the type of neutralization and the strategy for the process should be specified before the process begins.

Benchmark neutralization eliminates any difference between the benchmark beta and the beta of the active portfolio. In this case, we say the portfolio alpha of the active portfolio is zero. Consider an

active portfolio that has a beta of 1.1 when the benchmark portfolio has a beta of 1. This represents an active bet on market (and benchmark portfolio) returns. When market returns are high, the active portfolio will outperform the benchmark portfolio; when returns are low (less than the risk-free rate) the active portfolio will underperform the benchmark portfolio. The alphas can be adjusted so that the active portfolio beta is the same as the benchmark portfolio beta, unless the manager intends to make an active bet by increasing or decreasing the active portfolio beta relative to that of the benchmark. Matching the beta of the active portfolio to the beta of the benchmark portfolio is referred to as **benchmark neutralization**. Note that this neutralization is equivalent to adding a constraint on portfolio beta in a mean-variance optimization.

Computing modified benchmark-neutral alpha involves subtracting (benchmark alpha × active position beta) from the alpha of the active position. For example, assume benchmark alpha is equal to 0.013%. If an active position has an alpha of 0.5% and a beta of 1.2, the modified benchmark-neutral alpha will equal: 0.5% − (0.013% × 1.2) = 0.48%.

In the explanation, we used a single risk factor, market risk. There may be other risk factors, such as those from a multi-factor returns generating model, that lead to unintended risk exposures relative to the benchmark. For example, consider the risk factor small cap returns minus large cap returns. The alpha inputs may produce an active portfolio with a greater sensitivity to this risk factor if the portfolio's weight on small-cap firms is larger than that of the benchmark portfolio. Again, if this is unintended, alphas can be adjusted so that the beta of the active portfolio with respect to this risk factor matches that of the benchmark portfolio.

The active portfolio may also be neutralized with respect to industry risk factors, by matching the portfolio weights of each industry to those of the benchmark portfolio. In this case, subtracting the average alpha for an industry from the alphas of each firm within that industry will result in an active portfolio that is neutral relative to the benchmark with respect to industry risk factors. In each of our examples, neutralization reduces active risk by matching the factor risks of the active portfolio to those of the benchmark portfolio.

An active portfolio can also be made **cash neutral**, by adjusting the alphas so that the portfolio has no active cash position. It's possible to make the alpha values both cash- and benchmark-neutral.

Transaction Costs

LO 83.d: Describe the implications of transaction costs on portfolio construction.

Transaction costs are the costs changing portfolio allocations, primarily trading commissions and spreads. Transaction costs reduce active portfolio returns relative to those of the benchmark portfolio and are uncertain, although typically less so than alphas. Because of this, transaction costs are an important input into the portfolio optimization process. Including transaction costs in portfolio optimization increases the importance of both precision in estimating alphas and of the choice of scale.

Transaction costs occur at points in time, while the benefits (i.e., additional return) are realized over time. Consider two stocks, one of which will return 2% over 6 months, at which time it can be replaced by another stock that returns 2% over 6 months, and another stock which will return 4% over 1 year. Also, assume transaction costs are 1%. The annual returns on the first stock will be approximately (2% − 1%) × 2 = 2% and the annual returns on the second stock will be

approximately 4% − 1% = 3%. With uncertain holding periods across portfolio holdings, the question arises over what period transaction costs should be amortized. Precision in scale is important in addressing the tradeoff between alphas and transaction costs. Annual transaction costs will be the cost of a round-trip trade divided by the holding period in years.

MODULE QUIZ 83.1

1. The most measurable of the inputs into the portfolio construction process is(are):
   A. the position alphas.
   B. the transaction costs.
   C. the current portfolio.
   D. the active risk aversion.
2. Which of the following is correct with respect to adjusting the optimal portfolio for portfolio constraints?
   A. No reliable method exists.
   B. By refining the alphas and then optimizing, it is possible to include constraints of both the investor and the manager.
   C. By refining the alphas and then optimizing, it is possible to include constraints of the investor, but not the manager.
   D. By optimizing and then refining the alphas, it is possible to include constraints of both the investor and the manager.
3. Which of the following statements most correctly describes a consideration that complicates the incorporation of transaction costs into the portfolio construction process?
   A. The transaction costs and the benefits always occur in two distinct time periods.
   B. The transaction costs are uncertain while the benefits are relatively certain.
   C. There are no complicating factors from the introduction of transaction costs.
   D. The transaction costs must be amortized over the horizon of the benefit from the trade.

MODULE 83.2: PRACTICAL ISSUES IN PORTFOLIO CONSTRUCTION

LO 83.e: Describe practical issues in portfolio construction, including the determination of an appropriate risk aversion, aversions to specific risks, and proper alpha coverage.

We need a measure of **active risk aversion** as an input to determine the optimal portfolio. As a practical matter, a portfolio manager does not likely have an intuitive idea of optimal active risk aversion in mind, but will have good intuition about his information ratio (the ratio of alpha to standard deviation) and the amount of active risk (as opposed to active risk aversion) he is willing to accept in pursuit of active returns. An equation that translates those values into a measure of active risk aversion is:

$$\text{risk aversion} = \frac{\text{information ratio}}{2 \times \text{active risk}}$$

For example, if the information ratio is 0.8 and the desired level of active risk is 10%, then the implied level of risk aversion is:

$$\frac{0.80}{2 \times 10} = 0.04$$

The utility function for the optimization is: utility = active return − (0.04 × variance). Of course, the accuracy of the estimate of active risk aversion is dependent on the accuracy of the inputs, the information ratio, and the preferred level of active risk.

PROFESSOR'S NOTE

Remember that active risk is just another name for tracking error. Also note that in the risk aversion equation, the desired level of active risk is measured in percentage points rather than in decimal form.

In addition to active risk aversion, **aversion to specific factor risk** is important for two reasons. First, it can help the manager address the risks associated with having a position with the potential for large losses. For example, the risk from a portfolio with sector risks that do not match those of the benchmark portfolio. Second, appropriately high risk aversion values for specific factor risks will reduce dispersion (of holdings and performance) across portfolios when the manager manages more than one portfolio. Setting high risk aversion values for factor specific risks will increase the similarity of client portfolios so that they will tend to hold the same assets. Considering these two effects of specific factor risk aversion values will help a manager determine appropriate values to include in portfolio optimization.

Proper **alpha coverage** refers to addressing situations where the manager has forecasts of stocks that are not in the benchmark or where the manager does not have alpha forecasts for stocks in the benchmark. When the manager has information on stocks not in the benchmark, a benchmark weight of zero should be assigned for benchmarking, but active weights can be assigned to these stocks to generate active alpha.

When there is not an alpha forecast for stocks in the benchmark, adjusted alphas can be inferred from the alphas of stocks for which there are forecasts. One approach is to first compute the following two measures:

value-weighted fraction of stocks with forecasts = sum of active holdings with forecasts

$$\text{average alpha for the stocks with forecasts} = \frac{(\text{weighted average of the alphas with forecasts})}{(\text{value-weighted fraction of stocks with forecasts})}$$

The second step is to subtract this measure from each alpha for which there is a forecast and set alpha to zero for assets that do not have forecasts. This provides a set of benchmark-neutral forecasts where assets without forecasts have alphas of zero.

Portfolio Revisions and Rebalancing

LO 83.f: Describe portfolio revisions and rebalancing, and analyze the tradeoffs between alpha, risk, transaction costs, and time horizon.

LO 83.g: Determine the optimal no-trade region for rebalancing with transaction costs.

If transaction costs are zero, a manager should revise a portfolio every time new information arrives. However, as a practical matter, a manager should make trading decisions based on expected active return, active risk, and transaction costs. The manager may wish to be conservative because these measures are uncertain. Underestimating transaction costs, for example, will lead to trading

too frequently. In addition, the frequent trading and short time horizons would cause alpha estimates to exhibit a great deal of uncertainty. Therefore, the manager must choose an optimal time horizon where the certainty of the alpha is sufficient to justify a trade given the transaction costs.

The rebalancing decision depends on the tradeoff between transaction costs and the value added from changing the position. Portfolio managers must be aware of the existence of a *no-trade region* where the benefits of rebalancing are less than the costs. The benefit of adjusting the number of shares of a given portfolio asset is given by the following expression:

> marginal contribution to value added = (alpha of asset) − [2 × (risk aversion) × (active risk) × (marginal contribution to active risk of asset)]

If this value is between the negative cost of selling and the cost of purchase, the manager would not trade that particular asset. In other words, the no-trade region is as follows:

> −(cost of selling) < (marginal contribution to value added) < (cost of purchase)

Rearranging this relationship with respect to alpha gives a no-trade region for alpha:

> [2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] − (cost of selling) < alpha of asset < [2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] + (cost of purchase)

The size of the no-trade region is determined by transaction costs, risk aversion, alpha, and the riskiness of the assets.

Portfolio Construction Techniques

LO 83.h: Evaluate the strengths and weaknesses of the following portfolio construction techniques: screens, stratification, linear programming, and quadratic programming.

The following four procedures comprise most of the institutional portfolio construction techniques: screens, stratification, linear programming, and quadratic programming. In each case the goal is the same: high alpha, low active risk, and low transaction costs.

An active manager's value depends on her ability to increase returns relative to the benchmark portfolio that are greater than the penalty for active risk and the additional transaction costs of active management.

> (portfolio alpha) − (risk aversion) × (active risk)^2 − (transaction costs)

Screens

Screens are just what you would expect; they allow some stocks "through" but not the rest. A screen can be designed in many ways, but two examples will illustrate how a screen might be used with alpha values to select portfolio stocks (given a universe of 200 stocks). Consider a screen that selects the 60 benchmark stocks with the greatest alphas. We could then construct a portfolio of these high-alpha stocks, either equal- or value-weighted.

Another screening method is based on assigning buy, hold, or sell ratings to all the stocks in the manager's universe of investable stocks. For example, we could assign a buy rating to the 60 stocks with the greatest alphas, a hold rating to the 40 remaining stocks with the next highest alphas, and a

sell rating to the remaining stocks under consideration. One way to rebalance the current portfolio would be to purchase any stocks on the buy list not currently in the portfolio and to sell any portfolio stocks on the sell list. Portfolio turnover can be adjusted by adjusting the sizes of the categories.

Stratification

Stratification refers to dividing stocks into multiple mutually exclusive categories prior to screening the stocks for inclusion in the portfolio. For example, we could divide the portfolio into large-cap, medium-cap, and small-cap stocks and further divide these categories into six different industry categories; giving us 18 different size-sector categories. By using percentage weights of these size-sector categories in the benchmark portfolio we can match the benchmark portfolio's size and sector coverage.

Stratification is a method of risk control. If the size and sector categories are chosen in such a way that they capture the risk dimensions of the benchmark well, portfolio risk control will be significant. If they are not, risk control will not be achieved.

Stratification will reduce the effects of bias in estimated alphas across the categories of firm size and sector. However, it takes away the possibility of adding value by deviating from benchmark size-sector weights. Using stratification, any value from information about actual alphas (beyond their category) and about possible sector alphas is lost.

Linear Programming

Linear programming is an improvement on stratification, in that it uses several risk characteristics, for example, firm size, returns volatility, sector, and beta. Unlike stratification, it does not require mutually exclusive categories of portfolio stocks. The linear programming methodology will choose assets for the optimal portfolio so that category weights in the active portfolio closely resemble those of the benchmark portfolio. This technique can also include the effects of transaction costs (which reduces turnover) and limits on position sizes.

Linear programming's strength is creating a portfolio that closely resembles the benchmark. However, the result can be a portfolio that is very different from the benchmark with respect to the number of assets included and any unincluded dimensions of risk.

Quadratic Programming

Quadratic programming can be designed to include alphas, risks, and transaction costs. Additionally, any number of constraints can be imposed. Theoretically, this is the best method of optimization, as it efficiently uses the information in alphas to produce the optimal (constrained) portfolio. However, estimation error is an important consideration. Consider that for a universe of 400 stocks, quadratic programming will require estimates of 400 stock volatilities and 79,800 covariances. The quadratic program will use the information in the estimates to reduce active risk.

Small estimation error in covariances will not necessarily reduce value added significantly. But even moderate levels of estimation error for the covariances can significantly reduce value added; with 5% estimation error, value added may actually be negative. The importance of good estimates of the relevant inputs, especially covariances, cannot be over emphasized.

Portfolio Return Dispersion

LO 83.i: Describe dispersion, explain its causes, and describe methods for controlling forms of dispersion.

For portfolio managers, **dispersion** refers to the variability of returns across client portfolios. One dispersion measure is the difference between the maximum return and minimum return over a period for separately managed client accounts.

Managers can reduce dispersion by reducing differences in asset holdings between portfolios and differences in portfolio betas though better supervision and control. Other causes of dispersion are outside the manager's control. Different portfolio constraints for different accounts will unavoidably increase dispersion (e.g., not being able to invest in derivatives or other asset classes).

Of course, if all client accounts were identical there would be no dispersion. All accounts will not be identical in the presence of transaction costs, however. The existence of transaction costs implies that there is some optimal level of dispersion. To understand the tradeoff between transaction costs and dispersion, consider a managed portfolio that is currently 60% stocks and 40% bonds. The manager knows the optimal portfolio is 62% stocks and 38% bonds, but transaction costs from rebalancing would reduce returns more than the change to optimal weights would increase them.

If the manager acquires a second client, he can set portfolio weights to 62% and 38% for that client's account. Because one client has a 60/40 portfolio and the other has a 62/38 portfolio, there will be dispersion. Clearly, higher transaction costs lead to greater dispersion. If the manager eliminates dispersion by matching the new client portfolio to the existing client portfolio, returns from the new information will be sacrificed. If the manager eliminates dispersion by rebalancing the existing client portfolio, the transaction costs of this rebalancing will reduce overall portfolio return. Given transaction costs, there is an optimal level of dispersion that balances transaction costs and gains from rebalancing.

A greater number of portfolios and higher active risk will both increase optimal dispersion, and for a given number of portfolios, dispersion is proportional to active risk. As long as alphas and risk are not constant (an unlikely occurrence) dispersion will decrease over time and eventually convergence (of account returns) will occur. However, there is no certainty as to the rate at which it will occur.

MODULE QUIZ 83.2

1. An increase in which of the following factors will increase the no-trade region for the alpha of an asset?
   I. Risk aversion.
   II. Marginal contribution to active risk.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.
2. A manager has forecasts of stocks A, B, and C, but not of stocks D and E. Stocks A, B, and D are in the benchmark portfolio. Stocks C and E are not in the benchmark portfolio. Which of the following is correct concerning specific weights the manager should assign in tracking the benchmark portfolio?
   A. $w_C = 0$.
   B. $w_D = 0$.

C. $w_C = (w_A + w_B) / 2$.
D. $w_C = w_D = w_E$.

KEY CONCEPTS

LO 83.a

The inputs into the portfolio construction process are the current portfolio, the alphas, covariance estimates, transaction costs, and active risk aversion. Except for the current portfolio, these inputs are all subject to estimation error and possible bias.

LO 83.b

Refining alphas is an alternative to including constraints (e.g., no short selling or maximum deviations from benchmark weights) in the portfolio optimization process. Using refined alphas and then performing optimization can achieve the same goal as a constrained optimization approach, but has the advantage of focusing on the alpha inputs and the effects of individual constraints on portfolio returns.

LO 83.c

Neutralization can remove undesirable portfolio risks. Benchmark neutralization can reduce active risk by matching active portfolio beta to that of the benchmark portfolio. Cash neutralization eliminates any active cash position in the portfolio. Risk-factor neutralization matches specific factor risks in the active portfolio to those of the benchmark.

LO 83.d

Transaction costs have several implications. First, they may make it optimal not to rebalance even with the arrival of new information. Second, transaction costs increase the importance of robust alpha estimates. The fact that transaction costs occur at a point in time while the benefits of the portfolio adjustments occur over the investment horizon complicates analysis and makes rebalancing decisions dependent on the estimated holding period of portfolio assets.

LO 83.e

Practical issues in portfolio construction include determining the level of risk aversion, the optimal risk, and the alpha coverage. The inputs in computing the level of risk aversion must be accurate. Including the aversion to specific risk factors can help a manager address the risks of a position with a large potential loss and the dispersion across separately managed portfolios. Proper alpha coverage addresses situations in which the manager has alpha estimates for stocks that have zero weight in (are not included in) the benchmark or does not have alpha estimates for some stocks in the benchmark portfolio.

LO 83.f

In the process of portfolio revisions and rebalancing, there are tradeoffs between alpha, risk, transaction costs, and the investment horizon. The manager may choose to be conservative, given the uncertainty regarding these inputs. Also, the shorter the horizon, the more uncertain the alpha, which means the manager should choose an optimal time horizon where the certainty of the alpha is sufficient to justify a trade given the transaction costs.

LO 83.g

Because of transaction costs, there will be an optimal no-trade region when new information arrives concerning the alpha of an asset, the costs of rebalancing the portfolio outweigh the expected

incremental returns. That region is determined by the level of risk aversion, a portfolio's active risk, the marginal contribution of rebalancing to active risk, and transaction costs.

LO 83.h

A screen may be as simple as "screening" for assets with the highest estimated alphas or as a method of assigning relative ranks based on estimated alphas.

Stratification applies screening separately to categories of stocks and weights the active portfolio across these categories with their weights in the benchmark portfolio.

Linear programming is an improvement on stratification in that the optimal portfolio is structured to closely resemble the benchmark with respect to such characteristics (risk factors) as industry groups, firm size, volatility, and beta.

Quadratic programming improves on the linear programming methodology by explicitly considering alpha, risk, and transaction costs. It is theoretically the best optimization method, incorporating the most information; however, the value added in the active portfolio is quite sensitive to the level of estimation error in the covariance inputs.

LO 83.i

For a manager with separately managed accounts, dispersion of client returns will result when the portfolios are not identical. The basic causes of dispersion are the different histories and cash flows of each of the clients. A manager can control this source of dispersion by trying to increase the proportion of assets that are common to all portfolios.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 83.1

1. **C** The current portfolio is the only input that is directly observable. (LO 83.a)
2. **B** The approach of first refining alphas and then optimizing can replace even the most sophisticated portfolio construction process. With this technique, both the investor and manager constraints are considered. (LO 83.b)
3. **D** A challenge is to correctly assign the transaction costs to projected future benefits. The transaction costs must be amortized over the horizon of the benefit from the trade. The benefits (e.g., the increase in alpha) occur over time while the transaction costs generally occur at a specific time when the portfolio is adjusted. (LO 83.d)

Module Quiz 83.2

1. **C** This is evident from the definition of the no-trade region for the alpha of the asset.

   [2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] − (cost of selling) < alpha of asset < [2 × (risk aversion) × (active risk) × (marginal contribution to active risk)] + (cost of purchase)

   (LO 83.g)
2. **A** The manager should assign a tracking portfolio weight equal to zero for stocks for which there is a forecast but that are not in the benchmark. A weight should be assigned to stock D, and it should be a function of the alphas of the other assets. (LO 83.e)

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Jorion, Chapter 7.

READING 84: PORTFOLIO RISK: ANALYTICAL METHODS

Jorion, Chapter 7

EXAM FOCUS

Due to diversification, the value at risk (VaR) of a portfolio will be less than or equal to the sum of the VaRs of the positions in the portfolio. If all positions are perfectly correlated, then the portfolio VaR equals the sum of the individual VaRs. A manager can make optimal adjustments to the risk of a portfolio with such measures as marginal VaR, incremental VaR, and component VaR. This reading is highly quantitative. Be able to find the optimal portfolio using the excess-return-to-marginal VaR ratios. For the exam, understand how correlations impact the measure of portfolio VaR. Also, it is important that you know how to compute incremental VaR and component VaR using the marginal VaR measure. We have included several examples to help with application of these concepts.

MODULE 84.1: VAR MEASURES

LO 84.a: Define, calculate, and distinguish between the following portfolio VaR measures: diversified and undiversified portfolio VaR, individual VaR, incremental VaR, marginal VaR, and component VaR.

LO 84.b: Explain the impact of correlation on portfolio risk.

Portfolio theory depends a lot on statistical assumptions. In finance, researchers and analysts often assume returns are normally distributed. Such an assumption allows us to express relationships in concise expressions such as beta. Actually, beta and other convenient concepts can apply if returns follow an elliptical distribution, which is a broader class of distributions that includes the normal distribution. In what follows, we will assume returns follow an elliptical distribution unless otherwise stated.

Diversified Portfolio VaR

Diversified VaR is simply the VaR of the portfolio where the calculation takes into account the diversification effects. The basic formula is:

$$VaR_p = Z_c \times \sigma_p \times P$$

where:

Z_c = the *z*-score associated with the level of confidence *c*

σ_p = the standard deviation of the portfolio return

P = the nominal value invested in the portfolio

Examining the formula for the variance of the portfolio returns is important because it reveals how the correlations of the returns of the assets in the portfolio affect volatility. The variance formula is:

$$\sigma_P^2 = \sum_{i=1}^{N} w_i^2 \sigma_i^2 + 2 \sum_{i=1}^{N} \sum_{j<i}^{N} w_i w_j \rho_{i,j} \sigma_i \sigma_j$$

where:
σ_P^2 = the variance of the portfolio returns
w_i = the portfolio weight invested in position *i*
σ_i = the standard deviation of the return in position *i*
$\rho_{i,j}$ = the correlation between the returns of asset *i* and asset *j*

The standard deviation, denoted σ_P , is:

$$\sigma_P = \sqrt{\sigma_P^2} = \sqrt{\sum_{i=1}^{N} w_i^2 \sigma_i^2 + 2 \sum_{i=1}^{N} \sum_{j<i}^{N} w_i w_j \rho_{i,j} \sigma_i \sigma_j}$$

Clearly, the variance and standard deviation are lower when the correlations are lower.

In order to calculate delta-normal VaR with more than one risk factor, we need a covariance matrix that incorporates correlations between each risk factor in the portfolio and volatilities of each risk factor. If we know the volatilities and correlations, we can derive the standard deviation of the portfolio and the corresponding VaR measure. We will discuss how to calculate VaR using matrix multiplication later in this reading.

Individual VaR is the VaR of an individual position in isolation. If the proportion or weight in the position is w_i, then we can define the individual VaR as:

$$VaR_i = Z_c \times \sigma_i \times |P_i| = Z_c \times \sigma_i \times |w_i| \times P$$

where:
P = the portfolio value
P_i = the nominal amount invested in position i

We use the absolute value of the weight because both long and short positions pose risk.

The Role of Correlation

In a two-asset portfolio, the equation for the standard deviation is:

$$\sigma_P = \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2}$$

and the VaR is:

$$VaR_P = Z_c P \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2}$$

We can square Z_c and P and put them under the square-root sign. This allows us to express VaR_P as a function of the VaRs of the individual positions, which we express as VaR_i for each position *i*. For a two-asset portfolio we will have VaR_1 and VaR_2. If the correlation is zero, $\rho_{1,2} = 0$, then the third term under the radical is zero and:

$$\text{VaR for uncorrelated positions: } \text{VaR}_P = \sqrt{\text{VaR}_1^2 + \text{VaR}_2^2}$$

The other extreme is when the correlation is equal to unity, $\rho_{1,2} = +1$. With perfect correlation, there is no benefit from diversification. For the two-asset portfolio, we find:

$$\text{Undiversified VaR} = \text{VaR}_P = \sqrt{\text{VaR}_1^2 + \text{VaR}_2^2 + 2\text{VaR}_1\text{VaR}_2}$$

$$= \text{VaR}_1 + \text{VaR}_2$$

In general, undiversified VaR is the sum of all the VaRs of the individual positions in the portfolio when none of those positions are short positions.

Notice how evaluating VaR using both uncorrelated positions and perfectly correlated positions will place a lower and upper bound on the total (or portfolio) VaR. Total VaR will be less if the positions are uncorrelated and greater if the positions are correlated. The following examples illustrate this point.

EXAMPLE: Computing portfolio VaR (part 1)

An analyst computes the VaR for the two positions in her portfolio. The VaRs: VaR_1 = $2.4 million and VaR_2 = $1.6 million. **Compute** VaR_P if the returns of the two assets are uncorrelated.

Answer:

For uncorrelated assets:

$$\text{VaR}_P = \sqrt{\text{VaR}_1^2 + \text{VaR}_2^2}$$

$$= \sqrt{\left(2.4^2 + 1.6^2\right)(\$\text{millions})^2} = \sqrt{8.32(\$\text{millions})^2}$$

$$\text{VaR}_P = \$2.8844 \text{ million}$$

EXAMPLE: Computing portfolio VaR (part 2)

An analyst computes the VaR for the two positions in her portfolio. The VaRs: VaR_1 = $2.4 million and VaR_2 = $1.6 million. **Compute** VaR_P if the returns of the two assets are perfectly correlated.

Answer:

For perfectly correlated assets:

$\text{VaR}_P = \text{VaR}_1 + \text{VaR}_2$ = $2.4 million + $1.6 million = $4 million

Under certain assumptions, the portfolio standard deviation of returns for a portfolio with more than two assets has a very concise formula. The assumptions are:

- The portfolio is equally weighted.
- All the individual positions have the same standard deviation of returns.
- The correlations between each pair of returns are the same.

The formula is then:

$$\sigma_P = \sigma\sqrt{\frac{1}{N} + \left(1 - \frac{1}{N}\right)\rho}$$

where:
N = the number of positions
σ = the standard deviation that is equal for all *N* positions
ρ = the correlation between the returns of each pair of positions

PROFESSOR'S NOTE

This formula greatly simplifies the process of having to calculate portfolio standard deviation with a covariance matrix.

To demonstrate the benefits of diversification, we can simply set up a 2 × 2 table where there is a small and large correlation (ρ) column and a small and large sample size (*N*) row. Assuming that the standard deviation of returns is 20% for both assets, we see how the portfolio variance is affected by the different inputs.

Figure 84.1: Portfolio Standard Deviation

Sample size/correlation	ρ = 0.1	ρ = 0.5
N = 4	σ_P = 11.40%	σ_P = 15.81%
N = 10	σ_P = 8.72%	σ_P = 14.83%

EXAMPLE: Computing portfolio VaR (part 3)

A portfolio has five positions of $2 million each. The standard deviation of the returns is 30% for each position. The correlations between each pair of returns is 0.2. **Calculate** the VaR using a Z-value of 2.33.

Answer:

The standard deviation of the portfolio returns is:

$$\sigma_P = 30\%\sqrt{\frac{1}{5} + \left(1 - \frac{1}{5}\right)0.2}$$

$$\sigma_P = 30\%\sqrt{0.36}$$

$$\sigma_P = 18\%$$

The VaR in nominal terms is:

$VaR_p = Z_c \times \sigma_p \times V$ = (2.33)(18%)($10 million)

VaR_p = $4,194,000

Marginal VaR

Marginal VaR applies to a particular position in a portfolio, and it is the *per unit change in a portfolio VaR that occurs from an additional investment in that position*. Mathematically speaking, it is the partial derivative of the portfolio VaR with respect to the position:

$$\text{Marginal VaR} = \text{MVaR}_i = \frac{\partial \text{VaR}_P}{\partial(\text{monetary investment in i})}$$

$$= Z_c \frac{\partial \sigma_P}{\partial w_i} = Z_c \frac{\text{cov}(R_i, R_P)}{\sigma_P}$$

Using CAPM methodology, we know a regression of the returns of a single asset *i* in a portfolio on the returns of the entire portfolio gives a beta, denoted β_i, which is a concise measure that includes the covariance of the position's returns with the total portfolio:

$$\beta_i = \frac{\text{cov}(R_i, R_P)}{{\sigma_P}^2}$$

Using the concept of beta gives another expression for marginal VaR:

$$\text{Marginal VaR} = \text{MVaR}_i = \frac{\text{VaR}_P}{\text{portfolio value}} \times \beta_i$$

> **EXAMPLE: Computing marginal VaR**
>
> Assume Portfolio X has a VaR of €400,000. The portfolio is made up of four assets: Asset A, Asset B, Asset C, and Asset D. These assets are equally weighted within the portfolio and are each valued at €1,000,000. Asset A has a beta of 1.2. **Calculate** the marginal VaR of Asset A.
>
> **Answer:**
>
> Marginal VaR_A = (VaR_P / portfolio value) × β_A
>
> Marginal VaR_A = (400,000 / 4,000,000) × 1.2 = 0.12
>
> Thus, portfolio VaR will change by 0.12 for each euro change in Asset A.

Incremental VaR

Incremental VaR is the change in VaR from the addition of a new position in a portfolio. Since it applies to an entire position, it is generally larger than marginal VaR and may include nonlinear relationships, which marginal VaR generally assumes away. The problem with measuring incremental VaR is that, in order to be accurate, a full revaluation of the portfolio after the addition of the new position would be necessary. The incremental VaR is the difference between the new VaR from the revaluation minus the VaR before the addition. The revaluation requires not only measuring the risk of the position itself, but it also requires measuring the change in the risk of the other positions that are already in the portfolio. For a portfolio with hundreds or thousands of positions, this would be time consuming. Clearly, VaR measurement becomes more difficult as portfolio size increases given the expansion of the covariance matrix. Using a shortcut approach for computing incremental VaR would be beneficial.

For small additions to a portfolio, we can approximate the incremental VaR with the following steps:

Step 1: Estimate the risk factors of the new position and include them in a vector [η].

Step 2: For the portfolio, estimate the vector of marginal VaRs for the risk factors [$MVaR_j$].

Step 3: Take the cross product.

This probably requires less work and is faster to implement because it is likely the managers already have estimates of the vector of $MVaR_j$ values in Step 2.

Before we take a look at how to calculate incremental VaR, let's review the calculation of delta-normal VaR using matrix notation (i.e., using a covariance matrix).

EXAMPLE: Computing VaR using matrix notation

A portfolio consists of assets A and B. These assets are the risk factors in the portfolio. The volatilities are 6% and 14%, respectively. There are $4 million and $2 million invested in them, respectively. If we assume they are uncorrelated with each other, **compute** the VaR of the portfolio using a confidence parameter, Z, of 1.65.

Answer:

We can use matrix notation to derive the dollar variance of the portfolio:

$$\sigma_P^2 V^2 = \begin{bmatrix} \$4 & \$2 \end{bmatrix} \begin{bmatrix} 0.06^2 & 0 \\ 0 & 0.14^2 \end{bmatrix} \begin{bmatrix} \$4 \\ \$2 \end{bmatrix} = 0.0576 + 0.0784 = 0.136$$

This value is in ($ millions)^2. VaR is then the square root of the portfolio variance times 1.65:

VaR = (1.65)($368,782) = $608,490

PROFESSOR'S NOTE

Matrix multiplication consists of multiplying each row by each column. For example: (4 × 0.06 ^{2}) + (2 × 0) = 0.0144; 0.0144 × 4 = 0.0576. Had the positions been positively correlated, some positive value would replace the zeros in the covariance matrix.

EXAMPLE: Computing incremental VaR

A portfolio consists of assets A and B. The volatilities are 6% and 14%, respectively. There are $4 million and $2 million invested in them respectively. If we assume they are uncorrelated with each other, **compute** the incremental VaR for an increase of $10,000 in Asset A. Assume a Z-score of 1.65.

Answer:

To find incremental VaR, we compute the per dollar covariances of each risk factor:

$$\begin{bmatrix} \text{cov}(R_A, R_P) \\ \text{cov}(R_B, R_P) \end{bmatrix} = \begin{bmatrix} 0.06^2 & 0 \\ 0 & 0.14^2 \end{bmatrix} \begin{bmatrix} \$4 \\ \$2 \end{bmatrix} = \begin{bmatrix} 0.0144 \\ 0.0392 \end{bmatrix}$$

These per dollar covariances represent the covariance of a given risk factor with the portfolio. Thus, we can substitute these values into the marginal VaR equations for the risk factors as follows.

The marginal VaRs of the two risk factors are:

$$\mathrm{MVaR_A} = \mathrm{Z_c} \times \frac{\mathrm{cov(R_A, R_P)}}{\sigma_\mathrm{P}} = 1.65 \times \frac{0.0144}{\sqrt{0.136}} = 0.064428$$

$$\mathrm{MVaR_B} = \mathrm{Z_c} \times \frac{\mathrm{cov(R_B, R_P)}}{\sigma_\mathrm{P}} = 1.65 \times \frac{0.0392}{\sqrt{0.136}} = 0.175388$$

Since the two assets are uncorrelated, the incremental VaR of an additional $10,000 investment in Position A would simply be $10,000 times 0.064428, or $644.28.

Component VaR

Component VaR for position *i*, denoted $\mathrm{CVaR_i}$, is the amount of risk a particular fund contributes to a portfolio of funds. It will generally be less than the VaR of the fund by itself (i.e., stand-alone VaR) because of diversification benefits at the portfolio level. In a large portfolio with many positions, the approximation is simply the marginal VaR multiplied by the dollar weight in position *i*:

$$\begin{aligned}\mathrm{CVaR_i} &= (\mathrm{MVaR_i}) \times (\mathrm{w_i} \times \mathrm{P}) = \mathrm{VaR} \times \beta_\mathrm{i} \times \mathrm{w_i} \\ &= (\alpha \times \sigma_\mathrm{p} \times \mathrm{P}) \times \beta_\mathrm{i} \times \mathrm{w_i} = (\alpha \times \sigma_\mathrm{i} \times \mathrm{w_i} \times \mathrm{P}) \times \rho_\mathrm{i} = \mathrm{VaR_i} \times \rho_\mathrm{i}\end{aligned}$$

The last two components consider the fact that $\mathrm{beta_i} = (\rho_\mathrm{i} \times \sigma_\mathrm{i}) / \sigma_\mathrm{P}$.

Using $\mathrm{CVaR_i}$, we can express the total VaR of the portfolio as:

$$\mathrm{VaR} = \sum_{\mathrm{i}=1}^{\mathrm{N}} \mathrm{CVaR_i} = \mathrm{VaR}\left(\sum_{\mathrm{i}=1}^{\mathrm{N}} \mathrm{w_i} \times \beta_\mathrm{i}\right)$$

Given the way the betas were computed we know: $\left(\sum_{\mathrm{i}=1}^{\mathrm{N}} \mathrm{w_i} \times \beta_\mathrm{i}\right) = 1$

EXAMPLE: Computing component VaR (Example 1)

Assume Portfolio X has a VaR of €400,000. The portfolio is made up of four assets: Asset A, Asset B, Asset C, and Asset D. These assets are equally weighted within the portfolio and are each valued at €1,000,000. Asset A has a beta of 1.2. **Calculate** the component VaR of Asset A.

Answer:

Component $\mathrm{VaR_A}$ = $\mathrm{VaR_P} \times \beta_\mathrm{A}$ × asset weight

Component $\mathrm{VaR_A}$ = 400,000 × 1.2 × (1,000,000 / 4,000,000)

= €120,000

Thus, portfolio VaR will decrease by €120,000 if Asset A is removed.

EXAMPLE: Computing component VaR (Example 2, Part 1)

Recall our previous incremental VaR example of a portfolio invested $4 million in A and $2 million in B. Using their respective marginal VaRs, 0.064428 and 0.175388, **compute** the component VaRs.

Answer:

$CVaR_A = (MVaR_A) \times (w_A \times P) = (0.064428) \times (\$4 \text{ million}) = \$257,713$

$CVaR_B = (MVaR_B) \times (w_B \times P) = (0.175388) \times (\$2 \text{ million}) = \$350,777$

PROFESSOR'S NOTE

The values have been adjusted for rounding.

EXAMPLE: Computing component VaR (Example 2, Part 2)

Using the results from the previous example, **compute** the percent of contribution to VaR of each component.

Answer:

The answer is the sum of the component VaRs divided into each individual component VaR:

$$\%\text{ contribution to VaR from A} = \frac{\$257,713}{(\$257,713 + \$350,777)} = 42.35\%$$

$$\%\text{ contribution to VaR from B} = \frac{\$350,777}{(\$257,713 + \$350,777)} = 57.65\%$$

Normal distributions are a subset of the class of distributions called elliptical distributions. As a class, elliptical distributions have fewer assumptions than normal distributions. Risk management often assumes elliptical distributions, and the procedures to estimate component VaRs up to this point have applied to elliptical distributions.

If the returns do not follow an elliptical distribution, we can employ other procedures to compute component VaR. If the distribution is homogeneous of degree one, for example, then we can use Euler's theorem to estimate the component VaRs. The return of a portfolio of assets is homogeneous of degree one because, for some constant, *k*, we can write:

$$k \times R_P = \sum_{i=1}^{N} k \times w_i \times R_i$$

The following steps can help us find component VaRs for a non-elliptical distribution using historical returns:

Step 1: Sort the historical returns of the portfolio.

Step 2: Find the return of the portfolio, which we will designate $R_{P(VaR)}$, that corresponds to a return that would be associated with the chosen VaR.

Step 3: Find the returns of the individual positions that occurred when $R_{P(VaR)}$ occurred.

Step 4: Use each of the position returns associated with $R_{P(VaR)}$ for component VaR for that position.

To improve the estimates of the component VaRs, an analyst should probably obtain returns for each individual position for returns of the portfolio slightly above and below $R_{P(VaR)}$. For each set

of returns for each position, the analyst would compute an average to better approximate the component VaR of the position.

MODULE QUIZ 84.1

1. Which of the following is the best synonym for diversified VaR?
   A. Vector VaR.
   B. Position VaR.
   C. Portfolio VaR.
   D. Incidental VaR.
2. When computing individual VaR, it is proper to:
   A. use the absolute value of the portfolio weight.
   B. use only positive weights.
   C. use only negative weights.
   D. compute VaR for each asset within the portfolio.
3. A portfolio consists of two positions. The VaR of the two positions are $10 million and $20 million. If the returns of the two positions are not correlated, the VaR of the portfolio would be closest to:
   A. $5.48 million.
   B. $15.00 million
   C. $22.36 million.
   D. $25.00 million.
4. Which of the following is true with respect to computing incremental VaR? Compared to using marginal VaRs, computing with full revaluation is:
   A. more costly, but less accurate.
   B. less costly, but more accurate.
   C. less costly, but also less accurate.
   D. more costly, but also more accurate.

MODULE 84.2: MANAGING PORTFOLIOS WITH VAR

LO 84.c: Apply the concept of marginal VaR to guide decisions about portfolio VaR.

LO 84.d: Explain the risk-minimizing position and the risk and return-optimizing position of a portfolio.

A manager can *lower a portfolio VaR by lowering allocations to the positions with the highest marginal VaR*. If the manager keeps the total invested capital constant, this would mean increasing allocations to positions with lower marginal VaR. Portfolio risk will be at a global minimum where all the marginal VaRs are equal for all *i* and *j*:

$$\text{MVaR}_i = \text{MVaR}_j$$

We can use our earlier example to see how we can use marginal VaRs to make decisions to lower the risk of the entire portfolio. In the earlier example, Position A has the smaller MVaR; therefore, we will compute the marginal VaRs and total VaR for a portfolio which has $5 million invested in A and $1 million in B. The portfolio variance is:

$$\sigma_p^2 V^2 = \begin{bmatrix} \$5 & \$1 \end{bmatrix} \begin{bmatrix} 0.06^2 & 0 \\ 0 & 0.14^2 \end{bmatrix} \begin{bmatrix} \$5 \\ \$1 \end{bmatrix} = 0.0900 + 0.0196 = 0.1096$$

This value is in ($ millions)^2. VaR is then the square root of the portfolio variance times 1.65 (95% confidence level):

VaR = (1.65)($331,059) = $546,247

The VaR of $546,247 is less than the VaR of $608,490, which was produced when Portfolio A had a lower weight. We can see that the marginal VaRs are now much closer in value:

$$\begin{bmatrix} \text{cov}(R_A,R_P) \\ \text{cov}(R_B,R_P) \end{bmatrix} = \begin{bmatrix} 0.06^2 & 0 \\ 0 & 0.14^2 \end{bmatrix} \begin{bmatrix} \$5 \\ \$1 \end{bmatrix} = \begin{bmatrix} 0.0180 \\ 0.0196 \end{bmatrix}$$

The marginal VaRs of the two positions are:

$$\text{MVaR}_A = Z_c \times \frac{\text{cov}(R_A,R_P)}{\sigma_P} = 1.65 \times \frac{0.0180}{\sqrt{0.1096}} = 0.08971$$

$$\text{MVaR}_B = Z_c \times \frac{\text{cov}(R_B,R_P)}{\sigma_P} = 1.65 \times \frac{0.0196}{\sqrt{0.1096}} = 0.09769$$

LO 84.e: Explain the difference between risk management and portfolio management and describe how to use marginal VaR in portfolio management.

As the name implies, risk management focuses on risk and ways to reduce risk; however, minimizing risk may not produce the optimal portfolio. Portfolio management requires assessing both risk measures and return measures to choose the optimal portfolio. Traditional efficient frontier analysis tells us that the minimum variance portfolio is not optimal. We should note that the **efficient frontier** is the plot of portfolios that have the lowest standard deviation for each expected return (or highest return for each standard deviation) when plotted on a plane with the vertical axis measuring return and the horizontal axis measuring the standard deviation. The optimal portfolio is represented by the point where a ray from the risk-free rate is just tangent to the efficient frontier. That optimal portfolio has the highest Sharpe ratio:

$$\text{Sharpe ratio} = \frac{(\text{portfolio return} - \text{risk-free rate})}{(\text{standard deviation of portfolio return})}$$

We can modify this formula by replacing the standard deviation with VaR so that the focus then becomes the excess return of the portfolio over VaR:

$$\frac{(\text{portfolio return} - \text{risk-free rate})}{(\text{VaR of portfolio})}$$

This ratio is maximized when the excess return in each position divided by its respective marginal VaR equals a constant. In other words, at the optimum:

$$\frac{(\text{position i return} - \text{risk-free rate})}{(\text{MVaR}_i)} = \frac{(\text{position j return} - \text{risk-free rate})}{(\text{MVaR}_j)}$$

for all positions *i* and *j*.

PROFESSOR'S NOTE

Equating the excess return/MVaR ratios will obtain the optimal portfolio. This differs from equating just the MVaRs, which obtains the portfolio with the lowest portfolio VaR.

Assuming that the returns follow elliptical distributions, we can represent the condition in a more concise fashion by employing betas, β_i, which are obtained from regressing each position's return on the portfolio return:

$$\frac{(\text{position i return} - \text{risk-free rate})}{\beta_i} = \frac{(\text{position j return} - \text{risk-free rate})}{\beta_j}$$

for all positions *i* and *j*.

The portfolio weights that make these ratios equal will be the optimal portfolio. We now turn our attention to determining the optimal portfolio for our example portfolio of A and B. We will assume the expected excess return of A is 6% and that of B is 11%. Even without this information, we should know that the optimal portfolio will have an allocation in A less than $5 million and in B greater than $1 million. This is because the marginal VaRs were almost equal with those allocations. *Thus, the resulting portfolio would be close to the minimum variance*, which will not be optimal. We might want to find out how to adjust the allocation with respect to the original values of $4 million in A and $2 million in B. By comparing the ratios of the two assets we find:

$$\frac{\text{excess return of A}}{\text{MVaR}_A} = \frac{0.06}{0.064428} = 0.9313$$

$$\frac{\text{excess return of B}}{\text{MVaR}_B} = \frac{0.11}{0.175388} = 0.6272$$

We see that there is too much allocated in B. Before we adjust the portfolio, we compute the excess-return-to-VaR ratio for the entire portfolio. The return is:

$$\text{\% excess return on portfolio} = 7.67\% = \frac{\$4 \text{ million}}{\$6 \text{ million}}\left(6\%\right) + \frac{\$2 \text{ million}}{\$6 \text{ million}}\left(11\%\right)$$

The return to VaR (scaled by the size of the portfolio) is:

$$0.7559 = \frac{0.0767}{\$608{,}490} \times \$6 \text{ million}$$

Now, because the return to MVaR ratio was greater for A, we will increase the allocation in A to $4.5 million and decrease that in B to $1.5 million. With those changes, the portfolio variance is:

$$\sigma_P^2 V^2 = \begin{bmatrix} \$4.5 & \$1.5 \end{bmatrix} \begin{bmatrix} 0.06^2 & 0 \\ 0 & 0.14^2 \end{bmatrix} \begin{bmatrix} \$4.5 \\ \$1.5 \end{bmatrix} = 0.0729 + 0.0441 = 0.1170$$

This value is in ($ millions)^2. VaR is then the square root of the portfolio variance times 1.65 (95% confidence level):

VaR = (1.65)($342,053) = $564,387

In this case, the marginal VaRs are found by:

$$\begin{bmatrix} \text{cov}(R_A,R_P) \\ \text{cov}(R_B,R_P) \end{bmatrix} = \begin{bmatrix} 0.06^2 & 0 \\ 0 & 0.14^2 \end{bmatrix} \begin{bmatrix} \$4.5 \\ \$1.5 \end{bmatrix} = \begin{bmatrix} 0.0162 \\ 0.0294 \end{bmatrix}$$

The marginal VaRs of the two positions are then:

$$\text{MVaR}_A = Z_c \times \frac{\text{cov}(R_A,R_P)}{\sigma_P} = 1.65 \times \frac{0.0162}{\sqrt{0.1170}} = 0.0781$$

$$\text{MVaR}_B = Z_c \times \frac{\text{cov}(R_B,R_P)}{\sigma_P} = 1.65 \times \frac{0.0294}{\sqrt{0.1170}} = 0.1418$$

We see the expected excess-return-to-marginal VaR ratios are much closer:

$$\frac{0.06}{0.0781} = 0.7678$$

$$\frac{0.11}{0.1418} = 0.7756$$

The portfolio return is now:

$$\%\text{ excess return on portfolio} = 7.25\% = \frac{\$4.5\text{ million}}{\$6\text{ million}}\left(6\%\right) + \frac{\$1.5\text{ million}}{\$6\text{ million}}\left(11\%\right)$$

The portfolio return divided by the portfolio VaR has risen. The return to VaR (scaled by the size of the portfolio) is:

$$0.7707 = \frac{0.0725}{\$564{,}387} \times \$6\text{ million}$$

This is greater than the 0.7559 value associated with the original $4 million and $2 million allocations. The result is a more optimal portfolio allocation.

MODULE QUIZ 84.2

1. A portfolio has an equal amount invested in two positions, X and Y. The expected excess return of X is 9% and that of Y is 12%. Their marginal VaRs are 0.06 and 0.075, respectively. To move toward the optimal portfolio, the manager will probably:
   A. increase the allocation in Y and/or lower that in X.
   B. increase the allocation in X and/or lower that in Y.
   C. do nothing because the information is insufficient.
   D. not change the portfolio because it is already optimal.

KEY CONCEPTS

LO 84.a

Diversified VaR is simply the VaR of the portfolio where the calculation takes into account the diversification effects. The basic formula is:

$$VaR_p = Z_c \times \sigma_p \times P$$

where:

Z_c = the *z*-score associated with the level of confidence *c*

σ_p = the standard deviation of the portfolio return

P = the nominal value invested in the portfolio

Individual VaR is the VaR of an individual position in isolation. If the proportion or weight in the position is w_i, then we can define the individual VaR as:

$$VaR_i = Z_c \times \sigma_i \times |P_i| = Z_c \times \sigma_i \times |w_i| \times P$$

where:

P = the portfolio value

P_i = the nominal amount invested in position *i*

Marginal VaR is the change in a portfolio VaR that occurs from an additional one unit investment in a given position. Useful representations are:

$$\text{Marginal VaR} = MVaR_i = Z_c \frac{\text{cov}\left(R_i, R_p\right)}{\sigma_p}$$

$$\text{Marginal VaR} = MVaR_i = \frac{VaR}{P} \times \beta_i$$

Incremental VaR is the change in VaR from the addition of a new position in a portfolio. It can be calculated precisely from a total revaluation of the portfolio, but this can be costly. A less costly approximation is found by (1) breaking down the new position into risk factors, (2) multiplying each new risk factor times the corresponding partial derivative of the portfolio with respect to the risk factor, and then (3) adding up all the values.

Component VaR for position *i*, denoted $CVaR_i$, is the amount a portfolio VaR would change from deleting that position in a portfolio. In a large portfolio with many positions, the approximation is simply the marginal VaR multiplied by the dollar weight in position *i*:

$$CVaR_i = (MVaR_i) \times (w_i \times P) = VaR \times \beta_i \times w_i$$

There is a method for computing component VaRs for distributions that are not elliptical. The procedure is to sort the historical returns of the portfolio and designate a portfolio return that corresponds to the loss associated with the VaR and then find the returns of each of the components associated with that portfolio loss. Those position returns can be used to compute component VaRs.

LO 84.b

For a two-asset portfolio, two special cases are:

1. VaR for uncorrelated positions:

$$\text{VaR}_{\text{p}} = \sqrt{\text{VaR}_1^2 + \text{VaR}_2^2}$$

2. VaR for perfectly correlated positions:

$$\text{Undiversified VaR} = \text{VaR}_{\text{P}} = \sqrt{\text{VaR}_1^2 + \text{VaR}_2^2 + 2\text{VaR}_1\text{VaR}_2}$$
$$= \text{VaR}_1 + \text{VaR}_2$$

LO 84.c

Portfolio risk will be at a global minimum where all the marginal VaRs are equal for all *i* and *j*:

$\text{MVaR}_{\text{i}} = \text{MVaR}_{\text{j}}$

LO 84.d

Equating the MVaRs will obtain the portfolio with the lowest portfolio VaR. Equating the excess return/MVaR ratios will obtain the optimal portfolio.

LO 84.e

The optimal portfolio is the one for which all excess-return-to-marginal VaR ratios are equal:

$$\frac{(\text{position i return} - \text{risk-free rate})}{(\text{MVaR}_{\text{i}})} = \frac{(\text{position j return} - \text{risk-free rate})}{(\text{MVaR}_{\text{j}})}$$

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 84.1

1. **C** Portfolio VaR should include the effects of diversification. None of the other answers are types of VaRs. (LO 84.a)
2. **A** The expression for individual VaR is $VaR_i = Z_c \times \sigma \times |P_i| = Z \times \sigma_i \times |w_i| \times P$. The absolute value signs indicate that we need to measure the risk of both positive and negative positions, and risk cannot be negative. (LO 84.a)
3. **C** For uncorrelated positions, the answer is the square root of the sum of the squared VaRs:

   $$\text{VaR}_\text{P} = \sqrt{\left(10^2 + 20^2\right)} \times (\$ \text{ million}) = \$22.36 \text{ million}$$

   (LO 84.b)
4. **D** Full revaluation means recalculating the VaR of the entire portfolio. The marginal VaRs are probably already known, so using them is probably less costly, but will not be as accurate. (LO 84.a)

Module Quiz 84.2

1. **A** The expected excess-return-to-MVaR ratios for X and Y are 1.5 and 1.6, respectively. Therefore, the portfolio weight in Y should increase to move the portfolio toward the optimal portfolio. (LO 84.e)

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Jorion, Chapter 17.

READING 85: VAR AND RISK BUDGETING IN INVESTMENT MANAGEMENT

Jorion, Chapter 17

EXAM FOCUS

Banks on the "sell side" of the investment industry have long used risk budgeting and value at risk (VaR). There is a trend for the "buy side" investment firms to increasingly use VaR. One reason for increased demand for risk budgeting is the increased complexity, dynamics, and globalization of the investment industry. Use of VaR can help set better guidelines than more traditional limits. By measuring marginal and incremental VaRs, a manager can make better decisions concerning portfolio weights. For the exam, be comfortable with the concept of surplus at risk (SaR). Also, understand how to budget risk across asset classes and active managers.

MODULE 85.1: BUDGETING AND MANAGING RISK WITH VAR

Risk Budgeting

LO 85.a: Define risk budgeting.

Risk budgeting is a top-down process that involves choosing and managing exposures to risk. The main idea is that the risk manager establishes a risk budget for the entire portfolio and then allocates risk to individual positions based on a predetermined fund risk level. The risk budgeting process differs from market value allocation since it involves the allocation of risk.

Managing Risk With VaR

LO 85.b: Describe the impact of horizon, turnover, and leverage on the risk management process in the investment management industry.

The "sell side" of the investment industry largely consists of banks that have developed VaR techniques and have used them for many years. Investors make up the "buy side" of the investment industry. Investors are now using VaR techniques, but they have to adapt them to the different nature of that side of the business. To understand why the needs are different, we should compare the characteristics of the two "sides." Figure 85.1 makes direct comparisons.

Figure 85.1: Sell Side and Buy Side Characteristics

Characteristic	Sell Side	Buy Side
Horizon	Short-term (days)	Long-term (month or more)
Turnover	Fast	Slow
Leverage	High	Low

Risk measures	VaR	Asset allocation
	Stress tests	Tracking error
	Position limits	Diversification
Risk controls	VaR limits	Benchmarking
	Stop-loss rules	Investment guidelines

Banks trade rapidly, which is why they cannot rely on traditional measures of risk that are based on historical data. For banks, yesterday's risk may not have anything to do with today's positions. Investors usually try to hold positions for longer periods of time (e.g., years).

Having a more dynamic method for measuring risk such as VaR is also important for banks because of their high leverage. Institutional investors often have much stronger constraints with respect to leverage; therefore, they have a much lower need to control downside risk.

The Investment Process

LO 85.c: Describe the investment process of large investors such as pension funds.

The *first step* in the investment process is to determine the long-term, strategic asset allocations. Usually, the goal of the first step is to balance returns and risks using methods like mean-variance portfolio optimization. This step determines the allocations to asset classes such as domestic and foreign stocks, domestic and foreign bonds, and alternative investments such as real estate, venture capital, and hedge funds. Making this allocation relies on passive indices and other benchmarks to help measure the properties of the investment, and the availability of passive indices helps make the allocations feasible.

The *second step* in the investment process is to choose the managers who may either passively manage the fund (i.e., simply track the benchmarks) or actively manage the fund in an effort to outperform the benchmarks. The investors should review the managers' activities and performance periodically. Their activities should conform to a list of guidelines, which includes the types of investments and risk exposure restrictions such as beta and duration. Managers' performance can be evaluated by analyzing their tracking error.

VaR risk management systems are beginning to become more important because of the globalization of available investments and the increased complexity of investments. Also, investment companies are becoming more dynamic, which makes it more difficult to assess risk. With many managers, for example, each of the managers may make changes within his constraints, but the collective changes could be difficult to gauge with historical measures. In sum, because of increased globalization, complexity, and the dynamic nature of the investment industry, simply measuring risk using historical measures is no longer adequate, which has increased the need for VaR.

Hedge Fund Issues

LO 85.d: Describe the risk management challenges associated with investments in hedge funds.

Hedge funds are a very heterogeneous class of assets that include a variety of trading strategies. Since they often use leverage and trade a great deal, their risk characteristics may be more similar to the "sell side" of the industry. Hedge funds have some other risks like liquidity and low transparency. Liquidity risk has many facets. First, there is the obvious potential loss from having to liquidate too quickly. Second, there is the difficulty of measuring the exact value of the fund to be able to ascertain its risk. Furthermore, the low liquidity tends to lower the volatility of historical prices as well as the correlations of the positions. These properties will lead to an underestimation of traditional measures of risk. In addition to these risks, there is the low level of transparency. This makes the risk measurement difficult with respect to both the size and type. Not knowing the type of risk increases the difficulty of risk management for the entire portfolio in which an investor might include hedge funds.

Absolute Risk vs. Relative Risk and Policy Mix vs. Active Risk

LO 85.e: Distinguish among the following types of risk: absolute risk, relative risk, policy-mix risk, active management risk, funding risk, and sponsor risk.

Absolute or asset risk refers to the total possible losses over a horizon. It is simply measured by the return over the horizon. **Relative risk** is measured by excess return, which is the dollar loss relative to a benchmark. The shortfall is measured as the difference between the fund return and that of a benchmark in dollar terms. VaR techniques can apply to tracking error (i.e., standard deviation of excess return) if the excess return is normally distributed.

PROFESSOR'S NOTE

The author's definition of tracking error differs from the definition of tracking error in other assigned readings. Jorion defines tracking error as active return minus the benchmark return. In other readings, this value is simply the excess return and tracking error is the volatility (i.e., standard deviation) of the excess return. Throughout this reading, we have expressed excess return as portfolio return minus benchmark return and tracking error as the volatility of the excess return. This methodology follows the definition of tracking error on previous FRM exams.

Distinguishing **policy mix** from **active risk** is important when an investment firm allocates funds to different managers in various asset classes. This breaks down the risk of the total portfolio into that associated with the target policy (i.e., the weights assigned to the various funds in the policy) and the risk from the fact that managers may make decisions which lead to deviations from the designated weights. VaR analysis is especially useful here because it can show the risk exposure associated with the two types of risk and how they affect the overall risk of the entire portfolio. Often, active management risk is not much of a problem for several reasons:

- For well-managed funds, it is usually fairly small for each of the individual funds.
- There will be diversification effects across the deviations.
- There can be diversification effects with the policy mix VaR to actually lower the total portfolio VaR.

Funding Risk

Funding risk refers to being able to meet the obligations of an investment company (e.g., a pension's payout to retirees). Put another way, funding risk is the risk that the value of assets will

not be sufficient to cover the liabilities of the fund. The level of funding risk varies dramatically across different types of investment companies. Some have zero, while defined benefit pension plans have the highest.

The focus of this analysis is the surplus, which is the difference between the value of the assets and the liabilities, and the change in the surplus, which is the difference between the change in the assets and liabilities:

$$\text{Surplus} = \text{Assets} - \text{Liabilities}$$

$$\Delta\text{Surplus} = \Delta\text{Assets} - \Delta\text{Liabilities}$$

Typically, in managing funding risk, an analyst will transform the nominal return on the surplus into a return on the assets, and break down the return as indicated:

$$R_{\text{surplus}} = \frac{\Delta\text{Surplus}}{\text{Assets}} = \frac{\Delta\text{Assets}}{\text{Assets}} - \left(\frac{\Delta\text{Liabilities}}{\text{Liabilities}}\right)\left(\frac{\text{Liabilities}}{\text{Assets}}\right)$$

$$= R_{\text{asset}} - R_{\text{liabilities}}\left(\frac{\text{Liabilities}}{\text{Assets}}\right)$$

Evaluating this expression requires assumptions about the liabilities, which are in the future and uncertain. For pension funds, liabilities represent “accumulated benefit obligations,” which are the present value of pension benefits owed to the employees and other beneficiaries. Determining the present value requires a discount rate, which is usually tied to some current level of interest rates in the market. An ironic aspect of funding risk is that assets for meeting the obligations like equities and bonds usually increase in value when interest rates decline, but the present value of future obligations may increase even more. When assets and liabilities change by different amounts, this affects the surplus, and the resulting volatility of the surplus is a source of risk. If the surplus turns negative, additional contributions will be required. This is called **surplus at risk (SaR)**.

One answer to this problem is to immunize the portfolio by making the duration of the assets equal that of the liabilities. This may not be possible since the necessary investments may not be available, and it may not be desirable because it may mean choosing assets with a lower return.

EXAMPLE: Determining a fund’s risk profile

The XYZ Retirement Fund has $200 million in assets and $180 million in liabilities. Assume that the expected return on the surplus, scaled by assets, is 4%. This means the surplus is expected to grow by $8 million over the first year. The volatility of the surplus is 10%. Using a Z-score of 1.65, **compute** VaR and the associated deficit that would occur with the loss associated with the VaR.

Answer:

First, we calculate the expected value of the surplus. The current surplus is $20 million (= $200 million – $180 million). It is expected to grow another $8 million to a value of $28 million. As for the VaR:

VaR = (1.65)(10%)($200 million) = $33 million

If this decline in value occurs, the deficit would be the difference between the VaR and the expected surplus value: $33 million − $28 million = $5 million.

PROFESSOR’S NOTE

According to the assigned reading, the surplus at risk (SaR) is the VaR amount calculated previously. Note that SaR on previous exams has been approached differently, as illustrated in the following example. Be prepared for either approach on the actual exam. In the example to follow, we will illustrate how to calculate the volatility of surplus growth. On previous FRM exams, this value has not been provided.

EXAMPLE: Surplus at risk (via computing volatility of surplus)

The XYZ Retirement Fund has $200 million in assets and $180 million in liabilities. Assume that the expected annual return on the assets is 4% and the expected annual growth of the liabilities is 3%. Also assume that the volatility of the asset return is 10% and the volatility of the liability growth is 7%. **Compute** 95% surplus at risk assuming the correlation between asset return and liability growth is 0.4.

Answer:

First, compute the expected surplus growth:

$$200 \times (0.04) - 180 \times (0.03) = \$2.6 \text{ million}$$

Next, compute the volatility of the surplus growth. To compute the volatility you need to recall one of the properties of covariance discussed in the FRM Part I curriculum. The variance of assets minus liabilities [i.e., Var(A − L)] = Var(A) + Var(L) – 2 × Cov(A,L). Where covariance is equal to the standard deviation of assets times the standard deviation of liabilities times the correlation between the two. The asset and liability amounts will also need to be applied to this formula.

$$\text{Variance}(A - L) = 200^2 \times 0.10^2 + 180^2 \times 0.07^2 - 2 \times 200 \times 180 \times 0.10 \times 0.07 \times 0.4 = 400 + 158.76 - 201.6 = \$357.16 \text{ million}$$

$$\text{Standard deviation} = \sqrt{357.16} = \$18.89$$

Thus, SaR can be calculated by incorporating the expected surplus growth and standard deviation of the growth.

$$95\% \text{ SaR} = 2.6 - 1.65 \times 18.89 = \$28.57 \text{ million}$$

PROFESSOR'S NOTE

Like VaR, SaR is a negative value since it is the surplus amount that is at risk. As a result, the negative sign is usually not presented since a negative amount is implied.

Plan Sponsor Risk

The plan sponsor risk is an extension of surplus risk and how it relates to those who ultimately bear responsibility for the pension fund. We can distinguish between the following risk measures:

- **Economic risk** is the variation in the total economic earnings of the plan sponsor. This takes into account how the risks of the various components relate to each other (e.g., the correlation between the surplus and operating profits).
- **Cash-flow risk** is the variation of contributions to the fund. Being able to absorb fluctuations in cash flow allows for a more volatile risk profile.

Ultimately, from the viewpoint of the sponsor, the focus should be on the variation of the economic value of the firm. The management should integrate the various risks associated with the movement of the assets and surplus with the overall financial goals of the sponsor. This is aligned with the current emphasis on enterprise-wide risk management.

MODULE QUIZ 85.1

1. With respect to the buy side and sell side of the investment industry
   I. the buy side uses more leverage.

II. the sell side has relied more on VaR measures.

A. I only.
B. II only.
C. Both I and II.
D. Neither I nor II.

2. Compared to policy risk, which of the following is not a reason that management risk is not much of a problem?
   A. There will be diversification effects across the deviations.
   B. Managers tend to make the same style shifts at the same time.
   C. For well-managed funds, it is usually fairly small for each of the individual funds.
   D. There can be diversification with the policy mix VaR to actually lower the total portfolio VaR.

MODULE 85.2: MONITORING RISK WITH VAR

LO 85.f: Explain the use of VaR to check manager compliance and monitor risk.

There are many types of risks that can increase dramatically in a large firm. For example, the "rogue trader" phenomenon is more likely in a large firm. This occurs when a manager of one of the accounts or funds within the larger portfolio deviates from her guidelines in terms of portfolio weights or even trades in unauthorized investments. Such deviations from compliance can be very short-term, and regular reporting measures may not catch the violations.

Risk management is necessary for all types of portfolios—even passively managed portfolios. Some analysts erroneously believe that passive investing, or benchmarking, does not require risk monitoring. This is not true because the risk profiles of the benchmarks change over time. In the late 1990s, a portfolio benchmarked to the S&P 500 would clearly have seen a change in risk exposures (e.g., an increase in the exposure to risks associated with the high-tech industry). A forward-looking risk measurement system would pick up on such trends.

Monitoring the risk of actively managed portfolios should help identify the reasons for changes in risk. Three explanations for dramatic changes in risk are (1) a manager taking on more risk, (2) different managers taking similar bets, and (3) more volatile markets. Thus, when there is an increase in the overall risk of a portfolio, top management would want to investigate the increase by asking the following questions.

Has the manager exceeded her risk budget? VaR procedures and risk management can allocate a risk budget to each manager. The procedures should give an indication if and why the manager exceeds the risk budget. Is it a temporary change from changes in the market? Has the manager unintentionally let the weights of the portfolio drift so as to increase risk? Or, more seriously, has the manager engaged in unauthorized trades?

Are managers taking too many of the same style bets? If the managers are acting independently, it is possible that they all start pursuing strategies with the same risk exposures. This could happen, for example, if all managers forecast lower interest rates. Bond managers would probably begin moving into long-term bonds, and equity managers would probably begin moving into stocks that pay a high and stable dividend like utility companies and REITs. This would drastically increase the interest rate risk of the overall portfolio.

Have markets become more volatile? If the risk characteristics of the entire market have changed, top management will have to decide if it is worth accepting the volatility or make decisions to

reduce it by changing the target portfolio weights.

VaR can also be reverse engineered by utilizing the VaR tools outlined in the previous reading, such as component VaR and marginal VaR. These tools provide insight on how the overall portfolio will be affected by individual position changes. This method can be used provided that all relevant risks have been identified within the risk management system.

In the risk management process, there is a problem with measuring the risk of some unique asset classes like real estate, hedge funds, and venture capital. Also, there may be limited information on investments in a certain class (e.g., emerging markets and initial public offerings).

There is a trend in the investment industry toward management choosing a **global custodian** for the firm. Such a choice means an investor aggregates the portfolios with a single custodian, which more easily allows a consolidated picture of the total exposures of the fund. The custodian can combine reports on changes in positions with market data to produce forward-looking risk measures. Thus, the global custodian is an easy choice in pursuing centralized risk management. Along with the trend toward global custodians, there has been a trend in the "custodian industry" toward fewer custodians that can provide more services. Large custodian banks such as Citibank, Deutsche Bank, and State Street are providing risk management products.

Those that choose not to use a global custodian have done so because they feel that they have a tighter control over risk measures and can better incorporate VaR systems into operations. There are often economies of scale for larger firms in that they can spread the cost of risk management systems over a large asset base. Also, they can require tighter control when their assets are partly managed internally.

Increasingly, clients are asking money managers about their risk management systems. The clients are no longer satisfied with quarterly performance reports. Many investment managers have already incorporated VaR systems into their investment management process. Widely used risk standards for institutional investors recommend measuring the risk of the overall portfolio and measuring the risk of each instrument. It may be the case that those who do not have comprehensive risk management systems will soon be at a significant disadvantage to those who do have such systems. There also seems to be some attempt by managers to differentiate themselves with respect to risk management.

VaR Applications

LO 85.g: Explain how VaR can be used in the development of investment guidelines and for improving the investment process.

Investment Guidelines

VaR can help move away from the ad hoc nature and overemphasis on notionals and sensitivities that characterize the guidelines many managers now use. Clearly, ad hoc procedures will generally be inferior to formal guidelines using established principles. Also, limits on notionals and sensitivities have proven insufficient when leverage and positions in derivatives exist. The limits do not account for variations in risk nor correlations. VaR limits include all of these factors.

The problem with controlling positions and not risk is that there are many rules and restrictions, which in the end may not achieve the main goal. There is no measure of the possible losses that can occur in a given time period—a good quantity to identify in order to know how much capital to have on hand to meet liquidity needs. Furthermore, simple restrictions on certain positions can be easily evaded with the many instruments that are now available. As a wider range of products develop, obviously, the traditional and cumbersome position-by-position guidelines will become even less effective.

Investment Process

VaR can help in the first step of the investment process, which is the strategic asset-allocation decision. Since this step usually uses mean-variance analysis, as does the most basic VaR measures, VaR can help in the portfolio allocation process. Furthermore, VaR can measure specific changes in risk that can result as managers subjectively adjust the weights from those recommended by pure quantitative analysis.

VaR is also useful at the trading level. A trader usually focuses on the return and stand-alone risk of a proposed position. The trader may have some idea of how the risk of the position will affect the overall portfolio, but an adequate risk management system that uses VaR can give a specific estimate of the change in risk. In fact, the risk management system should stand ready to automatically calculate the marginal VaR of each existing position and proposed position. When the trader has the choice between adding one of two positions with similar return characteristics, the trader would choose the one with the lower marginal VaR. VaR methodology can help make choices between different assets too. The optimal portfolio will be the one that has the excess-return-to-marginal VaR ratios equal for all asset types, as seen in the previous reading. Thus, when a trader is searching for the next best investment, the trader will look at securities in the asset classes that currently have the higher returns-to-marginal-VaR ratios.

Budgeting Risk

LO 85.h: Describe the risk budgeting process and calculate risk budgets across asset classes and active managers.

Risk budgeting should be a top down process. The first step is to determine the total amount of risk, as measured by VaR, that the firm is willing to accept. The next step is to choose the optimal allocation of assets for that risk exposure. As an example, a firm's management might set a return volatility target equal to 20%. If the firm has $100 million in assets under management and assuming the returns are normally distributed, at a 95% confidence level, this translates to:

$$\text{VaR} = (1.65) \times (20\%) \times (\$100 \text{ million}) = \$33 \text{ million}$$

The goal will be to choose assets for the fund that keep VaR less than this value. Unless the asset classes are perfectly correlated, the sum of the VaRs of the individual assets will be greater than the actual VaR of the portfolio. Thus, the budgeting of risk across asset classes should take into account the diversification effects. Such effects can be carried down to the next level when selecting the individual assets for the different classes.

> **EXAMPLE: Budgeting risk across asset classes (part 1)**

A manager has a portfolio with only one position: a $500 million investment in W. The manager is considering adding a $500 million position X or Y to the portfolio. The current volatility of W is 10%. The manager wants to limit portfolio VaR to $200 million at the 99% confidence level. Position X has a return volatility of 9% and a correlation with W equal to 0.7. Position Y has a return volatility of 12% and a correlation with W equal to zero. **Determine** which of the two proposed additions, X or Y, will keep the manager within his risk budget.

Answer:

Currently, the VaR of the portfolio with only W is:

VaR_{W} = (2.33)(10%)($500 million) = $116.5 million

When adding X, the return volatility of the portfolio will be:

$$8.76\% = \sqrt{\left(0.5^2\right)\left(10\%\right)^2 + \left(0.5^2\right)\left(9\%\right)^2 + \left(2\right)\left(0.5\right)\left(0.5\right)\left(0.7\right)\left(10\%\right)\left(9\%\right)}$$

$$\text{VaR}_{\text{W+X}} = 2.33(8.76\%)(\$1,000 \text{ million}) = \$204 \text{ million}$$

When adding Y, the return volatility of the portfolio will be:

$$7.81\% = \sqrt{\left(0.5^2\right)\left(10\%\right)^2 + \left(0.5^2\right)\left(12\%\right)^2}$$

$$\text{VaR}_{\text{W+X}} = (2.33)(7.81\%)(\$1,000 \text{ million}) = \$182 \text{ million}$$

Thus, Y keeps the total portfolio within the risk budget.

EXAMPLE: Budgeting risk across asset classes (part 2)

In the previous example, **demonstrate** why focusing on the stand-alone VaR of X and Y would have led to the wrong choice.

Answer:

Obviously, the VaR of X is less than that of Y.

VaR_{X} = (2.33)(9%)($500 million) = $104.9 million

VaR_{Y} = (2.33)(12%)($500 million) = $139.8 million

The individual VaRs would have led the manager to select X over Y; however, the high correlation of X with W gives X a higher incremental VaR, which puts the portfolio of W and X over the limit. The zero correlation of W and Y makes the incremental VaR of Y much lower, and the portfolio of W with Y keeps the risk within the limit.

The traditional method for evaluating active managers is by measuring their excess return and tracking error and using it to derive a measure known as the information ratio. Excess return is the active return minus the benchmark return. The **information ratio** of manager *i* is:

$$\text{IR}_{\text{i}} = \frac{(\text{expected excess return of the manager})}{(\text{the manager's tracking error})}$$

For a portfolio of funds, each managed by a separate manager, the top management of the entire portfolio would be interested in the portfolio information ratio:

$$\text{IR}_{\text{P}} = \frac{(\text{expected excess return of the portfolio})}{(\text{the portfolio's tracking error})}$$

If the excess returns of the managers are independent of each other, it can be shown that the optimal allocation across managers is found by allocating weights to managers according to the following formula:

$$\text{weight of portfolio managed by manager } i = \frac{\text{IR}_\text{i} \times (\text{portfolio's tracking error})}{\text{IR}_\text{P} \times (\text{manager's tracking error})}$$

One way to use this measure is to "budget" portfolio tracking error. Given the IR_P, the IR_i, and the manager's tracking error, top management can calculate the respective weights to assign to each manager. The weights of the allocations to the managers do not necessarily have to sum to one. Any difference can be allocated to the benchmark itself because, by definition, $\text{IR}_\text{benchmark} = 0$.

Determining the precise weights will be an iterative process in that each selection of weights will give a different portfolio expected excess return and tracking error. Figure 85.2 illustrates a set of weights derived from the given inputs that satisfy the condition.

Figure 85.2: Budgeting Risk Across Active Managers

	Tracking Error	Information Ratio	Weights
Manager A	5.0%	0.70	51%
Manager B	5.0%	0.50	37%
Benchmark	0.0%	0.00	12%
Portfolio	3.0%	0.82	100%

Although we have skipped the derivation, we can see that the conditions for optimal allocation hold true:

$$\text{For A: } 51\% = \frac{(3\%)(0.70)}{(5\%)(0.82)}$$

$$\text{For B: } 37\% = \frac{(3\%)(0.50)}{(5\%)(0.82)}$$

The difference between 100% and the sum of the weights 51% and 37% is the 12% invested in the benchmark.

MODULE QUIZ 85.2

1. Using VaR to monitor risk is important for a large firm with many types of managers because:
   A. it can help catch rogue traders and it can detect changes in risk from changes in benchmark characteristics.
   B. although it cannot help catch rogue traders, it can detect changes in risk from changes in benchmark characteristics.
   C. although it cannot detect changes in risk from changes in benchmark characteristics, it can help detect rogue traders.
   D. of no reason. VaR is not useful for monitoring risk in large firms.
2. VaR can be used to compose better guidelines for investment companies by
   I. relying less on notionals.
   II. focusing more on overall risk.

A. I only.
B. II only.
C. Both I and II.
D. Neither I nor II.

3. In making allocations across active managers, which of the following represents the formula that gives the optimal weight to allocate to a manager denoted *i*, where IR_i and IR_P are the information ratios of the manager and the total portfolio respectively?

1. $$\frac{IR_P \times (\text{portfolio's tracking error})}{IR_i \times (\text{manager's tracking error})}$$
2. $$\frac{IR_i \times (\text{manager's tracking error})}{IR_P \times (\text{portfolio's tracking error})}$$
3. $$\frac{IR_i \times (\text{portfolio's tracking error})}{IR_P \times (\text{manager's tracking error})}$$
4. $$\frac{IR_P \times (\text{manager's tracking error})}{IR_i \times (\text{portfolio's tracking error})}$$

KEY CONCEPTS

LO 85.a

Risk budgeting is a top-down process that involves choosing and managing exposures to risk.

LO 85.b

Compared to banks on the "sell side," investors on the "buy side" have a longer horizon, slower turnover, and lower leverage. They have tended to use historical risk measures and focus on tracking error, benchmarking, and investment guidelines. Banks use forward-looking VaR risk measures and VaR limits. Investors seem to be using VaR more and more, but they have to adapt it to their needs.

LO 85.c

Investors are relying more on VaR because of increased globalization, complexity, and dynamics of the investment industry. They have found simply measuring risk from historical measures is no longer adequate.

LO 85.d

Hedge funds have risk characteristics that make them more similar to the "sell side" of the industry like the use of leverage and high turnover. In addition to that, they have other risks such as low liquidity and low transparency. Low liquidity leads to problems in measuring risk because it tends to put a downward bias on volatility and correlation measures.

LO 85.e

Absolute or asset risk refers to the total possible losses over a horizon. Relative risk is measured by excess return, which is the dollar loss relative to a benchmark. VaR measures can apply to both.

The risk from the policy mix is from the chosen portfolio weights, and active risk is from individual managers deviating from the chosen portfolio weights.

Funding risk is the risk that the value of assets will not be sufficient to cover the liabilities of the fund. It is important for pension funds. In applying VaR, a manager will add the expected increase in the surplus to the surplus and subtract the VaR of the assets from it. The difference between the expected surplus and the portfolio VaR is the shortfall associated with the VaR.

Two components of sponsor risk are cash-flow risk, which addresses variations of contributions to the fund, and economic risk, which is the variation of the earnings.

LO 85.f

Risk monitoring is important in large firms to catch "rogue traders" whose activities may go undetected with simple periodic statements. It is also needed for passive portfolios because the risk characteristics of the benchmarks can change. Risk monitoring can also determine why changes in risk have occurred (e.g., individual managers exceeding their budget, different managers taking on the same exposures, or the risk characteristics of the whole market changing).

There is a trend toward using a global custodian in the risk management of investment firms. It is an easy means to the goal of centralized risk management. The custodians can combine reports on

changes in positions with market data to produce forward-looking risk measures. Those that choose not to use a global custodian have done so because they feel they have tighter control over risk measures and can better incorporate VaR systems into operations.

LO 85.g

There is a trend of investment managers incorporating VaR systems into their investment management process. There is evidence that money managers are differentiating themselves with respect to their risk management systems, and those that do not use such systems are at a competitive disadvantage.

VaR techniques can help move away from the ad hoc nature and overemphasis on notionals and sensitivities that characterize the guidelines many managers now use. Such guidelines are cumbersome and ineffective in that they focus on individual positions and can be easily circumvented.

VaR is useful for the investment process. When a trader has a choice between two new positions for a portfolio, the trader can compare the marginal VaRs to make the selection. When deciding whether to increase one existing position over another, the trader can compare the excess-return-to-MVaR ratios and increase the position in the one with the higher ratio.

LO 85.h

Budgeting risk across asset classes means selecting assets whose combined VaRs are less than the total allowed. The budgeting process would examine the contribution each position makes to the portfolio VaR.

For allocating across active managers, it can be shown that the optimal allocation is achieved with the following formula:

$$\text{weight of portfolio managed by manager } i = \frac{\text{IR}_\text{i} \times (\text{portfolio's tracking error})}{\text{IR}_\text{p} \times (\text{manager's tracking error})}$$

For a given group of active managers, the weights may not sum to one. The remainder of the weight can be allocated to the benchmark, which has no tracking error.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 85.1

1. **B** Compared to banks on the "sell side," investors on the "buy side" have a longer horizon, slower turnover, and lower leverage. Banks use forward-looking VaR risk measures and VaR limits. (LO 85.b)
2. **B** If managers make the same style shifts, then that would actually increase management risk. All the other reasons are valid. (LO 85.e)

Module Quiz 85.2

1. **A** Both of these are reasons large firms find VaR and risk monitoring useful. (LO 85.f)
2. **C** Investment companies have been focusing on limits on notionals, which is cumbersome and has proved to be ineffective. (LO 85.g)
3. **C** $\text{weight of portfolio managed by manager} i = \dfrac{\text{IR}_\text{i} \times (\text{portfolio's tracking error})}{\text{IR}_\text{P} \times (\text{manager's tracking error})}$

   (LO 85.h)

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Litterman, Chapter 17.

READING 86: RISK MONITORING AND PERFORMANCE MEASUREMENT

Litterman, Chapter 17

EXAM FOCUS

Most of this reading is qualitative in nature, however, it does contain several testable concepts. Many of the concepts covered here are also covered in other assigned readings, so this reading should serve as reinforcement of those concepts. For the exam, focus on the three dimensions of effective risk management: planning, budgeting, and monitoring. Understand the concept of a risk management unit (RMU) and be able to discuss its appropriate role within a company. Always keep in mind while reviewing this reading that it is the amount of risk taken that ultimately drives the level of returns—risk is the "cost" of returns.

MODULE 86.1: RISK PLANNING, BUDGETING, AND MONITORING

LO 86.a: Describe the three fundamental dimensions behind risk management, and their relation to VaR and tracking error.

Value at risk (VaR) is defined to be the *largest* loss possible for a *certain* level of confidence over a *specific* period of time. For example, a firm could express its VaR as being 95% certain that they will lose a maximum of $5 million in the next ten days. Delta-normal VaR assumes a normal distribution, and its calculation reflects losses in the lower tail of the returns distribution.

Tracking error is defined as the standard deviation of excess returns. Excess return is defined as the portfolio return less the benchmark return (i.e., alpha). Assuming a normal distribution of excess returns, 95% of the outcomes will fall within the mean benchmark return plus or minus roughly two standard deviations.

VaR and tracking error are both measures of risk. An organization's objective is to maximize profits for a given level of risk taken. Too much risk taken suggests a VaR level that is too high and a willingness to accept large losses to produce unnecessarily high returns. Too little risk taken suggests that there is not enough active management.

VaR may be used to identify the maximum dollar value of losses for a specific level of confidence over a specific time. From a portfolio management perspective, VaR could be determined for each asset class, and capital allocation decisions could be made amongst the asset classes depending on risk and return preferences. This will help to achieve targeted levels of dollar VaR. In contrast, tracking error may be used to determine the relative amount of discretion that can be taken by the portfolio manager (away from benchmark returns) in his or her attempts at active management.

An effective risk management process has three related dimensions: risk planning, risk budgeting, and risk monitoring. A risk plan creates expectations for return and risk (e.g., VaR and tracking error). A risk budget allocates capital to meet those expectations, and risk monitoring identifies any variations from budget.

Risk Planning

LO 86.b: Describe risk planning, including its objectives, effects, and the participants in its development.

There are five risk planning objectives for any entity to consider.

1. Setting expected return and expected volatility goals.

   Examples of an entity's goals could include specifying the acceptable amounts of VaR and tracking error for a given period of time. Scenario analysis could be employed to determine potential sources of failure in the plan as well as ways to respond should those sources occur.
2. Defining quantitative measures of success or failure.

   Specific guidelines should be stated. For example, one could state an acceptable level of return on equity (ROE) or return on risk capital (RORC). This would help regulatory agencies assess the entity's success or failure from a risk management perspective.
3. Generalizing how risk capital will be utilized to meet the entity's objectives.

   Objectives relating to return per unit of risk capital need to be defined. For example, the minimum acceptable RORC should be defined for each activity where risk is allocated from the budget. The correlations between the RORCs should also be considered within an entity-wide risk diversification context.
4. Defining the difference between events that cause ordinary damage versus serious damage.

   Specific steps need to be formulated to counter any event that threatens the overall long-term existence of the entity, even if the likelihood of occurrence is remote. The choice between seeking external insurance (i.e., put options) versus self-insurance for downside portfolio risk has to be considered from a cost-benefit perspective, taking into account the potential severity of the losses.
5. Identifying mission critical resources inside and outside the entity and discussing what should be done in case those resources are jeopardized.

   Examples of such resources would include key employees and financing sources. Scenario analysis should be employed to assess the impact on those resources in both good and bad times. Specifically, adverse events often occur together with other adverse (and material) events.

In general, the risk planning process frequently requires the input and approval of the entity's owners and its management team. An effective plan requires very active input from the entity's highest level of management so as to ensure risk and return issues are addressed, understood, and communicated within the entity, to key stakeholders, and to regulatory agencies.

Risk Budgeting

LO 86.c: Describe risk budgeting and the role of quantitative methods in risk budgeting.

The risk budget quantifies the risk plan. There needs to be a structured budgeting process to allocate risk capital to meet the entity's objectives and minimize deviations from the plan. Each specific allocation from the risk budget comes with a reasonable return expectation. The return expectation comes with an estimate of variability around that expectation.

With risk budgets, an amount of VaR could be calculated for each item on the income statement. This allows RORC to be calculated individually and in aggregate.

Quantitative methods (i.e., mathematical modeling) may be used in risk budgeting as follows:

1. Set the minimum acceptable levels of RORC and ROE over various time periods. This is to determine if there is sufficient compensation for the risks taken (i.e., risk-adjusted profitability).
2. Apply mean-variance optimization (or other quantitative methods) to determine the weights for each asset class.
3. Simulate the portfolio performance based on the weights and for several time periods. Apply sensitivity analysis to the performance by considering changes in estimates of returns and covariances.

Risk Monitoring

LO 86.d: Describe risk monitoring and its role in an internal control environment.

Within an entity's internal control environment, risk monitoring attempts to seek and investigate any significant variances from budget. This is to ensure, for example, that there are no threats to meeting its ROE and RORC targets. Risk monitoring is useful in that it should detect and address any significant variances in a timely manner.

LO 86.e: Identify sources of risk consciousness within an organization.

The increasing sense of risk consciousness within and among organizations is mainly derived from the following three sources:

1. *Banks* who lend funds to investors are concerned with where those funds are invested.
2. *Boards of investment clients, senior management, and plan sponsors* have generally become more versed in risk management issues and more aware of the need for effective oversight over asset management activities.
3. *Investors* have become more knowledgeable about their investment choices. For example, beneficiaries of a defined contribution plan are responsible for selecting their individual pension investments.

MODULE QUIZ 86.1

1. Which of the following statements about tracking error and value at risk (VaR) is least accurate?
   A. Tracking error and VaR are complementary measures of risk.
   B. Both tracking error and VaR may assume a normal distribution of returns.
   C. Tracking error is the standard deviation of the excess of portfolio returns over the return of the peer group.

D. VaR can be defined as the maximum loss over a given period at a given level of confidence.

2. Which of the following statements about the use of quantitative methods in risk budgeting is least accurate? They may be used:
   A. to simulate the performance of portfolios.
   B. to set levels of return on equity (ROE) and return on risk capital (RORC).
   C. in a scenario analysis context to determine the weights for each asset class.
   D. in a sensitivity analysis context to consider changes in estimates of returns and covariances.

MODULE 86.2: RISK MANAGEMENT UNITS, LIQUIDITY CONSIDERATIONS, AND PERFORMANCE MEASUREMENT

Risk Management Units

LO 86.f: Describe the objectives and actions of a risk management unit in an investment management firm.

A **risk management unit (RMU)** monitors an investment management entity's portfolio risk exposure and ascertains that the exposures are authorized and consistent with the risk budgets previously set. To ensure proper segregation of duties, it is crucial that the risk management function has an independent reporting line to senior management.

The objectives of a RMU include:

- Gathering, monitoring, analyzing, and distributing risk data to managers, clients, and senior management. Accurate and relevant information must be provided to the appropriate person(s) at the appropriate time(s).
- Assisting the entity in formulating a systematic and rigorous method as to how risks are identified and dealt with. Promotion of the entity's risk culture and best risk practices is crucial here.
- Going beyond merely providing information by taking the initiative to research relevant risk topics that will affect the firm.
- Monitoring trends in risk on a continual basis and promptly reporting unusual events to management before they become significant problems.
- Promoting discussion throughout the entity and developing a process as to how risk data and issues are discussed and implemented within the entity.
- Promoting a greater sense of risk awareness (culture) within the entity.
- Ensuring that transactions that are authorized are consistent with guidance provided to management and with client expectations.
- Identifying and developing risk measurement and performance attribution analytical tools.
- Gathering risk data to be analyzed in making portfolio manager assessments and market environment assessments.
- Providing the management team with information to better comprehend risk in individual portfolios as well as the source of performance.
- Measuring risk within an entity. In other words, measuring how consistent portfolio managers are with respect to product objectives, management expectations, and client objectives.

Significant deviations are brought to the attention of appropriate management to provide a basis for correction.

PROFESSOR'S NOTE

You may see references elsewhere to an Independent Risk Oversight Unit. This is the same concept as RMU. Both measure and manage risk exposure and operate as an independent business unit.

LO 86.g: Describe how risk monitoring can confirm that investment activities are consistent with expectations.

Is the manager generating a forecasted level of tracking error that is consistent with the target?

The forecasted tracking error is an approximation of the potential risk of a portfolio using statistical methods. For each portfolio, the forecast should be compared to budget using predetermined guidelines as to how much variance is acceptable, how much variance requires further investigation, and how much variance requires immediate action. Presumably, the budget was formulated taking into account client expectations.

Tracking error forecast reports should be produced for all accounts that are managed similarly in order to gauge the consistency in risk levels taken by the portfolio manager.

Is risk capital allocated to the expected areas?

Overall tracking risk is not sufficient as a measure on its own; it is important to break down the tracking risk into "subsections." If the analysis of the risk taken per subsection does not suggest that risk is being incurred in accordance with expectations, then there may be **style drift**. Style drift may manifest itself in a value portfolio manager who attains the overall tracking error target but allocates most of the risk (and invests) in growth investments.

Therefore, by engaging in risk decomposition, the RMU may ensure that a portfolio manager's investment activities are consistent with the predetermined expectations (i.e., stated policies and manager philosophy). Also, by running the report at various levels, unreasonably large concentrations of risk (that may jeopardize the portfolio) may be detected.

Liquidity Considerations

LO 86.h: Describe the Liquidity Duration Statistic and how it can be used to measure liquidity.

Liquidity considerations are important because a portfolio's liquidity profile could change significantly in the midst of a volatile market environment or an economic downturn, for instance. Therefore, measuring portfolio liquidity is a priority in stress testing.

One potential measure is **liquidity duration**. It is an approximation of the number of days necessary to dispose of a portfolio's holdings without a significant market impact. For a given security, the liquidity duration could be calculated as follows:

$$\text{LD} = \frac{\text{Q}}{(0.10 \times \text{V})}$$

where:

LD = liquidity duration for the security on the assumption that the desired maximum daily volume of any security is 10%
Q = number of shares of the security
V = daily volume of the security

Performance Measurement

LO 86.i: Describe the objectives of performance measurement tools.

Performance measurement looks at a portfolio manager's actual results and compares them to relevant comparables such as benchmarks and peer groups. Therefore, performance measurement seeks to determine whether a manager can consistently outperform (through excess returns) the benchmark on a risk-adjusted basis. Similarly, it seeks to determine whether a manager consistently outperforms its peer group on a risk-adjusted basis.

Furthermore, performance measurement may help to determine whether the returns achieved are commensurate with the risk taken. Finally, performance measurement provides a basis for identifying managers who are able to generate consistent excess risk-adjusted returns. Such superior processes and performance could be replicated on an on-going basis, thereby maximizing the entity's long-run returns and profitability.

Comparison of Performance With Expectations

From a risk perspective (e.g., tracking error), portfolio managers should be assessed on the basis of being able to produce a portfolio with risk characteristics that are expected to approximate the target. In addition, they should also be assessed on their ability to actually achieve risk levels that are close to target.

From a returns perspective (e.g., performance), portfolio managers could be assessed on their ability to earn excess returns.

Goldman Sachs Asset Management utilizes a so-called "green zone" to identify instances of actual tracking error or performance that are outside of normal expectations. An acceptable amount of deviation (from a statistical perspective) is determined, and any deviations up to that amount are considered a green zone event. Unusual events that are expected to occur with some regularity are considered "yellow zone" events. Truly unusual events that require immediate investigation are considered "red zone" events. In using this simple color-coded system, the various zones are predefined and provide clear expectations for the portfolio managers. The movements of portfolios into yellow or red zones are triggering events that require further investigation and discussion.

Return Attribution

The source of returns can be attributed to specific factors or securities. For example, it is important to ensure that returns result from decisions where the manager intended to take risk and not simply from sheer luck.

Variance analysis is used to illustrate the contribution to overall portfolio performance by each security. The securities can be regrouped in various ways to conduct analysis by industry, sector, and country, for example.

In performing return attribution, factor risk analysis and factor attribution could be used. Alternatively, risk forecasting and attribution at the security level could also be used.

Sharpe and Information Ratio

The **Sharpe ratio** is calculated by taking the portfolio's actual return and subtracting the risk-free rate in the numerator. The denominator is the portfolio's standard deviation. The **information ratio** is calculated by taking the portfolio's excess returns and subtracting the benchmark's excess returns (if applicable) in the numerator. The denominator is the portfolio's tracking error. These two measures are both considered risk-adjusted return measures.

Strengths of these metrics include the following: (1) easy to use as a measure of relative performance compared to a benchmark or peer group; (2) easy to determine if the manager has generated sufficient excess returns in relation to the amount of risk taken; and (3) easy to apply to industrial sectors and countries.

Weaknesses of these metrics include the following: (1) insufficient data available to perform calculations; and (2) the use of realized risk (instead of potential risk) may result in overstated performance calculations.

Comparisons With Benchmark Portfolios and Peer Groups

LO 86.j: Describe the use of alpha, benchmarks, and peer groups as inputs in performance measurement tools.

One could use linear regression analysis to regress the excess returns of the investment against the excess returns of the **benchmark**. One of the outputs from this regression is **alpha**, and it could be tested for statistical significance to determine whether the excess returns are attributable to manager skill or just pure luck. The other output is **beta**, and it relates to the amount of leverage used or underweighting/overweighting in the market compared to the benchmark.

The regression also allows a comparison of the absolute amount of excess returns compared to the benchmark. Furthermore, there is the ability to separate excess returns due to leverage and excess returns due to skill. One limitation to consider is that there may not be enough data available to make a reasonable conclusion as to the manager's skill.

One could also regress the excess returns of the manager against the excess returns of the manager's **peer group**. The features of this regression are generally similar to that for the benchmark, except that the returns of the peer group suffer from **survivorship bias**, and there is usually a wide range of funds under management amongst the peers (that reduces the comparability).

MODULE QUIZ 86.2

1. A risk management unit (RMU) is most likely to be active in which of the following contexts?
   A. Risk monitoring.
   B. Risk measurement.
   C. Risk budgeting.
   D. Risk planning.
2. Which of the following statements does not help explain the purpose of risk decomposition?
   A. To ensure that there is no style drift.
   B. To detect large concentrations of risk.

C. To detect excessive amounts of tracking risk.
D. To ensure that investment activities are consistent with expectations.

3. Which of the following statements regarding alphas and betas is incorrect?
   A. Alpha is the excess return attributable to pure luck.
   B. Alpha is the excess return attributable to managerial skill.
   C. Beta suggests the relative amount of leverage used.
   D. Beta suggests whether some of the returns are attributable to over or under weighting the market.

KEY CONCEPTS

LO 86.a

VaR and tracking error are both measures of risk. VaR is defined to be the largest loss possible for a certain level of confidence over a specific period of time. Tracking error is defined as the standard deviation of excess returns.

LO 86.b

There are five risk planning objectives to consider.

- Setting expected return and expected volatility goals.
- Defining quantitative measures of success or failure.
- Generalizing how risk capital will be utilized to meet the entity's objectives.
- Defining the difference between events that cause ordinary damage versus serious damage.
- Identifying mission critical resources inside and outside the entity and discussing what should be done in case those resources are jeopardized.

The risk planning process frequently requires the input and approval of the entity's owners and its management team.

LO 86.c

The risk budget quantifies the risk plan. There needs to be a structured budgeting process to allocate risk capital to meet the corporate objectives and minimize deviations from plan.

Quantitative methods may be used in risk budgeting. Activities include: setting the minimum acceptable levels of RORC and ROE, applying mean-variance optimization, simulating portfolio performance, and applying sensitivity analysis.

LO 86.d

Within an entity's internal control environment, risk monitoring attempts to seek and investigate any significant variances from budget.

LO 86.e

Sources of risk consciousness include: (1) banks, (2) boards of investment clients, senior management, and plan sponsors, and (3) investors.

LO 86.f

A risk management unit (RMU) monitors an investment management entity's portfolio risk exposure and ascertains that the exposures are authorized and consistent with the risk budgets previously set. To ensure proper segregation of duties, it is crucial that the risk management function has an independent reporting line to senior management.

LO 86.g

The risk monitoring process attempts to confirm that investment activities are consistent with expectations. Specifically, is the manager generating a forecasted level of tracking error that is consistent with the target? And is risk capital allocated to the expected areas?

LO 86.h

Liquidity considerations are important because a portfolio's liquidity profile could change significantly in the midst of a volatile market environment or an economic downturn, for instance.

LO 86.i

Performance measurement looks at a portfolio manager's actual results and compares them to relevant comparables such as benchmarks and peer groups.

A performance measurement framework includes: (1) comparison of performance with expectations, (2) return attribution, (3) calculation of metrics such as the Sharpe ratio and the information ratio, and (4) comparisons with benchmark portfolios and peer groups.

LO 86.j

The excess returns of an investment can be regressed against the excess returns of its benchmark (e.g., S&P 500 Index). An output from this regression is alpha, which determines whether the investment's excess returns are due to skill or luck.

The excess returns of a manager can be regressed against the excess returns of the manager's peer group. This is similar to the liner regression with a benchmark portfolio, but differs since it suffers from survivorship bias.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 86.1

1. **C** All of the statements are accurate with the exception of the one relating to the peer group. Tracking error is the standard deviation of the excess of portfolio returns over the return of an appropriate benchmark, not peer group. (LO 86.a)
2. **C** All of the statements are accurate with the exception of the one relating to scenario analysis. One should apply mean-variance optimization (and not scenario analysis) to determine the weights for each asset class. (LO 86.c)

Module Quiz 86.2

1. **A** A RMU monitors an investment management firm's portfolio risk exposure and ascertains that the exposures are authorized and consistent with the risk budgets previously set. (LO 86.f)
2. **C** Risk decomposition is not designed to detect excessive amounts of tracking risk. In fact, it is the forecasted tracking error amount that should be compared to budget to ensure that there is not excessive tracking risk. All the other reasons are consistent with the purpose of risk decomposition. (LO 86.g)
3. **A** Alpha is a measure of the excess return of a manager over the peer group/benchmark that relates to skill as opposed to pure luck. Beta is a measure of the amount of leverage used compared to the peer group or a measure of the underweighting or overweighting of the market compared to the benchmark. (LO 86.j)

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Bodie, Kane, and Marcus, Chapter 24.

READING 87: PORTFOLIO PERFORMANCE EVALUATION

Bodie, Kane, and Marcus, Chapter 24

EXAM FOCUS

Professional money managers are routinely evaluated using a wide array of metrics. In this reading, alternative methods of computing portfolio returns will be presented, and contrasts will be made between time-weighted and dollar-weighted returns for portfolios experiencing cash redemptions and contributions. For the exam, be sure to understand differences in the risk-adjusted performance measures, including the Sharpe ratio, Treynor ratio, Jensen's alpha, information ratio, and M^2, and how the trading practices of hedge funds complicates the evaluation process. Be able to apply Sharpe's regression-based style analysis to conduct performance attributions.

MODULE 87.1: TIME-WEIGHTED AND DOLLAR-WEIGHTED RETURNS

LO 87.a: Differentiate between the time-weighted and dollar-weighted returns of a portfolio and describe their appropriate uses.

The **dollar-weighted rate of return** is defined as the internal rate of return (IRR) on a portfolio, taking into account all cash inflows and outflows. The beginning value of the account is an inflow as are all deposits into the account. All withdrawals from the account are outflows, as is the ending value.

EXAMPLE: Dollar-weighted rate of return

Assume an investor buys a share of stock for $100 at t = 0, and at the end of the next year (t = 1), she buys an additional share for $120. At the end of year 2, the investor sells both shares for $130 each. At the end of each year in the holding period, the stock paid a $2.00 per share dividend. What is the investor's dollar-weighted rate of return?

Answer:

Step 1: Determine the timing of each cash flow and whether the cash flow is an inflow (+) or an outflow (–).

t = 0:	purchase of first share	= –$100
t = 1:	dividend from first share	= +$2
	purchase of second share	= –$120
	subtotal, t = 1	–$118
t = 2:	dividend from two shares	= +$4
	proceeds from selling shares	= +$260
	subtotal, t = 2	+$264

Step 2: Net the cash flows for each time period, and set the PV of cash inflows equal to the present value of cash outflows.

$$PV_{inflows} = PV_{outflows}$$

$$\$100 + \frac{\$120}{(1+r)} = \frac{\$2}{(1+r)} + \frac{\$264}{(1+r)^2}$$

Step 3: Solve for r to find the dollar-weighted rate of return. This can be done using trial and error or by using the IRR function on a financial calculator or spreadsheet.

The intuition here is that we deposited $100 into the account at t = 0, then added $118 to the account at t = 1 (which, with the $2 dividend, funded the purchase of one more share at $120), and ended with a total value of $264.

To compute this value with a financial calculator, use these net cash flows and follow the procedure described in Figure 87.1 to calculate the IRR.

Net cash flows: $CF_0 = -100$; $CF_1 = -120 + 2 = -118$;
$CF_2 = 260 + 4 = 264$

Figure 87.1: Calculating Dollar-Weighted Return With the TI Business Analyst II Plus® Calculator

Key Strokes	Explanation	Display
[CF] [2nd] [CLR WORK]	Clear cash flow registers	CF0 = 0.00000
100 [+/–] [ENTER]	Initial cash outlay	CF0 = –100.00000
[↓] 118 [+/–] [ENTER]	Period 1 cash flow	C01 = –118.00000
[↓] [↓] 264 [ENTER]	Period 2 cash flow	C02 = 264.00000
[IRR] [CPT]	Calculate IRR	IRR = 13.86122

The dollar-weighted rate of return for this problem is 13.86%.

Time-weighted rate of return measures compound growth. It is the rate at which $1.00 compounds over a specified time horizon. Time-weighting is the process of averaging a set of values over time. The *annual* time-weighted return for an investment may be computed by performing the following steps:

Step 1: Value the portfolio immediately preceding significant addition or withdrawals. Form subperiods over the evaluation period that correspond to the dates of deposits and withdrawals.

Step 2: Compute the holding period return (HPR) of the portfolio for each subperiod.

Step 3: Compute the product of $(1 + HPR_t)$ for each subperiod t to obtain a total return for the entire measurement period [i.e., $(1 + HPR_1) \times (1 + HPR_2) \ldots (1 + HPR_n)$]. If the total investment period is greater than one year, you must take the geometric mean of the measurement period return to find the annual time-weighted rate of return.

EXAMPLE: Time-weighted rate of return

A share of stock is purchased at t = 0 for $100. At the end of the next year, t = 1, another share is purchased for $120. At the end of year 2, both shares are sold for $130 each. At the end of years 1 and 2, the stock paid a $2.00 per share dividend. What is the time-weighted rate of return for this investment? (This is the same data as presented in the dollar-weighted rate-of-return example.)

Answer:

Step 1: Break the evaluation period into two subperiods based on timing of cash flows.

Holding period 1: beginning price = $100.00
dividends paid = $2.00
ending price = $120.00

Holding period 2: beginning price = $240.00 (2 shares)
dividends paid = $4.00 ($2 per share)
ending price = $260.00 (2 shares)

Step 2: Calculate the HPR for each holding period.

$$HPR_1 = [(\$120 + 2) / \$100] - 1 = 22\%$$

$$HPR_2 = [(\$260 + 4) / \$240] - 1 = 10\%$$

Step 3: Take the geometric mean of the annual returns to find the annualized time-weighted rate of return over the measurement period.

$$(1 + \text{time-weighted rate of return})^2 = (1.22)(1.10)$$

$$\text{time-weighted rate of return} = \left[\sqrt{(1.22)(1.10)}\right] - 1 = 15.84\%$$

In the investment management industry, the time-weighted rate of return is the preferred method of performance measurement for a portfolio manager because it is not affected by the timing of cash inflows and outflows, which may be beyond the manager's control.

In the preceding examples, the time-weighted rate of return for the portfolio was 15.84%, while the dollar-weighted rate of return for the same portfolio was 13.86%. The difference in the results is attributable to the fact that the procedure for determining the dollar-weighted rate of return gave a larger weight to the year 2 HPR, which was 10% versus the 22% HPR for year 1.

If funds are contributed to an investment portfolio just before a period of relatively poor portfolio performance, the dollar-weighted rate of return will tend to be depressed. Conversely, if funds are contributed to a portfolio at a favorable time, the dollar-weighted rate of return will increase. The use of the time-weighted return removes these distortions, providing a better measure of a manager's ability to select investments over the period. If a private investor has complete control over money flows into and out of an account, the dollar-weighted rate of return may be the more appropriate performance measure.

Therefore, the dollar-weighted return will exceed the time-weighted return for a manager who has superior market timing ability.

MODULE QUIZ 87.1

Use the following data to answer Questions 1 and 2.

Assume you purchase a share of stock for $50 at time t = 0 and another share at $65 at time t = 1, and at the end of year 1 and year 2, the stock paid a $2.00 dividend. Also at the end of year 2, you sold both shares for $70 each.

1. The dollar-weighted rate of return on the investment is:

A. 10.77%.
B. 15.45%.
C. 15.79%.
D. 18.02%.

2. The time-weighted rate of return on the investment is:
   A. 18.04%.
   B. 18.27%.
   C. 20.13%.
   D. 21.83%.

MODULE 87.2: RISK-ADJUSTED PERFORMANCE MEASURES

LO 87.b: Describe risk-adjusted performance measures, such as Sharpe's measure, Treynor's measure, Jensen's measure (Jensen's alpha), and the information ratio, and identify the circumstances under which the use of each measure is most relevant.

LO 87.c: Describe the uses for the Modigliani-squared and Treynor's measure in comparing two portfolios and the graphical representation of these measures.

Universe Comparisons

Portfolio rankings based merely on returns ignore differences in risk across portfolios. A popular alternative is to use a comparison universe. This approach classifies portfolios according to investment style (e.g., small cap growth, small cap value, large cap growth, large cap value) and, then, ranks portfolios based on rate of return within the appropriate style universe. The rankings are now more meaningful because they have been standardized on the investment style of the funds. This method will fail, however, if risk differences remain across the funds within a given style.

The Sharpe Ratio

The **Sharpe ratio** uses standard deviation (total risk) as the relevant measure of risk. It shows the amount of excess return (over the risk-free rate) earned per unit of total risk. Hence, the Sharpe ratio evaluates the performance of the portfolio in terms of both overall return and diversification.

The Sharpe ratio is defined as:

$$S_A = \frac{\overline{R}_A - \overline{R}_F}{\sigma_A}$$

where:
$\overline{R}_A$ = average account return
$\overline{R}_F$ = average risk-free return
σ_A = standard deviation of account returns

PROFESSOR'S NOTE

Again, the risk measure, standard deviation, should ideally be the actual standard deviation during the measurement period.

The Treynor Measure

The **Treynor measure** is very similar to the Sharpe ratio except that it uses beta (systematic risk) as the measure of risk. It shows the excess return (over the risk-free rate) earned per unit of systematic risk.

The Treynor measure is defined as:

$$T_A = \frac{\overline{R}_A - \overline{R}_F}{\beta_A}$$

where:
$\overline{R}_A$ = average account return
$\overline{R}_F$ = average risk-free return
β_A = average beta

PROFESSOR'S NOTE

Ideally, the Treynor measure should be calculated using the actual beta for the portfolio over the measurement period. Since beta is subject to change due to varying covariance with the market, using the premeasurement period beta may not yield reliable results. The beta for the measurement period is estimated by regressing the portfolio's returns against the market returns.

For a well-diversified portfolio, the difference in risk measurement between the Sharpe ratio and the Treynor measure becomes irrelevant as the total risk and systematic risk will be very close. For a less than well-diversified portfolio, however, the difference in rankings based on the two measures is likely due to the amount of diversification in the portfolio. Used along with the Treynor measure, the Sharpe ratio provides additional information about the degree of diversification in a portfolio.

Sharpe vs. Treynor. If a portfolio was not well-diversified over the measurement period, it may be ranked relatively higher using Treynor than using Sharpe because Treynor considers only the beta (i.e., systematic risk) of the portfolio over the period. When the Sharpe ratio is calculated for the portfolio, the excess total risk (standard deviation) due to diversifiable risk will cause rankings to be lower. Although we do not get an absolute measure of the lack of diversification, the change in the rankings shows the presence of unsystematic risk, and the greater the difference in rankings, the less diversified the portfolio.

Jensen's Alpha

Jensen's alpha, also known as Jensen's measure, is the difference between the actual return and the return required to compensate for systematic risk. To calculate the measure, we subtract the return calculated by the capital asset pricing model (CAPM) from the account return. Jensen's alpha is a direct measure of performance (i.e., it yields the performance measure without being compared to other portfolios).

$$\alpha_A = R_A - E(R_A)$$

where:
α_A = alpha
R_A = the return on the account

$$E(R_A) = R_F + \beta_A[E(R_M) - R_F]$$

A superior manager would have a statistically significant and positive alpha. Jensen's alpha uses the portfolio return, market return, and risk-free rate for each time period separately. The Sharpe and Treynor measures use only the average of portfolio return and risk-free rate. Furthermore, like the Treynor measure, Jensen's alpha only takes into account the systematic risk of the portfolio and, hence, gives no indication of the diversification in the portfolio.

Information Ratio

The Sharpe ratio can be changed to incorporate an appropriate benchmark instead of the risk-free rate. This form is known as the **information ratio** or **appraisal ratio**:

$$IR_A = \frac{\overline{R}_A - \overline{R}_B}{\sigma_{A-B}}$$

where:

$\overline{R}_A$ = average account return

$\overline{R}_B$ = average benchmark return

σ_{A-B} = standard deviation of excess returns measured as the difference between account and benchmark returns

The information ratio is the ratio of the surplus return (in a particular period) to its standard deviation. It indicates the amount of risk undertaken (denominator) to achieve a certain level of return above the benchmark (numerator). An active manager makes specific cognitive bets to achieve a positive surplus return. The variability in the surplus return is a measure of the risk taken to achieve the surplus. The ratio computes the surplus return relative to the risk taken. A higher information ratio indicates better performance.

PROFESSOR'S NOTE

The version of the information ratio presented here is the most common. However, you should be aware that an alternative calculation of this ratio exists that uses alpha over the expected level of unsystematic risk over the time period, $\frac{\alpha_A}{\sigma(\varepsilon_A)}$.

M-Squared (M^2) Measure

A relatively new measure of portfolio performance developed by Leah Modigliani and her grandfather, 1985 Nobel Prize recipient Franco Modigliani, has become quite popular. The M^2 measure compares the return earned on the managed portfolio against the market return, after adjusting for differences in standard deviations between the two portfolios.

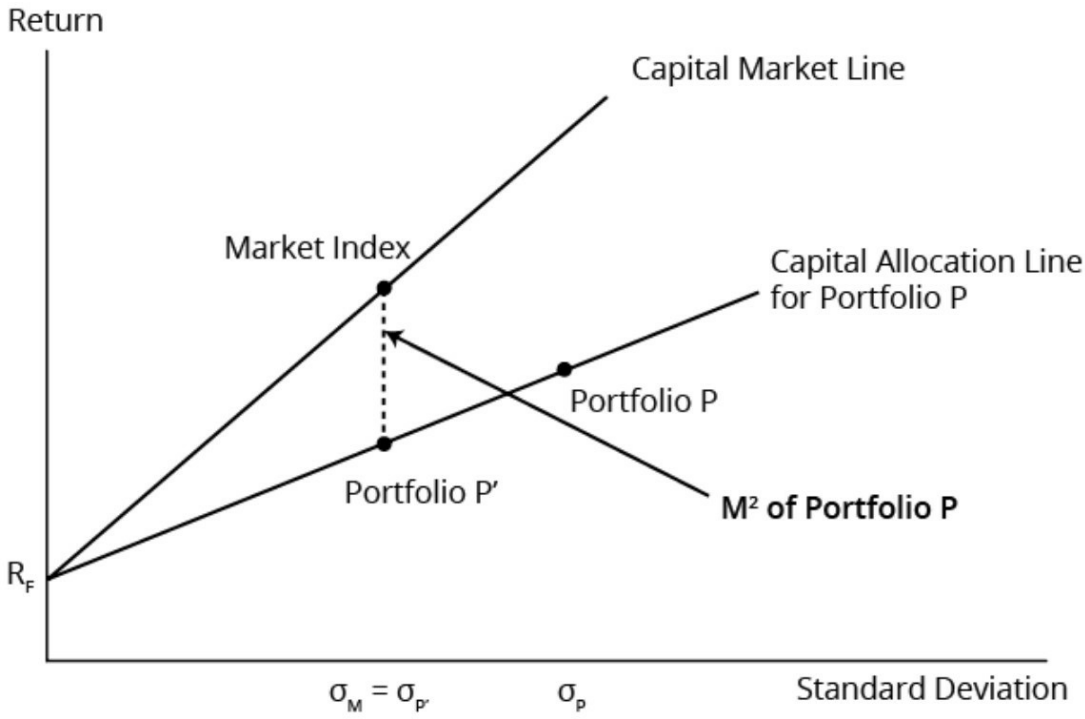
PROFESSOR'S NOTE

There are no squared terms in the M-squared calculation. The term "M-squared" merely refers to the last names of its originators (Leah and Franco Modigliani).

The M^2 measure can be illustrated with a graph comparing the capital market line for the market index and the capital allocation line for managed Portfolio P. In Figure 87.2, notice that Portfolio P has a higher standard deviation than the market index. But, we can easily create a Portfolio P' that

has standard deviation equal to the market standard deviation by investing appropriate percentages in both the risk-free asset and Portfolio P. The difference in return between Portfolio P' and the market portfolio, equals the M^2 measure for Portfolio P.

Figure 87.2: The M^2 Measure of Portfolio Performance



EXAMPLE: Calculating the M^2 performance measure

Calculate the M^2 measure for Portfolio P:

Portfolio P mean return	10%
Portfolio P standard deviation	40%
Market portfolio mean return	12%
Market portfolio standard deviation	20%
Risk-free rate	4%

Answer:

To answer the question, first note that a portfolio, P', can be created that allocates 50/50 to the risk-free asset and to Portfolio P such that the standard deviation of Portfolio P' equals the standard deviation of the market portfolio:

$$\sigma_{P'} = w_P\sigma_P = 0.50(0.40) = 0.20$$

Therefore, a 50/50 allocation between Portfolio P and the risk-free asset provides risk identical to the market portfolio. What is the difference in return between Portfolio P' and the market portfolio? To answer this question, first we must derive the mean return on Portfolio P':

$$R_{P'} = w_F R_F + w_P R_P = 0.50(0.04) + 0.50(0.10) = 0.07$$

Alternatively, the mean return for Portfolio P' can be derived by using the equation of the capital allocation line for Portfolio P:

$$R_{P'} = R_F + \left(\frac{R_P - R_F}{\sigma_P}\right)\sigma_{P'} = R_F + \left(\frac{R_P - R_F}{\sigma_P}\right)\sigma_M$$
$$= 0.04 + \left(\frac{0.10 - 0.04}{0.40}\right)0.20 = 0.04 + \left(0.15\right)0.20 = 0.07$$

Therefore, we now have created a portfolio, P', that matches the risk of the market portfolio (standard deviation equals 20%). All that remains is to calculate the difference in returns between Portfolio P' and the market portfolio:

$$M^2 = R_{P'} - R_M = 0.07 - 0.12 = -0.05$$

Clearly, Portfolio P is a poorly performing portfolio. After controlling for risk, Portfolio P provides a return that is 5 percentage points below the market portfolio.

PROFESSOR'S NOTE

Unfortunately, a consistent definition of M^2 does not exist. Sometimes M^2 is defined as equal to the return on the risk-adjusted Portfolio P' rather than equal to the difference in returns between P' and M. However, portfolio rankings based on the return on P' or on the difference in returns between P' and M will be identical. Therefore, both definitions provide identical portfolio performance rankings.

M^2 will produce the same conclusions as the Sharpe ratio. As stated earlier, Jensen's alpha will produce the same conclusions as the Treynor measure. However, M^2 and Sharpe may not give the same conclusion as Jensen's alpha and Treynor. A discrepancy could occur if the manager takes on a large proportion of unsystematic risk relative to systematic risk. This would lower the Sharpe ratio but leave the Treynor measure unaffected.

EXAMPLE: Risk-adjusted performance appraisal measures

The data in Figure 87.3 has been collected to appraise the performance of four asset management firms:

Figure 87.3: Performance Appraisal Data

	Fund 1	Fund 2	Fund 3	Fund 4	Market Index
Return	6.45%	8.96%	9.44%	5.82%	6%
Beta	0.88	1.02	1.36	0.80	1.00
Standard deviation	2.74%	4.54%	3.72%	2.64%	2.80%
Standard deviation of excess returns	5.6%	6.1%	12.5%	5.3%	N/A

The market index return and risk-free rate of return for the relevant period were 6% and 3%, respectively. **Calculate** and **rank** the funds using Jensen's alpha, the Treynor measure, the Sharpe ratio, the information ratio, and M^2.

Answer:

Evaluation Tool	Fund 1	Fund 2	Fund 3	Fund 4
Jensen's Alpha	6.45 – 5.64 = 0.81%	8.96 – 6.06 = 2.90%	9.44 – 7.08 = 2.36%	5.82 – 5.40 = 0.42%
Rank	3	1	2	4
Treynor	$\frac{6.45-3}{0.88} = 3.92$	$\frac{8.96-3}{1.02} = 5.84$	$\frac{9.44-3}{1.36} = 4.74$	$\frac{5.82-3}{0.80} = 3.53$
Rank	3	1	2	4
Sharpe	$\frac{6.45-3}{2.74} = 1.26$	$\frac{8.96-3}{4.54} = 1.31$	$\frac{9.44-3}{3.72} = 1.73$	$\frac{5.82-3}{2.64} = 1.07$
Rank	3	2	1	4
Information Ratio	$\frac{6.45-6}{5.6} = 0.08$	$\frac{8.96-6}{6.1} = 0.49$	$\frac{9.44-6}{12.5} = 0.28$	$\frac{5.82-6}{5.3} = -0.03$
Rank	3	1	2	4
M^2	3 + (1.26) × (2.8) = 6.53% – 6% = 0.53%	3 + (1.31) × (2.8) = 6.67% – 6% = 0.67%	3 + (1.73) × (2.8) = 7.84% – 6% = 1.84%	3 + (1.07) × (2.8) = 6% – 6% = 0
Rank	3	2	1	4

Note that Jensen's alpha and the Treynor measures give the same rankings, and the Sharpe and M^2 measures give the same rankings. However, when comparing the alpha/Treynor rankings to the Sharpe/M^2 measures, Funds 2 and 3 trade places.

Fund 2 has a much higher total risk (standard deviation) than Fund 3 but has a much lower beta. Relatively speaking, a smaller proportion of Fund 2's total risk relates to systematic risk, which is reflected in the low beta. Compared to Fund 3, it must have a bigger proportion of risk relating to non-systematic risk factors.

Hence, Fund 2 does better in the alpha/Treynor measures, as those measures only look at systematic risk (beta). It fares less well when it comes to the Sharpe/M^2 measures that look at total risk.

MODULE QUIZ 87.2

1. The following information is available for funds ABC, RST, JKL, and XYZ:

Fund	Annual Rate of Return	Beta	Volatility
ABC	15%	1.25	20%
RST	18%	1.00	25%
JKL	25%	1.20	15%
XYZ	11%	1.36	9%

The average risk-free rate was 5%. Rank the funds from best to worst according to their Treynor measure.

A. JKL, RST, ABC, XYZ.
B. JKL, RST, XYZ, ABC.
C. RST, JKL, ABC, XYZ.
D. XYZ, ABC, RST, JKL.

Use the following information to answer Question 2.

The following data has been collected to appraise funds A, B, C, and D:

	Fund A	Fund B	Fund C	Fund D	Market Index
Return	8.25%	7.21%	9.44%	10.12%	8.60%
Beta	0.91	0.84	1.02	1.34	1.00
Standard deviation	3.24%	3.88%	3.66%	3.28%	3.55%

The risk-free rate of return for the relevant period was 4%.

2. Calculate and rank the funds from best to worst using Jensen's alpha.
   A. B, D, A, C.
   B. A, C, D, B.
   C. C, A, D, B.
   D. C, D, A, B.

MODULE 87.3: ALPHA, HEDGE FUNDS, DYNAMIC RISK, MARKET TIMING, AND STYLE

Statistical Significance of Alpha Returns

LO 87.d: Determine the statistical significance of a performance measure using standard error and the t-statistic.

Alpha (α) plays a critical role in determining portfolio performance. A positive alpha produces an indication of superior performance; a negative alpha produces an indication of inferior performance; and zero alpha produces an indication of normal performance matching the benchmark. The performance indicated by alpha, however, could be a result of luck and not skill. In order to assess a manager's ability to generate alpha, we conduct a *t*-test under the following hypotheses.

Null (H_0): True alpha is zero.

Alternative (H_A): True alpha is not zero.

$$\mathrm{t} = \frac{\alpha - 0}{\sigma/\sqrt{\mathrm{N}}}$$

where:
α = alpha estimate
σ = alpha estimate volatility
N = sample number of observations
standard error of alpha estimate = $\sigma/\sqrt{\mathrm{N}}$

In order to compute the ***t*-statistic**, we will need to know the alpha estimate, the sample number of observations, and the alpha estimate of volatility. From the volatility and sample size estimates, we can compute the **standard error** of the alpha estimate, which is shown in the denominator of the *t*-statistic calculation.

At a 95% confidence level (5% significance level) we reject the null hypothesis if we estimate a *t*-value of 2 or larger. That is, the probability of observing such a large estimated alpha by chance is only 5%, assuming returns are normally distributed.

PROFESSOR'S NOTE

Using a t-value of 2 is a general test of statistical significance. From the FRM Part I curriculum, we know that the actual t-value with a 95% confidence level given a large sample size is 1.96.

If we assume an excess (alpha) return of 0.09% and a standard error of the alpha of 0.093%, the *t*-statistic would be equal to 0.97 (t = 0.09% / 0.093%); therefore, we fail to reject H_0 and conclude that there is no evidence of superior (or inferior) performance.

PROFESSOR'S NOTE

Using statistical inference when evaluating performance is extremely challenging in practice. By the time you are reasonably confident that a manager's returns are in fact due to skill, the manager may have moved elsewhere.

Measuring Hedge Fund Performance

LO 87.f: Explain the difficulties in measuring the performance of actively managed portfolios.

Long-short hedge funds are often used to complement an investor's well-diversified portfolio. For example, the investor might allocate funds to a passively managed index fund and an actively managed long-short hedge fund. The hedge fund is designed to provide positive alpha with zero beta to the investor's overall composite portfolio. The hedge fund creates **portable alpha** in the sense that the alpha does not depend on the performance of the broad market and can be ported to any existing portfolio. Because the long-short fund is market-neutral, the alpha may be generated outside the investor's desired asset class mix.

Unfortunately, hedge fund performance evaluation is complicated because:

- Hedge fund risk is not constant over time (nonlinear risk).
- Hedge fund holdings are often illiquid (data smoothing).
- Hedge fund sensitivity with traditional markets increases in times of a market crisis and decreases in times of market strength.

The latter problem necessitates the use of estimated prices for hedge fund holdings. The values of the hedge funds, therefore, are not transactions-based. The estimation process unduly smooths the hedge fund "values," inducing serial correlation into any statistical examination of the data.

Performance Evaluation With Dynamic Risk Levels

LO 87.g: Describe performance manipulation and the problems associated with using conventional performance measures.

The Sharpe ratio is useful when evaluating the portfolio performance of a passive investment strategy, where risk and return characteristics are relatively constant over time. However, the application of the Sharpe ratio is challenged when assessing the performance of active investment strategies, where risk and return characteristics are more dynamic. Changes in volatility will likely bias the Sharpe ratio, and produce incorrect conclusions when comparing portfolio performance to a benchmark or index.

Take for example a low-risk portfolio with an alpha return of 1% and a standard deviation of 3%. The manager implements this strategy for one-year, producing quarterly returns of −2%, 4%, −2%, and 4%. The Sharpe ratio for this portfolio is calculated as: 1% / 3% = 0.3333. If the market index has a Sharpe ratio of 0.3, we would conclude that this portfolio has superior risk-adjusted performance. In the following year, the portfolio manager decides to switch to a high-risk strategy. The alpha return and risk correspondingly increase to 5% and 15%, respectively. For the second year, quarterly returns were −10%, 20%, −10%, and 20%. The Sharpe ratio in this case is still 0.3333 (= 5% / 15%), which still indicates superior performance compared to the market index. However, if the Sharpe ratio is evaluated over the two-year time frame, considering both the low-risk and high-risk strategies, the measure will drop to 0.2727 since average excess return over both years was 3% with volatility of 11%. The lower Sharpe ratio now suggests underperformance relative to the market index.

In this example, the Sharpe ratio was biased downward due to the perceived increase in risk in portfolio returns. In isolation, both the low-risk and high-risk strategies produced higher Sharpe ratios than the market index. However, when analyzed together, the Sharpe ratio suggests that the portfolio excess returns are inferior to the market. Therefore, it is important to consider changes in portfolio composition when using performance measures, as dynamic risk levels can lead to incorrect ranking conclusions.

Measuring Market Timing Ability

LO 87.h: 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.

Measuring Market Timing with Regression

Extending basic return regression models offers a tool to assess superior market timing skills of a portfolio manager. A market timer will include high (low) beta stocks in her portfolio if she expects an up (down) market. If her forecasts are accurate, her portfolio will outperform the benchmark portfolio. Using a market timing regression model, we can empirically test whether there is evidence of superior market timing skills exhibited by the portfolio manager. The regression equation used for this test is as follows:

$$R_P - R_F = \alpha + \beta_P(R_M - R_F) + M_P(R_M - R_F)D + \varepsilon_P$$

In this equation, *D* is a dummy variable that is assigned a value of 0 for down markets (i.e., when $R_M < R_F$) and 1 for up markets (i.e., when $R_M > R_F$). M_P is the difference between the up market and down market betas and will be positive for a successful market timer. In a bear market, beta is simply equal to β_P. In a bull market, beta is equal to $\beta_P + M_P$. Empirical evidence of mutual fund return data suggests that M_P is actual negative for most funds. Thus, researchers have concluded that fund managers exhibit little, if any, ability to correctly time the market.

Measuring Market Timing with a Call Option Model

Consider an investor who has 100% perfect market forecasting ability and holds a portfolio allocated either 100% to Treasury bills or 100% to the S&P 500 equity market index, depending on

the forecast performance of the S&P 500 versus the Treasury bill return. The investor's portfolio will be:

100% invested in the S&P 500 if $E(R_M) > R_F$

100% invested in Treasury bills if $E(R_M) < R_F$

If the investor has perfect forecasting ability, then his return performance will be as follows:

R_M if $R_M > R_F$

R_F if $R_M < R_F$

Now consider an investor who invests S_0 (the current value of the S&P 500) in Treasury bills and also owns a call option on the S&P 500 with exercise price equal to the current value of the index times $(1 + R_F)$, or $S_0(1 + R_F)$. Note that the exercise price equals the value of the S&P 500 if it grows at a rate equal to the risk-free rate.

What are the return possibilities for this investor? To answer this question, note that if the S&P 500 holding period return exceeds the risk-free rate, then the ending value of the call option will be:

$$S_T - X = S_0(1 + R_M) - S_0(1 + R_F)$$

The investor also owns Treasury bills with face value equal to $S_0(1 + R_F)$. Therefore, the face value (FV) of the Treasury bills will perfectly offset the exercise price of the call option. In the up-market scenario, the ending value of the calls plus bills portfolio equals:

$$S_T - X + FV = S_0(1 + R_M) - S_0(1 + R_F) + S_0(1 + R_F) = S_0(1 + R_M)$$

Therefore, the return performance on the calls plus bills portfolio will equal:

R_M if $R_M > R_F$

If the market rises by less than the risk-free rate, the call option has no value, but the risk-free asset will still return R_F. Therefore, the down-market scenario return for the calls plus bills portfolio is:

R_F if $R_M < R_F$

In summary, the returns to the calls plus bills portfolio are identical to the 100% perfect foresight returns. Therefore, the value or appropriate fee for perfect foresight should equal the price of the call option on the market index.

Style Analysis

LO 87.e: Describe style analysis.

LO 87.i: Describe and apply performance attribution procedures, including the asset allocation decision, sector and security selection decision, and the aggregate contribution.

William Sharpe introduced the concept of style analysis. From January 1985 to December 1989 he analyzed the returns on Fidelity's Magellan Fund for style and selection bets. His study concluded that 97.3% of the fund's returns were explained by style bets (asset allocation), and 2.7% were due to selection bets (individual security selection and market timing). The importance of long-run asset

allocation has been well established empirically. These results suggest that the returns to market timing and security selection are minimal at best and at worst insufficient to cover the associated operating expenses and trading costs.

The steps for Sharpe's style analysis are as follows:

1. Run a regression of portfolio returns against an exhaustive and mutually exclusive set of asset class indices:

   $R_P = b_{P1}R_{B1} + b_{P2}R_{B2} + ... + b_{Pn}R_{Bn} + e_P$

   where:

   R_P = return on the managed portfolio

   R_{Bj} = return on passive benchmark asset class j

   b_{Pj} = sensitivity or exposure of Portfolio P return to passive asset class j return

   e_P = random error term

   In Sharpe's style analysis, the slopes are constrained to be non-negative and to sum to 100%. In that manner, the slopes can be interpreted to be "effective" allocations of the portfolio across the asset classes.

2. Conduct a performance attribution (return attributable to asset allocation and to selection):
   - The percent of the performance attributable to asset allocation = R^2 (the coefficient of determination).
   - The percent of the performance attributable to selection = $1 - R^2$.

The **asset allocation attribution** equals the difference in returns attributable to active asset allocation decisions of the portfolio manager:

$[b_1R_{B1} + b_2R_{B2} + ... + b_nR_{Bn}] - R_B$

Notice if the slopes (estimated allocations) for the managed portfolio equal those within the benchmark (passive asset allocation), then the asset allocation attribution will be zero.

The **selection attribution** equals the difference in returns attributable to superior individual security selection (correct selection of mispriced securities) and sector allocation (correct over and underweighting of sectors within asset classes):

$R_P - [b_1R_{B1} + b_2R_{B2} + ... + b_nR_{Bn}]$

Notice if the manager has no superior selection ability, then portfolio returns earned within each asset class will equal the benchmark asset class returns: $R_{Pj} = R_{Bj}$, and the selection attribution will equal zero. Also, notice that the sum of the two attribution components (asset allocation plus selection) equals the total excess return performance: $R_P - R_B$.

3. Uncover the investment style of the portfolio manager: the regression slopes are used to infer the investment style of the manager. For example, assume the following results are derived:

   $R_P = 0.75R_{LCG} + 0.15R_{LCV} + 0.05R_{SCG} + 0.05R_{SCV}$

   where:

   R_{LCG} = return on the large cap growth index

   R_{LCV} = return on the large cap value index

R_{SCG} = return on the small cap growth index

R_{SCV} = return on the small cap value index

The regression results indicate that the manager is pursuing primarily a large cap growth investment style.

MODULE QUIZ 87.3

1. Sharpe's style analysis, used to evaluate an active portfolio manager's performance, measures performance relative to:
   A. a passive benchmark of the same style.
   B. broad-based market indices.
   C. the performance of an equity index fund.
   D. an average of similar actively managed investment funds.

KEY CONCEPTS

LO 87.a

The dollar-weighted rate of return is defined as the internal rate of return (IRR) on a portfolio, taking into account all cash inflows and outflows. The beginning value of the account is an inflow as are all deposits into the account. All withdrawals from the account are outflows, as is the ending value.

Time-weighted rate of return measures compound growth. It is the rate at which $1 compounds over a specified time horizon. Time-weighting is the process of averaging a set of values over time.

LO 87.b

The Sharpe ratio uses standard deviation (total risk) as the relevant measure of risk. It shows the amount of excess return (over the risk-free rate) earned per unit of total risk.

The Treynor measure is very similar to the Sharpe ratio except that it uses beta (systematic risk) as the measure of risk. It shows the excess return (over the risk-free rate) earned per unit of systematic risk.

Jensen's alpha is the difference between the actual return and the return required to compensate for systematic risk. To calculate the measure, we subtract the return calculated by the capital asset pricing model (CAPM) from the account return.

The information ratio is the ratio of the surplus return (in a particular period) to its standard deviation. It indicates the amount of risk undertaken to achieve a certain level of return above the benchmark.

LO 87.c

The M^2 measure compares the return earned on the managed portfolio against the market return, after adjusting for differences in standard deviations between the two portfolios.

LO 87.d

A positive alpha produces an indication of superior performance; a negative alpha produces an indication of inferior performance; and zero alpha produces an indication of normal performance matching the benchmark.

LO 87.e

William Sharpe introduced the concept of style analysis. From January 1985 to December 1989 he analyzed the returns on Fidelity's Magellan Fund for style and selection bets. His study concluded that 97.3% of the fund's returns were explained by style bets (asset allocation), and 2.7% were due to selection bets (individual security selection and market timing).

LO 87.f

Hedge fund performance evaluation is complicated because:

- Hedge fund risk is not constant over time (nonlinear risk).
- Hedge fund holdings are often illiquid (data smoothing).

- Hedge fund sensitivity with traditional markets increases in times of a market crisis and decreases in times of market strength.

LO 87.g

Changes in volatility will likely bias the Sharpe ratio, and produce incorrect conclusions when comparing portfolio performance to a benchmark or index.

LO 87.h

Extending basic return regression models offers a tool to assess superior market timing skills of a portfolio manager. A market timer will include high (low) beta stocks in her portfolio if she expects an up (down) market. If her forecasts are accurate, her portfolio will outperform the benchmark portfolio.

LO 87.i

The importance of long-run asset allocation has been well established empirically. Historical results suggest that the returns to market timing and security selection are minimal at best and at worst insufficient to cover the associated operating expenses and trading costs.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 87.1

1. **D** One way to do this problem is to set up the cash flows so that the PV of inflows = PV of outflows and then to plug in each of the multiple choices.

   $50 + 65 / (1 + IRR) = 2 / (1 + IRR) + 144 / (1 + IRR)^2 \rightarrow IRR = 18.02\%$

   Alternatively, on your financial calculator, solve for IRR:

   $$-50 - \frac{65-2}{1+IRR} + \frac{2(70+2)}{(1+IRR)^2} = 0$$

Calculating Dollar-Weighted Return		
Key Strokes	**Explanation**	**Display**
[CF] [2nd] [CLR WORK]	Clear CF Memory Registers	CF0 = 0.00000
50 [+/–] [ENTER]	Initial cash inflow	CF0 = –50.00000
[↓] 63 [+/–][ENTER]	Period 1 cash inflow	C01 = –63.00000
[↓] [↓] 144 [ENTER]	Period 2 cash outflow	C02 = 144.00000
[IRR] [CPT]	Calculate IRR	IRR = 18.02210

   (LO 87.a)

2. **D** $HPR_1 = (65 + 2) / 50 - 1 = 34\%$, $HPR_2 = (140 + 4) / 130 - 1 = 10.77\%$

   time-weighted return $= [(1.34)(1.1077)]^{0.5} - 1 = 21.83\%$

   (LO 87.a)

Module Quiz 87.2

1. **A** Treynor measures:

   $$T_{ABC} = \frac{0.15-0.05}{1.25} = 0.08 = 8$$
   $$T_{RST} = \frac{0.18-0.05}{1.00} = 0.13 = 13$$
   $$T_{JKL} = \frac{0.25-0.05}{1.20} = 0.1667 = 16.7$$

   The following table summarizes the results:

Fund	Treynor Measure	Rank
ABC	8.00%	3
RST	13.00%	2
JKL	16.67%	1
XYZ	4.41%	4

   (LO 87.b)

2. **C** CAPM Returns:

   $R_A = 4 + 0.91(8.6 - 4) = 8.19\%$

$R_B = 4 + 0.84(8.6 - 4) = 7.86\%$

$R_C = 4 + 1.02(8.6 - 4) = 8.69\%$

$R_D = 4 + 1.34(8.6 - 4) = 10.16\%$

	Fund A	**Fund B**	**Fund C**	**Fund D**
Alpha	8.25% − 8.19% = +0.06	7.21% − 7.86% = −0.65%	9.44% − 8.69% = +0.75%	10.12% − 10.16% = −0.04%
Ranking	2	4	1	3

(LO 87.b)

Module Quiz 87.3

1. **A** Sharpe's style analysis measures performance relative to a passive benchmark of the same style. (LO 87.h)

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Constantinides, Harris, and Stulz, Chapter 17.

READING 88: HEDGE FUNDS

Constantinides, Harris, and Stulz, Chapter 17

EXAM FOCUS

The reading examines two decades of hedge fund performance. Significant events that shaped the hedge fund industry are discussed, including the growth of institutional investments. Different hedge fund strategies are explained, along with the continuing growth of assets under management. Performance is analyzed to see if the rewards justify the risks, and performance is compared with the broad equity markets. The performance of top fund managers is also compared to the performance across the hedge fund industry.

MODULE 88.1: HEDGE FUND INDUSTRY, ALPHA-BETA SEPARATION, AND HEDGE FUND STRATEGIES

Characteristics of Hedge Funds

LO 88.a: Describe the characteristics of hedge funds and the hedge fund industry and compare hedge funds with mutual funds.

There are important distinctions between hedge funds and mutual funds. Hedge funds are private, much less regulated investment vehicles, not available to the general public. On the other hand, mutual funds are more structured and regulated. Hedge funds are highly leveraged, and managers obtain profits from both long and short positions. Hedge fund managers tend to take large bets based on perceived relative price discrepancies of assets.

Privacy is a hallmark of hedge funds. There is little transparency in the hedge fund industry because managers do not want their methods copied. A hedge fund charges a fixed management fee plus a healthy share of new profits from the fund, generally around 10–20%.

Evolution of the Hedge Fund Industry

LO 88.b: Explain biases that are commonly found in databases of hedge funds.

LO 88.c: Explain the evolution of the hedge fund industry and describe landmark events that precipitated major changes in the development of the industry.

Historical data on hedge fund performance was difficult to obtain prior to the early 1990s. In early 1994, dramatic losses triggered by a Federal Reserve change in interest rate policy had a large impact on hedge fund performance reporting. This prompted the development of hedge fund databases so that participants could better obtain and analyze hedge fund performance.

Assets under management have increased 10 times from 1997 to 2010 as the number of funds has quadrupled. There are some hedge funds that do not participate in commercial databases, which impacts aggregate hedge fund performance. Thus, there is **selection bias**, also known as **self-reporting bias**, contained in hedge fund databases.

There is evidence that suggests that selection bias in large hedge fund databases is actually small. The average return of funds-of-hedge funds (FOHF), comprised of managers who theoretically invest across all hedge funds, not just funds reported to commercial databases, is highly correlated to the average return of hedge funds in commercial databases.

However, there are still concerns about possible measurement errors and various biases in reported hedge fund returns. The consensus is that hedge fund index returns became increasingly reliable beginning in 1996. Prior to 1996, looking at the period from 1987 to 1996, 27 large hedge funds substantially outperformed the S&P 500 index. The outperformance is high, which is more than enough to account for any measurement biases.

The collapse of Long-Term Capital Management (LTCM) in 1998 was a watershed event in the hedge fund industry. It was a reminder that higher returns are accompanied by higher risk. The LTCM collapse had a much greater effect on hedge fund performance compared to equity performance.

The time period of 2000 to 2001 brought the dot-com bubble collapse. During this period, the hedge fund industry experienced a 20% net asset inflow and there was a major shift in the hedge fund industry structure. Hedge funds outperformed the S&P 500 with half of the S&P 500 standard deviation. As a result, institutional investors poured money into hedge funds.

Impact of Institutional Investors

LO 88.d: 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.

Beginning in 1999, institutional investor funds flowed into hedge funds. Assets under management in the hedge fund industry grew from $197 billion at 1999 year-end to $1.39 trillion by 2007 year-end. Thus, investors in hedge funds shifted from exclusively private wealth to institutions, including foundations, endowments, pension funds, and insurance companies.

Institutional investors were rewarded for allocating capital to a much higher fee environment. Three hedge fund performance databases, DJCSI, HFRI, and HFRFOFI, respectively, reported cumulative performance of 72.64%, 69.82%, and 38.18% from the 2002 to 2010 time period, compared to the S&P 500 index return of 13.5%. The S&P 500 index had a 16% standard deviation during that period, versus annualized standard deviations of return of 5.84%, 6.47%, and 5.51%, for the respective hedge fund indices.

With the increase of institutional investment came greater demands on hedge fund management for operational integrity and governance. Some institutional investors were seeking absolute performance, while others were seeking alternative sources of return beyond equities. There is some concern that there is no identifiable alpha associated with hedge fund investing, so it is increasingly important that hedge fund managers differentiate themselves from their peers.

Alpha-Beta Separation

LO 88.e: Explain the relationship between risk and alpha in hedge funds.

Alpha is a risk-adjusted measure of return often used to assess the performance of active managers. It is the return in excess of the compensation for risk. It is important to identify how much of a strategy's return results from risk (i.e., beta) and how much results from active management (i.e., alpha). This is known as **distinguishing alpha and beta**. A manager who uses statistical techniques, quantitative tools, and benchmarking to discern whether high returns are the result of the superior performance of an active manager or a function of bearing high levels of systematic risk is attempting to distinguish alpha from beta.

A hedge fund may attempt to independently manage alpha and beta. The firm may manage beta exposure while separately managing the portfolio's alpha. This is known as **separating alpha and beta**. Managers can use investment tools to pursue alpha while sustaining a target beta for the portfolio. Managers typically seek to limit beta while trying to optimize alpha. Derivatives are often used to minimize or eliminate undesired systematic risk.

For example, assume a manager's benchmark is the S&P 500. He would like to pursue opportunities that increase alpha, but the result is beta exposure different from the benchmark. He can use futures contracts to hedge all systematic risks other than exposure to the S&P 500 such that the portfolio's beta relative to the S&P 500 is 1.0. He does this while simultaneously pursuing an alpha optimizing strategy. In this way, he is independently managing, or separating, alpha from beta.

Hedge Fund Strategies

LO 88.f: Compare and contrast the different hedge fund strategies, describe their return characteristics, and describe the inherent risks of each strategy.

Managed Futures and Global Macro

Managed futures funds focus on investments in bond, equity, commodity futures, and currency markets around the world. Systematic trading programs are used which rely on historical pricing data and market trends. A high degree of leverage is employed because futures contracts are used. With managed futures, there is no net long or net short bias.

Many managed futures funds are market timing funds, which switch between stocks and Treasuries. When both short and long positions are considered, the payoff function of this strategy is similar to a lookback straddle, which is a combination of a lookback call option and a lookback put option. The lookback call option gives the owner the right to purchase the underlying instrument at the lower price during the call option's life, while the lookback put option gives the owner the right to sell the underlying instrument at the highest price during the put option's life.

Global macro fund managers make large bets on directional movements in interest rates, exchange rates, commodities, and stock indices. They are dynamic asset allocators, betting on various risk factors over time.

Both managed futures and global macro funds have *trend following* behavior (i.e., directional styles). Global macro funds do better during extreme moves in the currency markets. Both of these

strategies are essentially *asset allocation* strategies, since the managers take opportunistic bets in different markets. They also both have a low return correlation to equities.

Merger/Risk Arbitrage and Distressed Securities

Merger (or risk) arbitrage strategies try to capture spreads in merger/acquisition transactions involving public companies, following public announcement of a transaction. The primary risk is **deal risk**, or the risk that the deal will fail to close.

Examining merger arbitrage returns, the largest negative monthly returns in this strategy are after the S&P 500 index has had a large negative return. This equates to being long deal risk. The logic is that when the market has a large decline, mergers have a greater tendency to be called off.

Distressed hedge funds is another event-driven hedge fund style. This strategy invests across the capital structure of firms that are under financial or operational distress, or are in the middle of bankruptcy. The strategy tends to have a long bias. With this strategy, hedge fund managers try to profit from an issuer's ability to improve its operation, or come out of a bankruptcy successfully.

A key feature of the strategy is long exposure to credit risk of corporations with low credit ratings. A good proxy for these types of returns is publicly traded high-yield bonds since the correlation between the DJCS Distress index and high-yield bonds is 0.55.

In sum, both of these event-driven strategies exhibit nonlinear return characteristics, since tail risk appears under extreme market conditions. With merger arbitrage, the tail risk is a large drop in equity investments. With distressed hedge funds, the tail risk is a big move in short-term rates. Unlike trend following strategies, event-driven funds are hurt by extreme market movements.

Fixed Income Arbitrage

Fixed income arbitrage funds attempt to obtain profits by exploiting inefficiencies and price anomalies between related fixed income securities. The fund managers try to limit volatility by hedging exposure to interest rate risk. An example of this strategy is leveraging long/short positions in fixed income securities that are related—mathematically or economically.

The sectors traded under fixed income arbitrage include:

- Credit yield curve relative value trading of swaps, government securities, and futures.
- Volatility trading using options.
- Mortgage-backed securities arbitrage.

A **swap spread trade** is a bet that the fixed side of the spread will stay higher than the floating side of the spread, and stay in a reasonable range according to historical trends. With **yield-curve spread trades**, the hope is that bond prices will deviate from the overall yield curve only in the short term, and will revert to normal spreads over time. **Mortgage spread trades** are bets on prepayment rates, while **fixed income volatility trades** are bets that the implied volatility of interest rate caps have a tendency to be higher than the realized volatility of, for example, a Eurodollar futures contract. **Capital structure** or **credit arbitrage trades** try to capitalize on mispricing among different types of securities (e.g., equity and debt).

Convertible Arbitrage

Convertible arbitrage funds attempt to profit from the purchase of convertible securities and the shorting of corresponding stock, taking advantage of a perceived pricing error made in the security's conversion factor. The number of shares shorted is based on a delta neutral or market neutral ratio. The plan is for the combined position to be insensitive to underlying stock price fluctuations under normal market conditions.

The return to convertible arbitrage hedge funds comes from the liquidity premium paid by issuers of convertible bonds to hedge fund managers, for holding convertible bonds and managing the inherent risk by hedging the equity part of the bonds.

Long/Short Equity

Long/short equity funds take both long and short positions in the equity markets, diversifying or hedging across sectors, regions, or market capitalizations. Examples are shifts from value to growth, small- to mid-cap stocks, and net long to net short. Trades in equity futures and options can also take place.

Thirty to forty percent of hedge funds are long/short. Long/short managers are stock pickers with varying opinions and abilities, so performance tends to be very idiosyncratic. Underpriced or under-researched stocks are favored, as are small stocks, on the long side. On the short side, low liquidity makes small stocks and foreign stocks less attractive. Long/short equity funds have directional exposure to the overall market and also have exposure to long small-cap/short large-cap positions.

Dedicated Short Bias

Funds with a dedicated short bias tend to take net short positions in equities. Sometimes the short position strategy is implemented by selling forward. To manage risk, managers take offsetting long positions and stop-loss positions. The returns are negatively correlated with equities.

Emerging Markets

Emerging market funds invest in currencies, debt, equities, and other instruments in countries with emerging or developing markets. These markets are usually identified in terms of gross national product (GNP) per capita. China, India, Latin America, Southeast Asia, parts of Eastern Europe, and parts of Africa are examples of emerging markets. These funds have a long bias because it is more difficult to short securities in emerging markets.

Equity Market Neutral

When reviewing equity market neutral hedge fund strategies, research shows that there is not one common component (or risk factor) in their returns. Different funds utilize different trading strategies, but they all have a similar goal of trying to achieve zero beta(s) against a broad set of equity indices.

MODULE QUIZ 88.1

1. What critical shift occurred in the hedge fund industry following the collapse of Long-Term Capital Management (LTCM) in 1998 and the dot-com bubble burst in 2001?
    A. There was a significant drop in assets under management in the hedge fund industry.
    B. There was a large influx of institutional investors investing in hedge funds.
    C. Reporting within the hedge fund industry became more regulated than mutual funds.

D. There was a significant increase in hedge fund failures.

2. Which of the following hedge fund strategies would be characterized as an “asset allocation” strategy that performs best during extreme moves in the currency markets?
   A. Global macro.
   B. Risk arbitrage.
   C. Dedicated short bias.
   D. Long/short equity.
3. Jamie Chen, FRM, is considering investing a client into distressed hedge funds. Which of the following investments would serve as the best proxy for the types of returns to expect?
   A. Convertible bonds.
   B. Small-cap equities.
   C. Managed futures.
   D. High-yield bonds.

MODULE 88.2: HEDGE FUND PERFORMANCE, RISK FACTORS, AND RISK SHARING

Hedge Fund Performance

LO 88.g: Describe the historical portfolio construction and performance trends of hedge funds compared to those of equity indices.

Twenty-seven large hedge funds were identified in 2000, and research has been done to determine if these hedge funds are truly a separate asset class, not correlated to equity or bond indices. Hedge fund returns were regressed against an 8-factor model used to analyze hedge fund performance. Findings were that hedge fund portfolios had no significant exposure to stocks and bonds. As an equally weighted portfolio, this portfolio of 27 top performing hedge funds had a large alpha of 1.48% per month. There was a persistent exposure to emerging markets, but other factor betas showed a lot of variability. Also, alpha declined over time, and there was not a persistent directional exposure to the U.S. equity market. Measurement bias may have affected these results somewhat.

Alternatively, a strategy of investing in a portfolio of the top 50 large hedge funds was tested using data from 2002 to 2010. Two test portfolios were constructed:

- The first test portfolio attempted to mimic performance of a strategy of investing in the top funds in equal dollar amounts, and rebalancing at the end of each calendar year. The funds were selected based on the assets under management at year-end 2001.
- A similar portfolio was constructed using top funds based on year-end 2010, rather than 2001.

For the first portfolio, the intent was to give a lower and upper bound of performance which investors could achieve, by just following a strategy of investing equally in the top 50 large hedge funds, and rebalancing yearly. The second portfolio was “foresight assisted.”

In evaluating performance characteristics, the first portfolio did not have a significant alpha, while the foresight-assisted portfolio had a monthly alpha of 0.53%, and was statistically significant at the 1% level. Compared to hedge fund returns prior to 2002, the decline in alpha is consistent with the thinking that there is more competition in the hedge fund industry. It should, however, be noted that there is no significant negative alpha.

Looking at the top 50 hedge funds versus all hedge funds, the top 50 portfolios (both versions) demonstrated statistically significant alpha relative to the DJCSI and HFRI hedge fund indices. The strategy of buying large hedge funds appears to deliver superior performance compared to just investing in hedge fund indices.

During the 2002 to 2010 time period, the top 50 hedge fund portfolios (with the exception of the foresight-assisted portfolio), and the two broad hedge fund indices, DJCSI and HFRI, all outperformed the equity market, as measured by the S&P 500 index. In sum, analysis of large hedge funds shows that managers are still delivering alpha return relative to peers, and also have low exposure to the U.S. equity market. These factors continue to attract institutional investors.

Convergences of Risk Factors

LO 88.h: Describe market events that resulted in a convergence of risk factors for different hedge fund strategies and explain the impact of such convergences on portfolio diversification strategies.

Theoretically, diversification among hedge fund strategies should protect investors, but there are certain events that affect all, or mostly all, strategies, as they all undergo stress at the same time. Portfolio diversification implodes, and seemingly diverse hedge fund portfolios *converge* in terms of risk factors during times of stress.

The first recorded major market event for hedge funds was in March and April of 1994 when unexpected changes in interest rate policy were set by the Federal Reserve. This caused two months of losses by seven of the ten style-specific sub-indices in the DJCS family. Exceptions were short sellers and managed futures funds. Merger arbitrage funds earned a positive return in March, while equity market neutral funds had a positive return in April.

Another major event was in August 1998 right before the collapse of LTCM. Eight of the ten niche DJCS style sub-indices had large losses. Short sellers and managed futures funds avoided losses. The losses occurred primarily due to market-wide liquidation of risky assets and the high amount of leverage on LTCM's balance sheet.

With hedge fund investing, leverage has a magnifying effect on gains and losses, and risk is on both sides of the balance sheet. There were events prior to the 2007–2009 financial crisis that illustrated how much a market-wide funding crisis can significantly impair leveraged positions. In August 2007, for the first time, all nine specialist style sub-indices lost money. The only positive return was from short sellers. During the peak of the financial crisis from July to October 2008, July to September brought losses for all hedge fund styles (excluding short sellers). When leveraged positions are forced to liquidate, losses can be high.

The point is that when there is a market-wide funding crisis, it is difficult to mitigate risk by simply spreading capital among different hedge fund strategies. There is significant credit-driven tail risk in a hedge fund portfolio. The use of managed futures may be a partial solution—it has been a strategy with a convex performance profile relative to other hedge fund strategies. Hedge fund investors need to consider portfolio risks associated with dramatic market events.

Risk Sharing Asymmetry

LO 88.i: Describe the problem of risk sharing asymmetry between principals and agents in the hedge fund industry.

In the hedge fund industry, risk sharing asymmetry between the principal (investor) and the agent (fund manager) is a concern due to variable compensation schemes.

The problem occurs when the incentive fee that a hedge fund manager is entitled to, typically 15–20% of new profits [profits above a high water mark (HWM)], encourages a fund manager to take outsized risks. This tends to increase the future loss-carried-forward if and when these bets fail. If the fund fails, the same fund manager can start up a new hedge fund.

However, there is an opportunity cost involved in cases where a hedge fund manager closes a fund. It is costly in terms of harming the track record of the manager and affects reputation risk of both the manager and the fund company. All things considered, this cost does not totally mitigate the basic principal/agent conflict.

Investors may be best served to invest in funds for which the fund managers invest a good portion of their own wealth. As much as this issue has been discussed, the basic structure of how fund managers are compensated has not changed.

MODULE QUIZ 88.2

1. Comparing hedge fund performance during the time period 2002–2010 to earlier time periods, how would monthly alpha compare, if looking at large hedge funds?
   A. Alpha was higher in the 2002–2010 time period.
   B. Alpha remained constant over both time periods.
   C. A “foresight-assisted” portfolio did not have a statistically significant alpha during the 2002–2010 time period.
   D. There was a decline in alpha in the 2002–2010 time period.
2. What would be an ideal approach for a hedge fund investor who is concerned about the problem of risk sharing asymmetry between principals and agents within the hedge fund industry?
   A. Focus on investing in funds for which the fund managers have a good portion of their own wealth invested.
   B. Focus on diversifying among the various niche hedge fund strategies.
   C. Focus on funds with improved operational efficiency and transparent corporate governance.
   D. Focus on large funds from the “foresight-assisted” group.

KEY CONCEPTS

LO 88.a

Hedge funds are private investments and have very little financial regulation. They tend to be highly leveraged, and managers make large bets. On the other hand, mutual funds are regulated and more structured.

LO 88.b

There are some hedge funds that do not participate in commercial databases, which impacts aggregate hedge fund performance. Thus, there is selection bias contained in hedge fund databases.

LO 88.c

There have been major events affecting the hedge fund industry, including large losses following a change in Fed policy in 1994, the LTCM collapse in 1998, and the dot-com collapse in 2001.

LO 88.d

Institutional investors flocked to hedge funds beginning in 1999. With the increase of institutional investment came greater demands on hedge fund management for operational integrity and governance.

LO 88.e

Alpha is the return in excess of the compensation for risk. Beta is a measure of the systematic risk of the security or portfolio relative to the market as a whole. Firms may independently manage alpha and beta. This is known as separating alpha and beta. Managers can use investment tools to pursue alpha while sustaining a target beta for the portfolio.

LO 88.f

Managed futures funds focus on investments in bond, equity, commodity futures, and currency markets around the world. The payoff function of this strategy is similar to a lookback straddle.

Global macro managers make large bets on directional movements in interest rates, exchange rates, commodities, and stock indices, and do better during extreme moves in the currency markets.

Merger arbitrage funds bet on spreads related to proposed merger and acquisition transactions, and perform poorly during major market declines.

Distressed hedge funds invest across the capital structure of firms that are under financial or operational distress, or are in the middle of bankruptcy. The strategy tends to have a long-bias. These hedge fund managers try to profit from an issuer’s ability to improve its operation, or come out of a bankruptcy successfully.

Fixed income arbitrage funds try to obtain profits by exploiting inefficiencies and price anomalies between related fixed income securities. Their performance is correlated to changes in the convertible bond default spread.

Convertible arbitrage funds attempt to profit from the purchase of convertible securities and the shorting of corresponding stock.

Long/short equity funds take both long and short positions in the equity markets, diversifying or hedging across sectors, regions, or market capitalizations, and have directional exposure to the overall market and also have exposure to long small-cap/short large-cap positions.

Dedicated short bias funds tend to take net short positions in equities, and their returns are negatively correlated with equities.

Emerging market funds invest in currencies, debt, equities, and other instruments in countries with emerging or developing markets.

Equity market neutral funds attempt to achieve zero beta(s) against a broad set of equity indices.

LO 88.g

The top 50 hedge funds demonstrated statistically significant alpha relative to the DJCSI and HFRI hedge fund indices. The strategy of buying large hedge funds appears to deliver superior performance compared to just investing in hedge fund indices. Hedge fund managers are still delivering alpha relative to peers, and also have low exposure to the U.S. equity market.

LO 88.h

Diversification among hedge fund strategies may not always be effective due to the convergence of risk during times of extreme market stress. There is significant credit-driven tail risk in a hedge fund portfolio. The use of managed futures may be a partial solution—it has been a strategy with a convex performance profile relative to other hedge fund strategies. Hedge fund investors need to consider portfolio risks associated with dramatic market events.

LO 88.i

In the hedge fund industry, risk sharing asymmetry between the principal (investor) and the agent (fund manager) is a concern due to variable compensation schemes.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 88.1

1. **B** During the time period following the dot-com collapse, hedge funds outperformed the S&P 500 with a lower standard deviation, which attracted institutional investment. (LO 88.c)
2. **A** A global macro fund does better if there are extreme moves in the currency markets. Along with managed futures, global macro is an asset allocation strategy. Managers take opportunistic bets in different markets. The strategy has a low correlation to equities. (LO 88.f)
3. **D** Distressed hedge funds have long exposure to credit risk of corporations with low credit ratings. Publicly traded high-yield bonds are a good proxy for the returns to expect. (LO 88.f)

Module Quiz 88.2

1. **D** Comparing the two different time periods, there was a decline in alpha due to more competition in the hedge fund industry. (LO 88.g)
2. **A** The incentive fee structure within the hedge fund industry has not really changed over the years, and there is incentive for managers to take undue risks in order to earn fees. Thus, there should be a focus on investing in funds for which the fund managers have a good portion of their own wealth invested. (LO 88.i)

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Mirabile, Chapter 12.

READING 89: PERFORMING DUE DILIGENCE ON SPECIFIC MANAGERS AND FUNDS

Mirabile, Chapter 12

EXAM FOCUS

This reading emphasizes the reasons investors should perform due diligence on potential investments. It provides a thorough list of items to consider in the due diligence process. For the exam, understand in detail the steps involved in evaluating a manager, a fund's risk management process, and a fund's operational environment.

MODULE 89.1: PAST FUND FAILURES, DUE DILIGENCE, AND EVALUATION

Past Fund Failures

LO 89.a: Identify reasons for the failures of hedge funds in the past.

Investors should be familiar with the reasons past funds have failed to ensure they can avoid investing in a failing fund. Following is a concise list of reasons past funds have failed.

1. **Poor investment decisions.** Could be a series of decisions ("domino effect") or a very calculated risk on a specific investment that backfired.
2. **Fraud.** Fraud could occur in several forms including accounting (e.g., misstating asset book values or misstating income), valuation (e.g., misstating asset market values), and theft of funds.
3. **Extreme events.** Events occurring that would otherwise occur with very low probability or were unexpected (e.g., market crashes).
4. **Excess leverage.** Related to making poor investment decisions. Leverage goes both ways. That is, it magnifies gains but also magnifies losses.
5. **Lack of liquidity.** Too many capital withdrawals and redemptions to honor at once, thereby creating a squeeze on cash flow and an inability to meet all capital withdrawals and redemptions.
6. **Poor controls.** Closely related to fraud. Lack of supervision could result in excessive risks being taken that lead to losses large enough to bankrupt the fund.
7. **Insufficient questioning.** Often in a committee-style decision-making process, there may be a dominant member who sways the decision and/or members who are afraid to voice any valid concerns over information they have discovered that would question the merits of the investment manager and/or investment. Ideally, all due diligence team members should be

encouraged to play the role of “devil’s advocate” when appropriate and raise reasonable concerns as early as possible, especially before they reach the committee stage.

8. **Insufficient attention to returns.** Investment funds attempting to reduce operational risk sometimes overcompensate by implementing excessive controls and may end up bearing too many expenses and not generating enough returns. Ideally, there is a healthy balance between generating strong returns while taking on a reasonable level of risk.

Due Diligence Elements

LO 89.b: Explain elements of the due diligence process used to assess investment managers.

Prior to investing, an investor performs due diligence on a potential investment manager, which involves assessing the manager, the fund, and the investment strategy. Information such as the investment background, manager’s reputation (e.g., education, employers), and past performance have always been key considerations but are insufficient on their own.

An additional element of due diligence involves assessing the investment process and risk controls. The starting point is a review of the fund’s prospectus or offering memorandum. Additionally, an attribution analysis could be performed to determine how the returns were generated. Were they generated through the skill and control of the manager, luck, and/or factors beyond the manager’s control? In addition, was the amount of return in line with the amount of risk taken?

Another related element is assessing the fund’s operations and business model. In general, are there internal controls and policies in place to preserve the investors’ funds? Specifically, are the controls in place sufficiently robust to detect and prevent fraudulent activities or are limits imposed on managers to seek higher level approval for transactions exceeding a certain dollar amount or frequency? Is there appropriate segregation of duties between the front office and the back office? What is the process and frequency of asset valuations? What is the fee structure and are there any additional fees after a specific threshold? Are there any limitations or blackout periods on redemptions?

In the end, investors should assess potential managers and their investment strategies with an objective and unbiased mind. They should not get caught up with a manager’s past successes.

Manager Evaluation

LO 89.c: Identify themes and questions investors can consider when evaluating a hedge fund manager.

Manager evaluation is not a task that should be taken lightly by potential investors. This process can be broken down into four areas including strategy, ownership, track record, and investment management.

Strategy

General questions regarding a manager’s strategy may include:

- Does the manager follow a particular investment style (e.g., growth, value)?

- Are there any current “trends” in the fund or specializations in specific securities, industries, or sectors?
- How has the fund changed its investment style or rebalanced its holdings over the past year? What changes are contemplated in light of anticipated market conditions?
- What is the extent of turnover and liquidity in the fund? What market signals are used to determine whether to exit or enter a position?
- What mechanisms are in place to limit any potential losses in the fund?
- To what extent is quantitative analysis and modeling utilized in the investment process? Have any models been developed or tested to date?
- Are short sales used to generate excess profits or to hedge? How successful or detrimental have they been so far?
- Are derivatives used in the portfolio? If so, are they used for hedging or speculative purposes?
- How does the trade execution process work? Does a central trading desk exist for maximum efficiency?
- What is the extent of any investment in private company securities and their role in the overall investment strategy?
- What is the tradeoff between maximizing current returns versus long-term fund growth?
- Has the fund ever been closed or provided investors with a return of capital?

Ownership

Ownership interests often help align the interests of the investment team and the investors. They can be useful in attracting and maintaining quality staff, thereby enhancing and/or continuing to generate strong investment returns for investors.

Therefore, potential investors should inquire as to whether any members of the investment team (e.g., traders, portfolio managers, research analysts) have ownership interests in the firm.

Track Record

Specific questions about the manager’s and fund’s track records may include:

- How does the past performance of the manager and/or fund compare to its peers and/or funds that follow the same or similar investment philosophy?
- Has past performance been audited or verified by a third party?
- Is there sufficient performance history to perform trend and/or attribution analysis? How did the manager or fund perform during market downturns?
- What were the investment returns relative to the size of the investment assets?
- Are most or all of the staff on the investment team that generated those past results still employed by the firm?

Investment Management

Inquiries during manager interviews may include:

- What is/was the manager's investment strategy for generating excess returns?
- How did the manager cope with tough market periods?

Reference checks on managers could include the following individuals:

- Former employers: Was the manager a leader or follower? Proactive or reactive? A team player or individualist?
- Current and former colleagues, clients, and other independent parties: Ensure consistency but if there are mixed reviews, follow up for explanations and/or obtain clarification from the manager.
- Current and former investors: What good and bad investment experiences did they have with the manager?

Background checks on managers may include the following questions/activities:

- Obtaining comprehensive background check reports on the manager.
- Review the Form ADV filed by the manager with the SEC and state securities authorities. It contains general information about the business as well as more detailed information such as fees, services provided, conflicts of interest, and background of key personnel.
- Has the manager consistently demonstrated herself to be a person of integrity? This could be verified by examining public databases and the SEC website to look for any past or current instances of litigation or criminal behavior.
- Has the manager demonstrated strong personal financial responsibility? This could be verified by examining personal credit reports and bankruptcy reports.
- Are the manager's stated representations accurate? This could be verified by inquiring with auditors and brokers who are currently working with the manager or have worked with the manager in the past.
- What is the extent of the manager's involvement in any related party transactions?

Risk Management Evaluation

LO 89.d: Describe criteria that can be evaluated in assessing a hedge fund's risk management process.

A proper risk management process should contain an assessment of the following areas: risk, security valuation, portfolio leverage and liquidity, tail risk exposure, risk reports, and consistency of the fund terms with the investment strategy.

Risk

- Assess the applicable systematic risk factors (i.e., regular market risks common to most or all funds) and unsystematic risk factors (i.e., risks specific to the manager, fund, or strategy).
- Determine whether written policies and procedures exist regarding measuring and monitoring risk.
- Determine whether a risk committee exists that would receive such measurements. If so, how often are they reported?

- Evaluate the extent of the risk management culture among the various types of employees. For example, how actively involved are employees with managing and mitigating the firm's risks on a day-to-day basis?
- Assess the information technology resources used to quantify the risks. For example, are they reliable and do they measure items consistently between traders and portfolio managers?
- Identify the existence and structure of any risk models. What are their inputs and assumptions? Have the models been tested and are they robust?

Security Valuation

- Identify the proportion of fund assets that are objectively valued through reliable market prices versus those that are more subjectively valued by the broker or through simulation.
- Examine the independence of valuations. Is valuation performed by the fund administrator (generally more independent) or by the fund manager (generally less independent)?
- Determine if prices may be overridden for valuation purposes. If so, by whom? Is there documentation or an approval process?

Portfolio Leverage and Liquidity

- Assess the sources of leverage as well as the current and historical levels of leverage.
- Calculate the current level of liquidity and observe how it has changed over time. The current level is especially relevant because of the impact on portfolio investment capacity and whether it can take on more investment capital.
- Within a stated investment strategy, excessive leverage and/or illiquidity could generate actual returns that are significantly different than expected (i.e., no longer comparing apples to apples), thereby requiring an adjustment in expected returns.

Exposure to Tail Risk

- Analyze information about the fund to conclude whether the fund's return distribution possesses skewness or kurtosis.
- Discuss the possibility of tail risk with the manager and determine whether the manager has sufficiently mitigated the risk or whether further action is required by the investor.

Risk Reports

- Review risk reports prior to investing in the fund. Investors should receive these risk reports on a regular basis (e.g., monthly, quarterly, annually) whether they are prepared in-house or by a third party.
- Analyze key risk metrics and compare them to other similar funds for benchmarking purposes and for determining if any unusual risks exist in the fund.

Consistency of the Fund Terms with the Investment Strategy

- Examine the general fee structure of the fund and determine whether it is consistent with similar funds.

- Identify the existence of any additional fees after a specific threshold (e.g., high-water mark, hurdle rate).
- Evaluate whether high fees are being paid to managers in search of market alpha (fair) as opposed to beta (unfair).
- Identify the existence of any limitations or blackout periods on redemptions.

MODULE QUIZ 89.1

1. Based on historical evidence, which of the following factors is least likely to result in the eventual failure of a hedge fund?
   A. Excessive controls in place.
   B. Taking on more systematic risk.
   C. Making decisions in a committee setting.
   D. Materially misstated financial statements.
2. In performing due diligence on a potential investment manager, which of the following factors is the least important for the investor to consider?
   A. Risk controls.
   B. Business model.
   C. Past performance.
   D. Investment process.
3. Which of the following statements regarding the assessment of a fund's risk management process is correct?
   A. The periodic valuation of a fund's securities is best performed by the fund manager.
   B. The existence of written policies and procedures for internal controls is useful in measuring and monitoring risk.
   C. The risk reports received by investors are preferably prepared by a third-party risk provider instead of by the fund itself.
   D. The key requirement for information technology resources used to quantify the risks is that they measure items consistently.
4. Lisa Tahara, FRM, is considering an institutional investment in a hedge fund that has experienced volatile and generally positive returns in the past. Which of the following considerations about the fund's track record is least relevant for consideration in her investment decision?
   A. Size of investment assets.
   B. Absolute level of past returns.
   C. Verification of returns by a third party.
   D. Employment continuity of the investment team.

MODULE 89.2: OPERATIONAL DUE DILIGENCE

LO 89.e: Explain how due diligence can be performed on a hedge fund's operational environment.

Investors should focus on several key areas when performing operational due diligence on a fund. The focus areas are internal control assessment, documents and disclosure, and service provider evaluation.

Internal Control Assessment

A starting point in due diligence is examining the qualifications and attitudes of the personnel. For instance, does the CEO believe in controls and compliance with the rules? An analyst must also

assess whether the internal control staff have sufficient technical and work experience to perform their compliance duties properly. Have they been properly trained and do they continue to expand their skills in compliance? Some assurance may be required regarding whether the back and middle office managers are sufficiently experienced in performing supervisory duties. Finally, background checks on critical internal control staff members might be required.

Examining the fund's policies and procedures may also be useful. Related documents may cover areas such as trading, derivatives usage, and transaction processing. One drawback is that these documents tend to be general and only demonstrate the intention to have a strong control environment. In other words, merely reading the documents provides little assurance that the policies and procedures are actually being followed or are effective. It is usually a good sign if a fund has been proactive and obtained an audit report and opinion on the effectiveness of its controls. If this report is available, it should be reviewed.

The due diligence process should include an examination of the in-house or outsourced compliance system that is in place. Examples of specific items to consider include the code of ethics (if one exists) and any restrictions on employee trading and related-party transactions.

There should be an investigation into how the funds deal with counterparty risk arising from OTC derivatives and other counterparties. Is such risk mitigated by dealing with more than one counterparty? Are the counterparties monitored for risk on a daily basis?

Finally, there should be an assessment as to the effectiveness of corporate governance. Is it pervasive throughout the organization? Are examples of internal control "breaches" followed up with appropriate actions to remedy and prevent future recurrence?

Documents and Disclosure

As part of the due diligence process, investors must confirm with the fund's legal counsel its involvement in preparing the original version of the fund documents as well as any subsequent revisions. The investor should also confirm if the law firm remains as the fund's legal counsel. A physical check of the documents should be made to look for any changes made after the date indicated on the documents.

The investor should corroborate the terms of the offering memorandum by examining other documents such as the Form ADV, subscription agreement, and investment management agreement. Consistency is important here. Terms relating to fees, redemption rights, liquidity, and lockups should be examined closely and clarified with the manager if required.

Conflicts of interest that are disclosed in the offering memorandum should be scrutinized carefully. Lack of clarity in the disclosure may be a red flag and warrant further discussion with the manager and/or require independent information.

Similarly, lack of clarity or sufficiency in the disclosure of risks may warrant further investigation. The discussion of very general or irrelevant risk factors may be cause for concern.

The focus of any due diligence should be on the manager. As a starting point, the potential investor should determine the extent of the manager's authority. Are the provisions very broad (potentially more risky) or quite specific? Is the manager subject to limitations on the amount of leverage employed or on the percentage of the fund invested in specific securities, sectors, or industries? Can

the manager be indemnified for his actions outside of fraud, gross negligence, or malicious intent? Additionally, there should be a consideration of the manager's reporting duties to investors (e.g., audited financial statements, disclosure of the tax treatment of the fund's income and transactions).

In analyzing the financial statements, the investor should begin by ensuring the audit opinion is unqualified (i.e., the auditor believes the financial statements contain no material misstatements). The balance sheet and income statement should be examined for consistency with the fund's investment strategy (e.g., a high leverage fund should have high interest expense on the income statement and high liabilities on the balance sheet). Any inconsistencies should be discussed with the manager on a timely basis. In addition, the footnotes (which are also audited) should be examined carefully since they provide more detailed information on key items (e.g., contingent liabilities, related-party transactions) than the corresponding financial statements.

Fees paid to the manager by the fund should be scrutinized and recalculated. They should be corroborated with the offering memorandum. Specifically, there should be a check of any incentive fees paid in loss years.

Finally, there should be a check for the level of net contributions to the fund by the general partner. Any fund withdrawals should be questioned.

Service Provider Evaluation

Third-party service providers may be hired by a fund for trade execution, information technology, valuation, verification, and asset safeguarding purposes.

A starting point for assessing the actual service providers is to examine the internal control letters issued by its auditors and its audited financial statements. Further due diligence could be performed through in-person discussions regarding the service provider's role.

LO 89.f: Explain how a hedge fund's business model risk and its fraud risk can be assessed.

In addition to the previous due diligence, potential investors need to closely examine the fund to ensure that the risks associated with its business model and potential fraud are not excessive.

Business Model Risk

Evaluating business model risk requires assessing whether managers know how to operate the business as well as generate high returns. Typical risks, potentially leading to failure and closure of the fund, include a lack of cash and working capital, a lack of a succession plan, and excessive redemptions in a short period of time.

A fund's business model risk can be assessed by performing the following tasks:

- Examining the nature of the revenues and expenses. For example, are revenue items stable, recurring, or one-time? Can costs be reduced or are they increasing uncontrollably?
- Calculating the percentage of revenues derived from variable incentive or performance fees (that may not materialize in market downturns).
- Assessing the significance of the gap between management fees (revenue) and operating expenses.

- Considering the sufficiency of the amount of working capital (especially cash) in place to cover revenue shortfalls and/or expense overages for a reasonable period of time.
- Determining how frequently budgets are created and for what period of time.
- Determining the fund's breakeven points in terms of assets under management and required performance level. Comparing those amounts to current (actual) and future (projected) amounts.
- Ascertaining if there is sufficient personnel or capacity to increase the fund's investment asset base.
- Ascertaining the existence of key person insurance on relevant individuals and the existence of a succession plan.

Fraud Risk

Fraud risk can always exist even though extensive due diligence has been performed on the manager and fund prior to investing. A fund's fraud risk can be assessed by determining the existence of the following factors:

- Frequent related-party transactions, including trading through a broker or using a valuator who is a related party.
- Frequent instances of illiquidity, including significant concentrations of illiquid investments (especially those that are valued by the manager only).
- Frequent litigation as a defendant, especially regarding claims of fraud.
- Unreasonably high (stated) investment returns.
- Frequent personal trading by the manager of the same or similar securities as those held by the fund.
- Frequent shorting transactions.

Fraud risk may be mitigated by performing the following actions:

- Check the SEC website for any prior regulatory infractions.
- Check court records for any prior litigation and bankruptcy records for examples of financial irresponsibility.
- Inquire with service providers for assurance over their competence and independence from the manager.
- Perform extensive background checks on the manager.

Due Diligence Questionnaire

LO 89.g: Describe elements that can be included as part of a due diligence questionnaire.

Properly designed due diligence questionnaires that are thoroughly and honestly answered by respondents can yield valuable information to a potential investor and may provide a list of concerns that need further assessment. The questionnaire should make the following inquiries:

1. Inquiry into general information on the manager provides a starting point in the due diligence process. Examples of such information include:

    - Confirmation of proper registration with regulatory authorities.
    - Determination of ownership form (e.g., corporation) and structure.
    - Identification of key shareholders.
    - Reference checks.
    - Information on past performance.
    - Business contact information.
2. Inquiry into general information on the fund also is critical. Examples of general information that should be collected include:
    - Fees.
    - Lockup periods.
    - Redemption policies.
    - Primary broker.
    - Fund director.
    - Administrator.
    - Compliance: auditor and legal advisor.
    - Financial: assets under administration, investment capacity, and historical performance (also see financial statements).
    - Historical drawdown levels.
3. Inquiry into execution and trading as well as service providers may provide some insight on the speed and accuracy of transaction processing and the existence of related-party service providers, the latter of which may raise red flags with potential investors as discussed earlier.
4. Inquiry regarding the firm's third-party research policy may be useful to determine a fund's sources of research information, thereby allowing the assessment of the extent and quality of the due diligence performed by the fund in its investment process.
5. Inquiry regarding compliance processes, the existence and degree of involvement of in-house legal counsel, and the existence of anti-money laundering policy and procedures may help provide comfort that the fund and its managers have a desire to operate in an ethical manner and/or within the boundaries of the law.
6. Inquiry into the existence of information regarding disaster recovery and business continuity plans as well as insurance coverage and key person provisions may provide some assurance regarding the stability of the firm and, therefore, the safety of any invested funds.
7. Inquiry into the investment process and portfolio construction provides the potential investor with information required to make an informed decision whether the overall risk and return profile of the fund is consistent with the investor's investment objectives.
8. Inquiry into risk controls such as leverage, liquidity, asset concentrations, portfolio diversification, and market risk factors give the investor a more complete picture of the investment risks and how the managers attempt to manage and mitigate them.

The existence of financial statements, especially if audited with an unqualified opinion, provide objective and historical financial information on the fund that can be used to assess performance. Information on the composition of the invested assets may also be helpful to the potential investor.

Finally, interim statements (not necessarily audited) may provide more timely information to make a more current assessment of the fund by the potential investor.

MODULE QUIZ 89.2

1. Which of the following items is least likely to be included as requested information on a due diligence questionnaire?
    A. Insurance coverage.
    B. Returns attribution analysis.
    C. Disaster recovery procedures.
    D. Anti-money laundering policy.

KEY CONCEPTS

LO 89.a

Past fund failures can be attributed to poor investment decisions, fraud, extreme events, excess leverage, lack of liquidity, poor controls, insufficient questioning, and insufficient attention to returns.

LO 89.b

The due diligence process for assessing investment managers should include information on the investment background and reputation of the managers and past performance. In addition, there should be an assessment of the fund's investment process, risk controls, operations, and business model.

LO 89.c

In evaluating a manager, investors should consider four broad themes including strategy (e.g., evolution, risk management, quantification, types of investments), ownership, track record (e.g., comparison with peers, independent verification of results), and investment management (e.g., manager interviews, reference checks, background checks).

LO 89.d

Criteria that could be used in assessing a fund's risk management process includes risk (e.g., types, culture, quantification/models), security valuation, portfolio leverage and liquidity, tail risk exposure, risk reports, and consistency of the fund terms with the investment strategy.

LO 89.e

Performing due diligence on a fund's operating environment focuses on:

- Internal control assessment (i.e., qualifications and attitude of personnel, written policies and procedures, compliance system, counterparty risk, effectiveness of governance).
- Documents and disclosure (i.e., confirmations with the fund's legal counsel regarding fund documents, corroborating terms of the offering memorandum, conflicts of interest, disclosure of risks, manager's authority, manager's reporting duties to investors, financial statements, and fees paid to the manager, net contributions/withdrawals by the general partner).
- Service provider evaluation.

LO 89.f

Business model risk can be assessed by considering revenues and expenses (detailed examination), sufficiency of working capital, existence of budgets, computation of breakeven points, ability to increase investment asset base, existence of key person insurance, and existence of a succession plan.

Fraud risk can be assessed by considering the existence of related-party transactions, illiquidity, litigation, unreasonably high (stated) investment returns, personal trading by the manager of the same or similar securities as those held by the fund, and shorting transactions.

LO 89.g

Items to include as part of the due diligence questionnaire include general information on the manager and the fund, execution and trading, service providers, third-party research policy, compliance processes, existence and degree of involvement of in-house legal counsel, existence of anti-money laundering policy and procedures, existence of information regarding disaster recovery and business continuity plans, insurance coverage, key person provisions, details of the investment process and portfolio construction, risk controls, and information contained in the fund’s financial statements.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 89.1

1. **B** If a fund takes on more systematic risk (i.e., regular market risk), it is less likely to result in a failure unless there is a significant market downturn. Taking on more unsystematic risk, however, is more likely to result in a failure. Excessive controls to reduce operational risk may be a good idea but may also result in excessive expenses and insufficient returns, thereby leading to a possible failure of the fund.

   In a committee-style decision-making process, there may be a dominant member who sways the decision and/or members who are afraid to voice any valid concerns. Materially misstated financial statements are a form of accounting fraud, which significantly increases the risk of the eventual failure of a fund. (LO 89.a)

2. **C** Investors should assess potential managers and their investment strategies with an objective and unbiased mind. They should not be unduly concerned with a manager's past successes given that past performance is not always indicative of future performance. Risk controls, the business model, and the investment process are all fundamental parts of the due diligence process. (LO 89.b)

3. **D** It is very important for the information technology resources used to quantify risks to measure items consistently. Securities valuation is an important and potentially subjective task, therefore, independence and objectivity is critical. Policies and procedures tend to be general and only demonstrate the intention to have a strong control environment. Their existence alone provides little assurance that they are properly measuring and monitoring risk. In general, the reporting of risk measures is a more objective task and as a result, there is little or no preference for the reporting to be done internally or externally. (LO 89.d)

4. **B** The absolute level of past returns is least relevant here given the volatile returns in the past. Also, past returns are not an assurance of similar returns in the future. The relative level of returns is more important than the absolute level. Verification of returns by a third party provides assurance that the return calculations were computed fairly and accurately by the fund. It is relevant to ascertain whether most or all of the staff on the investment team that generated the past results are still currently employed by the fund. It provides some (but not absolute) assurance that similar returns may be generated in the future. (LO 89.c)

Module Quiz 89.2

1. **B** A returns attribution analysis could be performed to determine how a fund's returns were generated. Return attributions are not generally part of a due diligence questionnaire but such an analysis could subsequently be performed based on some of the information received from the questionnaire. The other items (insurance coverage, disaster recovery procedures, and anti-money laundering policy) are all standard items that would be found in most, if not all, due diligence questionnaires. (LO 89.g)

The following is a review of the Risk Management and Investment Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Dimmock and Gerken.

READING 90: FINDING BERNIE MADOFF: DETECTING FRAUD BY INVESTMENT MANAGERS

Dimmock and Gerken

EXAM FOCUS

Investors should utilize investment adviser disclosures to avoid fraud. For the exam, know that investment firms that have conflicts of interests, have an association with their broker/dealer, are registered under the Investment Company Act (ICA) of 1940, have smaller investors, have clients who are agents, and have past violations are more likely to experience fraud in the future. Also, understand the problems that prevent fraud prediction methods from being implemented sooner.

MODULE 90.1: DETECTING FRAUD BY INVESTMENT MANAGERS

Using Disclosures to Predict Fraud

LO 90.a: Explain the use and efficacy of information disclosures made by investment advisors in predicting fraud.

It is important that investors be able to predict fraud for two reasons. First, in many cases, fraud results in a total loss for the investor. When fraud is disclosed, an investment firm has a much greater probability of losing investor capital and going bankrupt.

Second, in the U.S., there are no requirements for investment advisor experience or accreditation. There are also no laws against investment advisors' conflicts of interests, but they simply must be disclosed. Therefore, it is up to investors to examine the required disclosures that investment advisors must make. The main federal law protecting investors is the Investment Advisers Act of 1940, which requires advisors to file **Form ADV**. This form requires disclosure of past regulatory and legal violations and possible conflicts of interest. Investors should use the information disclosed to predict and avoid fraud.

Predictive Variables From Form ADV

In the U.S., investment advisors who manage more than $25 million are required to file [with the Securities and Exchange Commission (SEC)] Form ADV annually or whenever there is a material change.

In addition to past fraudulent activity, there are other items reported on Form ADV of which potential investors should be aware.

- *Conflicts of interest the firm may have with its investors*: including whether the firm recommends securities to investors in which the investment manager has an ownership interest, transacts with clients, or receives referral fees. The existence of conflicts of interest suggests a higher likelihood of fraud.
- *Soft dollar arrangements*: whether the investment firm receives benefits from the broker who executes client trades. The concern here is that the firm may do business with a more costly broker to benefit the firm at the expense of the investor. However, despite the potential conflict of interest, disclosed soft dollar arrangements do not predict fraud.
- *The broker/dealer*: whether the firm is associated with the broker/dealer. The concern here is that the firm may front run its investors or overcharge them. Without the use of an unrelated broker, the investors lose an external monitor of the firm. If the firm is associated with the broker/dealer, fraud is much more likely to occur.
- *The custodian*: whether the firm serves as the custodian for client cash or securities. If the firm serves as the custodian, third-party oversight is absent and there is greater risk of the firm expropriating investor wealth, even with an audit requirement (e.g., at least one unannounced annual asset verification visit). However, a firm serving as a custodian does not support greater likelihood of fraud.
- *Registration under the Investment Company Act (ICA) of 1940*: despite the fact that registered firms have greater regulatory requirements, they may also have vulnerable clients who could easily be defrauded. Therefore, although counterintuitive, registration under the ICA is a predictor for fraud from theft *(but it does suggest a reduction in the risk of fraudulent misrepresentation—see discussion below).*
- *Chief compliance officer (CCO)*: whether the firm has a dedicated CCO who does not hold other positions. Having a CCO does not significantly reduce fraud from theft *(but it does suggest a reduction in the risk of fraudulent misrepresentation—see discussion below).*
- *Majority employee owned:* it may be argued that when the majority of the firm is employee owned, there is more risk of fraud because externally-owned firms would likely be monitoring employees and that is lost when the firm is internally-owned. However, there is not significant evidence to suggest greater likelihood of fraud with majority employee-owned firms.
- *Investor size*: the smaller (larger) the firm's investors, the more (less) likely fraud will occur.
- *Clients who are agents*: an example would be a pension fund manager who is the client but not a direct beneficiary of the funds. Firms that have more clients who are agents are more likely to engage in fraud.
- *Firms that manage hedge funds*: the opaque nature of hedge funds would suggest a greater likelihood of fraud. However, there is no significant evidence to support that conclusion, although the opaque nature may reduce fraud detection and understate the actual fraud.

In summary, investors could use much of the information currently reported on Form ADV to reasonably predict fraud in the future. An informal and rough estimate of Form ADV compliance costs of $500 million is small compared with the fraud losses of over $4 billion experienced by investors in the 5% of firms identified in advance as having the greatest likelihood of experiencing fraud.

Predicting Different Types of Fraud

Two general categories of fraud include theft and fraudulent misrepresentation.

Using Form ADV disclosures, firms with any past regulatory violations, firms that pay referral fees, firms with mainly smaller clients, and firms with mainly clients who are agents would have a high probability of committing future fraud in the form of **theft** (e.g., Ponzi schemes, self-dealing, misappropriation, overstating asset values).

Using Form ADV disclosures, past regulatory violations are a strong predictor of future **fraudulent misrepresentation**. The fact that violations occur would suggest underlying issues with unethical behavior and internal control weaknesses. The additional attention given to firms with past violations may result in the discovery of misrepresentations. At the same time, firms that are registered under the ICA of 1940 are less likely to suffer from fraudulent misrepresentation, perhaps due to the audit requirements. The same goes for firms with an appointed CCO, perhaps due to greater internal monitoring.

Firm-wide fraud perpetrated by senior management is more challenging to predict than fraud perpetrated by a rogue employee. In that regard, firms with noted weaknesses in internal controls are more likely to experience rogue employee fraud.

Costs of Fraud Prediction

LO 90.b: Describe the barriers and the costs incurred in implementing fraud prediction methods.

Implementing fraud prediction methods is a cost-benefit decision—although zero fraud is often desired, it is likely the case that the costs involved with 100% eradication of fraud would exceed the benefits. In the past, cost considerations likely kept the emphasis on disclosure, but in the post-Madoff environment, more attention has been given to securities law enforcement.

It is also possible that some investors are willing to assume more fraud risk in exchange for lower fees or higher returns. In that case, having strong fraud prediction methods may lower the amount of fraud but also hurt those investors who were willing to take on fraud risk. Those investors would not be able to earn a fraud risk premium.

The costs of obtaining relevant data and estimating fraud risk may be lower than the benefits for investors as a whole. However, the costs may be too high for a single investor to bear, and even if the single investor were to bear it, the other investors who benefit would not likely contribute to the costs (i.e., free-rider problem).

Finally, the benefits of identifying investments with fraud risk are limited because of short sale restrictions. In those instances, the investor only accrues an indirect benefit because the investor is limited to only avoiding such investments.

LO 90.c: Discuss ways to improve investors' ability to use disclosed data to predict fraud.

Although the public could always access a firm's current Form ADV, historical filings were not always made available. Previously, the SEC disclosed only the most recent Form ADV so investors were unaware that fraudulent activity (one-time or repeated) had occurred at the firm in the past. To improve transparency, the SEC began providing historical filings for potential investors.

However, the format in which the SEC provided the historical information was not in a user-

friendly format, in that each Form ADV had to be downloaded manually in an encoded format and then the data had to be extracted. As a result, it was impractical for many investors to do so. The SEC has since started to provide the information in a standardized format that would allow most investors to access the relevant information in the Form ADV for due diligence purposes.

MODULE QUIZ 90.1

1. In the U.S., investment advisors are required to file Form ADV annually or whenever there is a material change when they manage at least how much in assets?
   A. $10 million.
   B. $25 million.
   C. $50 million.
   D. $100 million.
2. Which of the following factors would lead to an increased likelihood of fraud perpetrated by an investment firm?
   A. Clients who are agents.
   B. The firm serving as a custodian.
   C. Existence of soft dollar arrangements.
   D. Firms that are majority owned by employees.
3. Which of the following factors would lead to a decreased likelihood of fraud perpetrated by an investment firm?
   A. Firms with larger clients.
   B. Firms that manage hedge funds.
   C. Firms with an appointed chief compliance officer (CCO).
   D. Firms that are registered under the Investment Company Act of 1940.
4. The free-rider problem suggests that the costs of obtaining relevant data and estimating fraud risk may be:
   A. higher than the benefits for investors as a whole and for single investors.
   B. higher than the benefits for investors as a whole and lower than the benefits for single investors.
   C. lower than the benefits for investors as a whole and for single investors.
   D. lower than the benefits for investors as a whole and higher than the benefits for single investors.
5. Which Form ADV and format is now made available for investors by the SEC?
   A. Current Form ADV in encoded format.
   B. Current Form ADV in standardized format.
   C. Current and historical Form ADV in encoded format.
   D. Current and historical Form ADV in standardized format.

KEY CONCEPTS

LO 90.a

In addition to past fraudulent activity, items on Form ADV of which potential investors should be aware include: conflicts of interest the firm may have with investors, soft dollar arrangements, associations with broker/dealers, firms serving as custodians, registration under the ICA of 1940, the existence of a CCO, firms that are majority employee owned, investor size, firms with clients who are agents, and firms that manage hedge funds.

LO 90.b

In the past, cost considerations pertaining to fraud likely kept the emphasis on disclosure, but in the post-Madoff environment, more attention has been given to securities law enforcement. Strong fraud prediction methods would prevent some investors from earning a fraud risk premium. Fraud detection methods also suffer from a free-rider problem. The benefits of identifying investments with fraud risk are limited because of short sale restrictions.

LO 90.c

Providing historical and current Form ADVs in a standardized format has improved investors' ability to use disclosed data to predict fraud.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 90.1

1. **B** In the U.S., investment advisors who manage more than $25 million are required to file Form ADV annually or whenever there is a material change. (LO 90.a)
2. **A** Firms that have more clients who are agents (e.g., pension fund manager who is the client but not a direct beneficiary of the funds) are more likely to engage in fraud. (LO 90.a)
3. **A** The smaller (larger) the firm's investors, the more (less) likely fraud will occur. (LO 90.a)
4. **D** The costs of obtaining relevant data and estimating fraud risk may be lower than the benefits for investors as a whole. However, the costs may be too high for a single investor to bear, and even if the single investor were to bear it, the other investors who benefit would not likely contribute to the costs (i.e., free-rider problem). (LO 90.b)
5. **D** To improve transparency, the SEC has now made the current and historical Form ADVs available to investors in a user-friendly (standardized) format. (LO 90.c)

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Schrimpf and Sushko.

READING 91: BEYOND LIBOR: A PRIMER ON THE NEW BENCHMARK RATES

Schrimpf and Sushko

EXAM FOCUS

This reading focuses on the features of an ideal reference rate and describes potential new risk-free rates (RFRs) in terms of these features. For the exam, be able to discuss a benchmark with respect to whether it is secured, from an active market, from a market that includes wholesale funding, and representative of bank marginal funding costs. In addition, be prepared to discuss the issues related to London Interbank Offered Rates (LIBORs) that have led to the search for a new risk-free reference rate, including the manipulation of LIBOR, inactivity of interbank offered rate (IBOR) markets, the increased dispersion in credit risk among banks, and increased reliance on nonbank repos. Lastly, know the risks of using secured repurchase agreements (i.e., repos) in place of LIBOR as a new benchmark.

MODULE 91.1: THE IDEAL REFERENCE RATE

Features of an Ideal Reference Rate

LO 91.a: Describe the features comprising an ideal benchmark.

The ideal benchmark for a reference rate must be widely accepted by market participants. Currently, the IBORs have many of the desired characteristics and are widely accepted. Conversely, IBORs are subject to manipulation as they are computed using survey data from a few large banks. Three features of an ideal reference rate are as follows:

1. The rate is derived from actual data of an active liquid market and is a robust and accurate representation of interest rates in money markets.
2. The rate is able to offer a reference rate for financial contracts outside of the money market. The reference rate would be able to discount and price cash instruments and interest rate derivatives. Reference rates should be determined for different tenors so that a term structure of interest rates is created. For example, overnight index swap (OIS) contracts provide reference rates for different maturities to construct an OIC curve for pricing different maturities.
3. The rate is able to serve as a term lending and funding benchmark. Banks manage both assets and liabilities through borrowing and lending. Therefore, they require an accurate market benchmark that behaves similarly to the cost of raising funds. For example, suppose a bank funds a long-term fixed-rate interest rate loan with short-term variable rate funding. The bank hedges this position by entering an interest rate swap where it receives floating interest rate

payments that represent the funding cost of the bank, and the bank pays fixed-rate payments. Basis risk occurs between asset and liability exposures when the two rates diverge.

Shortcomings of LIBOR as a Reference Rate

LO 91.b: Examine the issues that led to the replacement of LIBOR as the reference rate.

This is not the first time a shift from a benchmark reference rate took place. In the 1980s, market participants switched from the U.S. Treasury bill rates to LIBORs. The primary reason for the switch was the third feature listed previously—banks needed a better benchmark to manage basis risk created by asset and liability mismatches on their balance sheets. LIBOR based on Eurodollar rates was a much closer proxy for the banks' actual borrowing costs and lending rates than the U.S. T-bill.

LIBOR was a desirable reference rate for financial contracts beyond the money market and as a benchmark for bank lending and funding costs. Conversely, the biggest problem with LIBOR is it is based on survey data that can be manipulated. Therefore, LIBOR does not meet the requirements of the first feature listed previously. The following four reasons summarize the problems with using LIBOR as a reference rate:

1. The British Bankers' Association (BBA) collects data from banks based on the rate they can borrow funds from other banks. The top and bottom four survey responses are removed, and LIBOR is calculated as a mean of the remaining rates. These rates are not based on actual transactions, and therefore, the surveyed banks are able to *manipulate LIBOR submissions*.
2. *Interbank deposit markets became less active*, especially following the global financial crisis of 2007–2009. Activity in the unsecured market is even more sparse. Central bank policies created an abundant supply of reserve balances. This led to less interbank market activity that is expected to continue, even if the central bank changes its policies and reduces the excess liquidity.
3. *The increased variance of individual bank credit risk since 2007* erodes the effectiveness of benchmarks based on IBORs that try to capture average bank credit risk exposures. In addition, money market pricing is more sensitive to liquidity and credit risk, with banks relying more on nonbanks for unsecured term funding. There are also greater differences between money market rates, RFRs, and IBORs.
4. *Banks rely more on less risky wholesale nonbank funding in the form of repos* in response to regulatory and market efforts to reduce counterparty risk.

Reforming Reference Rates

The International Organization of Securities Commissions (IOSCO) published a recommendation for the reformation of benchmarks for financial markets in July 2013. The principles that were developed in this meeting state that interest rate benchmarks should be derived from transactional data in active markets and include governance arrangements for benchmark administrators. The most important change for interest rate benchmarks is to use the most liquid sections of the money market to address the issues related with LIBOR. Specifically, recommendations from the IOSCO and Financial Stability Board (FSB) are to establish new reference rates that incorporate some (or all) of the following features, such as:

- Having shorter tenor transactions based on overnight (O/N) RFRs that have large trading volumes.
- Including nonbank wholesale counterparties (e.g., money market funds, investment funds, insurance companies) and not just relying on IBORs.
- Being determined by secured transactions (e.g., bank repurchase agreements, or repos) rather than unsecured transactions for some jurisdictions.

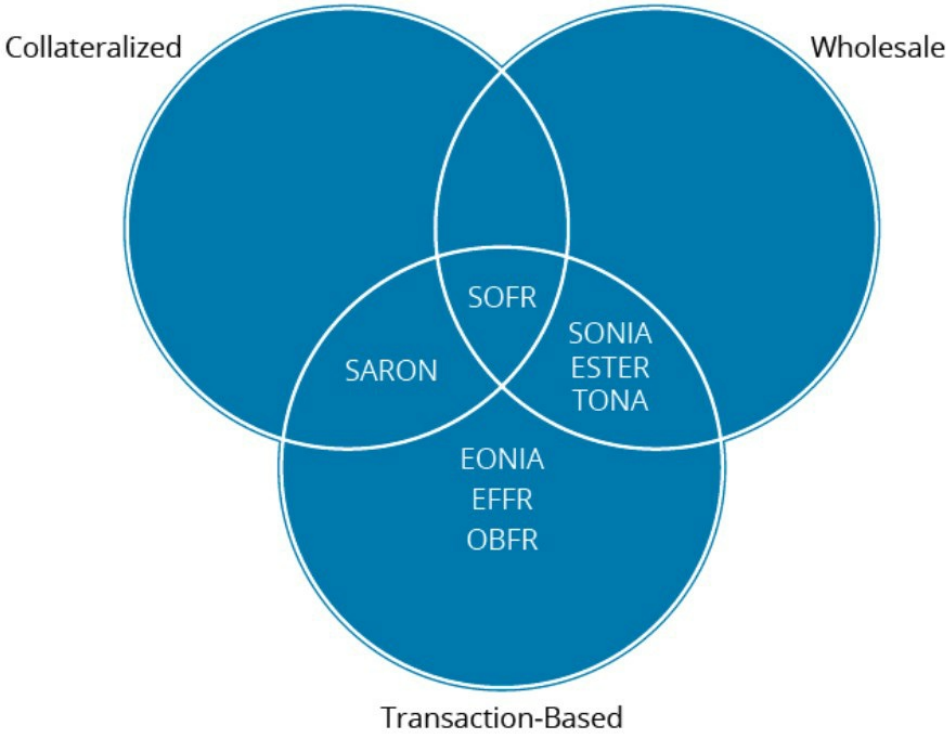
All of these features may not currently be possible with just one benchmark. O/N RFRs satisfy features of deriving a benchmark from a transaction-based active market, but they do not provide the hedging features needed by banks to address their balance sheet risks. Figure 91.1 summarizes the five largest currency alternative reference rates based on the three features just listed. The five proposed reference rates are the **secured overnight financing rate (SOFR)** in the United States, the **sterling overnight index average (SONIA)** in the United Kingdom, the **euro short-term rate (ESTER**) in the Euro area, the **Swiss average overnight rate (SARON)** in Switzerland, and the **Tokyo overnight average rate (TONA)** in Japan. Figure 91.1 illustrates that all five are based on active O/N markets. All five of the RFRs are also derived from wholesale nonbank counterparties, except SARON. Only the SOFR and SARON are based on secured repos.

Figure 91.1: Possible RFRs to Replace LIBOR

RFR	SOFR	SONIA	ESTER	SARON	TONA
Overnight	Y	Y	Y	Y	Y
Wholesale	Y	Y	Y	N	Y
Secured	Y	N	N	Y	N

Figure 91.2 compares the information just provided with old O/N LIBORs. The unsecured O/N LIBORs are summarized in the bottom circle and include the **euro overnight index average (EONIA)**, **effective federal funds rate (EFFR)**, **overnight bank funding rate (OBFR)**, and the old SONIA (not listed in the circle). The Bank of England took over for the SONIA in 2016 and reformed the index, so the SONIA listed in the figure is the new O/N rate.

Figure 91.2: Overnight Reference Rate Classifications



Trading volumes of the newly proposed RFR are much higher than old reference rates. For example, the SOFR has three times the trading volume of EFFR or OBFR. Trading volumes also increased significantly when the SONIA was reformed to include wholesale nonbank counterparties where 70% of this volume is from money market funds.

Furthermore, the new RFRs tracked the Fed policy rate well from 2016 to the end of 2019. However, the new RFRs are more likely to move outside target ranges set by central banks because nonbanks have no access to central bank reserves. In addition, the SOFR and SARON based on repo rates are more volatile than the O/N unsecured rates. Volatility in the SOFR market reflects conditions in the collateral markets and dealer balance sheet window dressing.

MODULE QUIZ 91.1

1. Regulatory authorities and financial market participants are considering potential new reference rates to replace interbank offering rates (IBORs) that have been preferred since the 1980s. One possible reference rate is linked to overnight index swap (OIS) contracts. The OIS reference rate would satisfy all key desirable features of an ideal benchmark except:
   A. it is derived from actual data of active liquid market.
   B. it is able to offer a reference rate for financial contracts outside of the money market.
   C. it is derived for different tenors so that a term structure of interest rates is created.
   D. it is able to serve financial intermediaries as a term lending and funding benchmark.
2. Regulators across jurisdictions are contemplating replacing LIBOR with a more appropriate reference rate. While a major concern is the exposure to bank manipulation, there are also other issues. Which of the following is not a cause that led to the removal of LIBOR as a reference rate?
   A. LIBORs are not widely accepted as a reference rate by most banks.
   B. Interbank deposit markets became less active, especially following the global finance crisis of 2007–2009.
   C. The increased variance of individual bank credit risk since 2007 erodes the effectiveness of benchmarks based on IBORs that try to capture average bank credit risk exposures.

D. Banks rely more on less risky wholesale funding in the form of repos in response to regulatory and market efforts to reduce counterparty risk.

MODULE 91.2: RISK-FREE RATES IN THE REPO MARKET

LO 91.c: Examine the risks inherent in basing risk-free rates (RFR's) on transactions in the repo market.

Using RFRs for new benchmarks will satisfy the first two desirable features of transaction-based rates from an active market including nonbank wholesale counterparty rates. The risk is related to the third feature of a desirable benchmark, which is a reference rate for bank lending and funding. Relying on O/N repo rates will not reflect the marginal funding costs of financial intermediaries. This creates new challenges for banks managing basis risk when marginal funding costs diverge from interest earned on assets.

Banks rely on a useful benchmark to help manage their asset-liability risks. When markets are under stress, secured repo rates can move in the opposite direction of unsecured rates. Insights are gained by examining the behavior of SOFRs in the United States and LIBORs during the 2007–2009 financial crisis. The spread between the SOFR and LIBORs widened significantly during the peak of the financial crisis. Rates increased for LIBOR, reflecting higher credit risk for the unsecured O/N rates. Conversely, rates decreased for secured O/N repos, reflecting a collateral shortage and flight to safety.

During normal times, new RFRs for longer tenors are expected to deviate from LIBOR counterparts. For example, term rates based on futures of SONIA in the United Kingdom were examined in November 2018 during rising concerns of Brexit. The three-month GBP LIBOR rose in response to the tightening of financial conditions. Conversely, the SONIA did not change based on the Brexit concerns, and tracked the risk-free three-month OIS rates.

Other concerns with switching from LIBOR to RFRs involve transition issues. Trillions of dollars of contracts linked to LIBOR will still be outstanding if LIBOR publication ceases in 2021. One possible solution is to convert floating rate cash instruments to fixed-rate contracts. Alternatively, the floating rate could just be linked to another RFR-based term rate. Cross-currency issues will also be a concern if LIBOR is discontinued. In addition, small, open economies with shallow markets in their own currency rely on FX swap-implied benchmarks with USD LIBOR or EURIBOR as an input. This could create potential market functioning risks in these markets.

Ultimately, one reference rate may not be able to meet all the needs of all market participants. Therefore, new benchmarks may feature multiple reference rates that have the desired characteristics to meet the needs of the market. However, it is not clear if this would create market segmentation or be an effective compromise for meeting the needs of market participants.

MODULE QUIZ 91.2

1. Suppose regulatory authorities and market participants agree to discontinue the publication of LIBORs in 2021. Instead, the new risk-free rate (RFR) benchmark chosen to replace LIBOR is the Secured Overnight Financing Rate (SOFR) in the United States. Which of the following statements best describe a risk of making the switch to overnight secured repos from LIBOR reference rates?
   A. The market volumes of the SOFR market may not be high enough to support accurate rates.
   B. The SOFR may be subject to manipulation in some jurisdictions.

C. Financial institutions will have a challenge in managing asset-liability risk based on the SOFR.
D. SOFR rates do not include wholesale funding from nonbanks, causing it to vary from market rates.

KEY CONCEPTS

LO 91.a

Three features of an ideal reference rate are as follows:

1. The rate is derived from actual data of an active liquid market and is a robust and accurate representation of interest rates in core money markets.
2. The rate is able to offer a reference rate for financial contracts outside of the money market and for different tenors so that a term structure of interest rates is created.
3. The rate is able to serve financial intermediaries as a term lending and funding benchmark.

LO 91.b

Problems with using LIBOR as a reference rate that led to its replacement as a benchmark are that:

- LIBORs are not based on actual transactions and are subject to manipulation by bank submissions.
- Interbank deposit markets became less active, especially following the global finance crisis of 2007–2009.
- The increased variance of individual bank credit risk since 2007 erodes the effectiveness of benchmarks based on IBORs that try to capture average bank credit risk exposures.
- Banks rely more on less risky wholesale funding in the form of repos in response to regulatory and market efforts to reduce counterparty risk.

LO 91.c

The switch to O/N repo rates from LIBOR is a concern for financial intermediaries that rely on the benchmark to reflect the marginal funding costs. During periods of market stress, secured repo rates can drop, thus reflecting a flight to quality, while unsecured rates increase reflecting higher credit risk.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 91.1

1. **D** Risk-free rate (RFR) benchmarks such as OIS are derived on active markets outside money markets and can create a term structure. Conversely, they do not reflect the marginal costs of borrowing and lending for banks. (LO 91.a)

2. **A** Despite shortcomings in IBOR-linked reference rates, they are still widely used, and new securities are linked more often to LIBOR than alternative benchmarks. Problems with using LIBOR as a reference rate include the following: (1) rates are subject to manipulation, (2) there is inactivity in the interbank deposit markets, (3) there is an increased variance of individual bank credit risk, and (4) banks rely more on less risky wholesale funding in the form of repos. (LO 91.b)

Module Quiz 91.2

1. **C** Switching to SOFR based on secured repos from LIBOR reference rates will not reflect the marginal funding costs of financial intermediaries. This creates new challenges for banks managing basis risk when marginal funding costs diverge from interest earned on assets. This is a concern because when markets are under stress, secured repo rates can move in the opposite direction of unsecured rates. (LO 91.c)

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—van Liebergen.

READING 92: MACHINE LEARNING: A REVOLUTION IN RISK MANAGEMENT AND COMPLIANCE?

van Liebergen

EXAM FOCUS

Financial institutions have been increasingly looking to complement traditional and less complex regulatory systems and models with more complex models that allow them to better identify risks and risk patterns. This reading focuses on machine learning within artificial intelligence models that have been successfully used in credit risk modeling, fraud detection, and trading surveillance. For the exam, understand the various forms of models, including supervised and unsupervised machine learning, and the three broad classes of statistical problems: regression, classification, and clustering. While machine learning can provide tremendous benefits to financial institutions in combatting risks, there are considerable limitations with these highly complex models, which can be too complex to be reliably used from an audit or regulatory perspective.

MODULE 92.1: MACHINE LEARNING

The Process of Machine Learning

LO 92.a: Describe the process of machine learning and compare machine learning approaches.

Machine learning is a field of artificial intelligence (AI) that uses algorithms which allow computers to learn without programming. There are two forms of machine learning: supervised and unsupervised. In **supervised machine learning**, a statistical model is built in order to predict outcomes based on specific inputs (e.g., predicting GDP growth based on inputs of various macroeconomic variables). In **unsupervised machine learning**, data analysis is performed to identify patterns without estimating a dependent variable.

Machine learning is important because it can analyze data samples in order to identify patterns and relationships in the data, and can make out-of-sample predictions. Models are then analyzed thousands or millions of times so that the model can improve its predictive capability. In this respect, machine learning is closely tied to the "big data" revolution. Supervised machine learning can also analyze nonparametric and nonlinear relationships that can fit any given model and make inferences about the dependent and independent variables.

Machine Learning Approaches

Although many approaches exist to analyzing machine learning, it can be applied to three broad classes of statistical problems: regression, classification, and clustering. Both regression and classification can be addressed through supervised machine learning, while clustering follows an unsupervised approach.

1. *Regression problems* make predictions on quantitative, continuous variables, including inflation and GDP growth. Regressions can involve both linear (e.g., partial least squares) and nonlinear (e.g., penalized regression in which complexity is penalized to improve predictability) learning methods.
2. *Classification problems* make predictions on discrete, dependent variables such as filtering spam email and blood types, where the variable can take on values in a class. Observations may be classified by support vector machines.
3. *Clustering* involves observing input variables without including a dependent variable. Examples include anti-money laundering (AML) analysis to detect fraud without knowing which variables are fraudulent. Data can be grouped into clusters, where outputs from unsupervised learning are used as inputs for supervised learning methods.

As mentioned, machine learning can be used to make out-of-sample predictions, for example, predicting borrowers' ability to repay their obligations and borrower default. However, a good predictive model does not need to also be good at explaining or inferring performance. For example, a credit scoring model will make inferences as to why borrowers default, whereas a good predictive model only needs to identify which indictors lead to borrower default.

Other Concepts in Machine Learning

Models that are very complex may describe noise or random error rather than true underlying relationships in the model. This is called **overfitting**. Overfitting is a particular concern in nonparametric, nonlinear models which tend to be complex by nature. Models that describe noise will only fit that specific dataset and will not perform well in out-of-sample datasets.

Boosting (or **bootstrapping**) refers to overweighting scarcer observations to train the model to detect these more easily. For example, overweighting scarcer fraudulent transactions in a dataset can train the model to better detect them. **Bagging** describes the process of running several hundreds of thousands of models on different subsets of the model to improve its predictive ability. These models may also be combined with other machine learning models, called an *ensemble*, in order to further improve their out-of-sample predictive capabilities.

Machine learning uses past, in-sample data to make predictions about future, out-of-sample data. As a result, it has been criticized at times for being backward looking and for making predictions without truly understanding the underlying relationships.

Deep Learning

Deep learning approaches move away from the "classic" model approaches we have been discussing until now. Whereas classic models focus on well-defined and structured datasets, **deep learning** essentially mimics the human brain by applying several layers of algorithms into the learning process and converts raw data to identify complex patterns. Each algorithm focuses on a particular feature of the data (called *representations*), and the layering of these representations

allows the model to incorporate a wide range of inputs, including low quality or unstructured data. Importantly, the layers are not designed by engineers, but instead learned by the model from the various data.

For example, deep learning has been used in face-recognition and natural language learning models. Models have been complex enough to be able to classify not only the discussion topics, but also the emotions of the people involved. However, deep learning models are extremely complex, often requiring several million or hundreds of millions of datasets.

The Application of Machine Learning

LO 92.b: Describe the application of machine learning approaches within the financial services sector and the types of problems to which they can be applied.

Financial institutions deal with an increasingly large volume of data they need to analyze, which requires complex analytical tools. In response to new regulations and compliance measures, following the 2007–2009 financial crisis, financial institutions have been required to report more comprehensive details on balance sheet metrics and business models. These include stress tests, and reporting on liquidity measures, capital, and collateral.

As a result, financial institutions need to be able to adequately structure, analyze, and interpret the data they collect. Various regulatory standards were introduced on data delivery with the aim to improve the quality of supervisory data, including the Basel Committee's Principles for Risk Data Aggregation (Basel 239) and IFRS 9.

Financial institutions are also faced with an exceptionally large amount of low-quality, unstructured data, called **big data**, from the output of consumer apps, social media feeds, and various systems' metadata. It has become increasingly more important that institutions are able to effectively analyze this high volume of data, including using conventional machine learning techniques as well as more complex deep learning techniques.

Financial institutions should use conventional machine learning techniques for mining high-quality, structured supervisory data. Deep learning and neural networks should be used for low-quality, high-frequency, "big data" type sources.

LO 92.c: Analyze the application of machine learning in three use cases:

- **Credit risk and revenue modeling.**
- **Fraud.**
- **Surveillance of conduct and market abuse in trading.**

Credit Risk and Revenue Modeling

Financial institutions recently moved to incorporate machine learning methods with traditional models in order to improve their abilities to predict financial risk. In turn, they have moved away from the less complex traditional linear credit risk model regressions.

However, machine learning models are often unfit to be successfully incorporated into the ongoing risk monitoring of financial institutions. Machine learning models can be overly complex and sensitive to overfitting data. Their (often extreme) complexity makes it difficult to apply jurisdictionally consistent definitions of data, and the models are too complex for regulatory

purposes, including internal models in the Basel internal ratings-based (IRB) approach, because it is very difficult for auditors to understand them.

Despite their disadvantages, machine learning models can be successfully used in optimizing existing models with regulatory functions. For example, both linear and less complex nonlinear machine learning models can be applied to existing regulatory and revenue forecasting models.

Fraud

Banks have successfully used machine learning in the detection of credit card fraud. Models are used to detect fraudulent transactions, which can then be blocked in real time. Credit card fraud can incorporate machine learning more usefully than other risk areas because of the very large number of credit card transactions that are needed for the training, backtesting, and validation of models. The models then predetermine the key features of a fraudulent transaction and are able to distinguish them from normal transactions. Models can also be successfully used in anti-money laundering or combating the financing of terrorism (AML/CFT) activities through unsupervised learning methods, such as clustering. Clustering identifies outliers that do not have strong connections with the rest of the data. In this way, financial institutions can detect anomalies and reduce the number of false positives.

Many banks still rely on traditional fraud detection through identifying individual transactions or simple patterns, but these systems lead to a large number of false positives and lack the predictive capabilities of the more sophisticated machine learning models. In addition, the traditional models still require significant human involvement to filter the false positives from suspicious activities. Data sharing, data usage, and entrenched regulatory frameworks can also hinder the successful use of machine learning.

Other factors also make the use of machine learning more difficult. Money laundering is difficult to define, and banks do not receive adequate feedback from law enforcement agencies on which transactions were truly fraudulent. As a result, it is difficult to use only historical data to teach money-laundering detection algorithms to detect fraudulent activity.

Surveillance of Conduct and Market Abuse in Trading

Surveillance of trader conduct breaches is another growing area in which machine learning is being increasingly used to detect rogue trading, insider trading, and benchmark rigging activities. Financial institutions find early detection of these violations important because they can cause material financial and reputational damage to the institution.

Early monitoring techniques tended to rely on monitoring trading behavior and assessing single trades. With machine learning, monitoring techniques were enhanced to evaluate entire trading portfolios, and connect information to other activities of the trader, including emails, calendar items, phone calls, and check-in and check-out times. The trader’s behavior could then be compared to other traders’ “normal” behavior. The system detects any deviation from the normal pattern and alerts the financial institution’s compliance team.

One of the challenges facing financial institutions in successfully applying machine learning includes the legal complexities of sharing past breach information with developers. Also, systems need to be auditable, but because machine learning models are designed to continuously learn from

the data, it can be difficult to explain to a compliance officer why a certain behavior set off an alert. As a remedy to these problems, systems can be designed to combine machine learning with human decisions. By incorporating human decisions with machine learning, systems data can be used to know a comprehensive set of information about a trader, and create a system that is less complex and more suitable for audit and regulatory purposes.

MODULE QUIZ 92.1

1. Which of the following classes of statistical problems typically cannot be solved through supervised machine learning?
   A. Regression problems.
   B. Penalized regression.
   C. Classification problems.
   D. Clustering.
2. Which of the following concepts best identifies the problem where a highly complex model describes random error or noise rather than true underlying relationships in the data?
   A. Bagging.
   B. Boosting.
   C. Overfitting.
   D. Deep learning.
3. Which data type is most characteristic of “big data”?
   A. High-quality data.
   B. Low frequency data.
   C. Structured supervisory data.
   D. Low-quality, unstructured data.
4. Which of the following factors does not explain why machine learning systems have been less widespread in the anti-money laundering (AML) space?
   A. Existence of unsupervised learning methods.
   B. Lack of a universal definition of money laundering.
   C. Inadequate feedback from law enforcement agencies.
   D. Inadequacy of historical data for money laundering detection algorithms.
5. A credit analyst makes the following statements:

   Statement 1: Financial institutions face barriers in applying machine learning systems because supervisory learning approaches are difficult to apply.

   Statement 2: Combining machine learning with human decisions tends to produce inferior model results.

   The analyst is accurate with respect to:
   A. statement 1 only.
   B. statement 2 only.
   C. both statements.
   D. neither statement.

KEY CONCEPTS

LO 92.a

Machine learning uses algorithms that allow computers to learn without programming. Supervised machine learning predicts outcomes based on specific inputs, whereas unsupervised machine learning analyzes data to identify patterns without estimating a dependent variable.

Three broad classes of statistical problems include regression, classification, and clustering. Regression problems make predictions on quantitative, continuous variables, including inflation and GDP growth. Classification problems make predictions on discrete, dependent variables. Clustering observes input variables without including a dependent variable.

Overfitting is a problem in nonparametric, nonlinear models which tend to be complex by nature. Boosting overweights less frequent observations to train the model to detect these more easily. Bagging involves running a very large number of model subsets to improve its predictive ability.

Deep learning differs from classical learning models in that it applies many layers of algorithms into the learning process to identify complex patterns.

LO 92.b

Machine learning is a powerful tool for financial institutions because it allows them to adequately structure, analyze, and interpret a very large set of data they collect, and improve the quality of their supervisory data.

Financial institutions can use both conventional machine learning techniques to analyze high-quality, structured data, and use deep learning techniques to analyze low-quality, high frequency data.

LO 92.c

Three cases of machine learning include (1) credit risk and revenue modeling, (2) fraud detection, and (3) surveillance of conduct and market abuse in trading.

Credit risk and revenue modeling, despite their disadvantages stemming from their complexity and overfitting, have been successfully used to optimize existing models with regulatory functions. These include both linear and less complex nonlinear machine learning models which can be paired with existing regulatory and revenue forecasting models.

Traditional fraud detection systems identify individual transactions or simple patterns, leading to a large number of false positives and require significant human involvement to filter the false positives from suspicious activities. Machine learning systems can help financial institutions detect fraudulent transactions and block them in real time. Clustering refers to identifying outliers that do not have strong connections with the rest of the data. Drawbacks of machine learning include difficulty identifying money laundering, and lack of adequate feedback from law enforcement agencies.

Surveillance of trader conduct breaches through machine learning allows for monitoring techniques to evaluate entire trading portfolios, and connecting information to other activities of the trader and comparing this information to traders' "normal" behavior.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 92.1

1. **D** Clustering typically involves applying unsupervised learning to a dataset. It involves observing input variables without knowing which dependent variable corresponds to them (e.g., detecting fraud without knowing which transactions are fraudulent).

   Regression problems, including penalized regression, and classification problems involve predictions around a dependent variable. These statistical problems can be solved through machine learning. (LO 92.a)

2. **C** Overfitting is a concern where highly complex models describe noise or random error rather than true underlying relationships in the model. Overfitting is a particular concern in non-parametric, nonlinear models.

   Boosting overweights less frequent observations to train the model to detect these more easily. Bagging involves running a very large number of model subsets to improve its predictive ability. Deep learning differs from classical learning models in that it applies many layers of algorithms into the learning process to identify complex patterns. (LO 92.a)

3. **D** "Big data" is data that arises from large volumes of low-quality, high-frequency, unstructured data. (LO 92.b)

4. **A** Unsupervised learning methods can be used in AML detection to identify and learn relevant patterns in client activity.

   Money laundering is difficult to define, and financial institutions do not receive adequate feedback from law enforcement agencies on which transactions were truly fraudulent. As a result, it is difficult to use only historical data to teach money-laundering detection algorithms to detect fraudulent activity. (LO 92.c)

5. **A** Incorporating human decisions with machine learning can improve data, because systems data can be used to identify a comprehensive set of information about a trader, and create a system that is less complex and more suitable for audit and regulatory purposes.

   Financial institutions have difficulty in successfully applying machine learning because of legal complexities of sharing past breach information with developers. (LO 92.c)

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Financial Stability Board.

READING 93: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN FINANCIAL SERVICES

Financial Stability Board

EXAM FOCUS

The financial services industry has quickly adopted artificial intelligence (AI) and machine learning (ML). Given this rapid expansion, it is important to understand how this technology will influence the stability of the financial markets. For the exam, be able to describe the supply and demand factors that have spurred the growth of AI, ML, and Fintech. Also, understand the impact of AI and ML on customers, operations, trading and portfolio management, and regulatory compliance.

MODULE 93.1: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN FINANCIAL SERVICES

Adoption of AI and Machine Learning

LO 93.a: Describe the drivers that have contributed to the growing use of FinTech and the supply and demand factors that have spurred adoption of AI and machine learning in financial services.

AI refers to computer applications that replace humans in performing sophisticated tasks and learn through experience how to better perform these tasks. ML, a specific type of AI, refers to learning over time through experience on how to perform a sequence of actions to address a problem, find patterns in big data, or optimize a process. Sometimes this is done with no human intervention, but sometimes human intervention is part of the "learning" process.

The growing use of Fintech, including AI and ML, is driven by the cost savings and increased revenue (i.e., increased profitability) for financial firms. We can look at the supply and demand factors separately to better understand the increasing use of Fintech by financial services firms.

Supply Factors

Drivers of the increasing adoption of AI and ML in a supply context include:

- Increased computing power and faster processors.
- The increasing availability of big data as firms collect, use, and attempt to profit from the information that can be extracted from this data.
- New software for using the information in large and diverse data sets has become more widely available and sophisticated. Specific tools for financial services have been introduced.
- The cost of data storage has decreased significantly.

Demand Factors

The demand for AI and ML solutions is driven by the desire for increased profitability. Drivers of the increasing adoption of AI and ML in a demand context include:

- Costs, which have fallen for Fintech solutions.
- Benefits of AI and ML for risk management.
- The ability to offer new products and services.
- Fraud protection benefits.
- Data reporting requirements and regulatory compliance.
- Benefits from analysis of rapidly growing amounts of digital data available.

Application of AI and Machine Learning

LO 93.b: Describe the use of AI and machine learning in the following cases:

- **customer-focused uses.**
- **operations-focused uses.**
- **trading and portfolio management in financial markets.**
- **uses for regulatory compliance.**

Customer-Focused Uses

Firms are using AI and ML to evaluate credit quality in general, but they have also expanded credit quality analysis using data not generally considered in credit reports. The latter allows credit analysis of those with little traditional credit history. Such use could cause issues by using data correlated with gender or race, which often cannot be used legally in decisions to grant credit.

AI and ML can be used to better estimate insurance risks. As with credit quality estimation, consumer protection issues could arise as a result. If insurance is priced to individuals based on more precise risk estimates from AI, a move toward greater pricing differentials could change the insurance market significantly.

Virtual assistants (“chatbots”) can be used to answer questions (text or voice), to provide balance and payment information, and, more recently, to give advice and cause customers to take actions. Cost savings and better communications with customers can both increase profitability.

Operations-Focused Uses

AI and ML are used to optimize capital allocation, allocating capital to areas where the risk-reward ratios are lower and perhaps reducing the overall amount of capital required to maintain the resilience of firms to the various risks they face.

The use of AI and ML can improve risk management. Specifically, firms can backtest their risk management activities and valuation models to determine if there is bias present and update model assumptions as necessary. Additionally, AI and ML can be incorporated in stress tests to get additional and better information about a firm’s risks and how well the risk management function has performed over time.

Trading and Portfolio Management

AI and ML are used in trading to assess the market impact of large trades, to time trades to minimize execution costs (including market impact costs), and to use the information in the limit order book (outstanding limit orders) and order imbalances to either inform trading or to automate order entry and trade strategies to minimize transaction costs.

AI and ML are used in portfolio management to predict changes in securities prices and price volatility, to increase returns. When returns from AI-based strategies are uncorrelated with (independent of) returns from other sources, portfolio risk can be reduced by the added diversification benefits.

Hedge funds that primarily make decisions using quantitative analysis (quant funds) use sophisticated data-based strategies to find value and produce returns. AI and ML are new and powerful tools for quantitative analysis. Quantitative funds rely on AI to varying (and unknown) degrees; few funds currently rely exclusively on AI to make trades.

Some firms sell insights from AI-based analysis to asset managers; others sell custom AI tools for asset managers to use in-house. As with previous sources of insight and trading advantage, it may be the case that the value of AI-based trading will decrease over time, as more funds trade on similar information and inferences.

Regulatory Compliance

Regtech, a subset of Fintech, refers to the use of technology, along with AI and ML algorithms, to perform regulatory functions in financial markets. This is a rapidly growing field that has the potential to increase efficiency significantly across multiple functions and to provide important information and insights.

In the regulation of brokerages, natural language processing (NLP; text or voice) is used to improve oversight and address product suitability issues. AI is used to improve compliance with the know your customer (KYC) rule, producing better risk evaluation and identifying accounts that appear to require further scrutiny.

AI is used to improve data quality by identifying missing or erroneous values. In general, AI is being used to replace human functions using NLP, unstructured text analysis, and analysis of large data sets.

Central banks are using AI to evaluate the impact of changes in monetary policy as well as to improve their forecasts of economic variables and their understanding of the relationships among these variables.

Regulators are using AI for fraud detection and for related analysis of the huge amount of market and trading data that is currently available to them. Such analysis can identify suspicious transactions, specific risks, and patterns that suggest more investigation is appropriate.

Securities regulators are using AI analysis of text to identify violations of marketing rules and restrictions. The Securities and Exchange Commission (SEC) is using text analytics and ML algorithms to identify instances of fraud or misconduct. One example is the use of unstructured text analysis of investment advisor filings to identify patterns in the filings. These patterns can then be compared to prior enforcement actions to identify those patterns that require closer examination (an

example of supervised learning). The time savings and improvement in identification of potential violations can be very significant.

Impact of AI and Machine Learning on Financial Markets

LO 93.c: Describe the possible effects and potential benefits and risks of AI and machine learning on financial markets and how they may affect financial stability.

The increasing use of AI and ML algorithms by financial services firms is driven by the cost savings, efficiency gains, and product improvements they make possible. Automation of much of the work performed by financial institutions clearly reduces costs and often improves quality and increases customer options. Risk management, fraud detection, and protection against cyberattacks can all be improved by using AI. There is the potential for these cost savings, improved efficiency, and improved product offerings to improve the profitability and capital position.

Increased use of AI and ML algorithms may lead to additional risks as well. Because the decision-making of AI systems is not transparent (and may not be understandable to those employing it), it is unclear how the increasing use of AI may affect financial markets during periods of financial stress or in response to financial shocks. Regulators who do not understand the working of AI systems are ill equipped to assess and manage the potential risks of their use, and finding additional staff who are experts in these systems may be quite difficult.

If economies of scale or proprietary systems lead to the concentration of some financial functions in a small number of firms, operational or financial problems at one firm may have widespread effects. However, whether such concentration will be the result of increasing use of AI is not clear at this point. The use of similar data and algorithms by many financial firms (e.g., hedge funds) could lead to systemic risks and financial instability (network effects).

The use of AI in fraud detection and improving the supervision of firms and markets may reduce the potential for financial market instability and systemic risk. However, there is also the possibility that large providers of AI applications will be operating outside of the existing regulatory framework, increasing systemic risk and the probability of financial market instability.

There is some concern that because ML algorithms and other AI models have “learned” over a period of unusually low volatility in the financial markets, they may not work well in periods with higher volatility, and could lead to financial instability in the event of a financial shock or financial crisis. Because AI systems for trading are designed with a primarily short-term focus, there is much uncertainty about the potential problems and probability of systemic risks to financial markets over longer horizons.

MODULE QUIZ 93.1

1. Which of the following is least likely a driver of demand for artificial intelligence (AI) and machine learning (ML) in financial services?
   A. Benefits of AI and ML for risk management.
   B. Increasing computing power and faster processors.
   C. Improved data reporting and regulatory compliance.
   D. The ability of financial services firms to offer new products and services.
2. The primary factor driving the adoption of Fintech by financial services firms is:
   A. risk reduction.

B. product innovation.
C. increased profitability.
D. delivering more value to customers.

3. Which of the following applications of AI has the greatest risk of raising consumer protection issues?
   A. Trading by hedge funds.
   B. Evaluation of credit quality.
   C. Automating trades in securities markets.
   D. Assessing the market impact of large trades.
4. Currently, AI and ML are being used in the financial services industry:
   A. across many types of firms and services.
   B. primarily to perform regulatory functions in financial markets.
   C. primarily by hedge funds to fully automate portfolio decision-making.
   D. primarily in the area of virtual assistants (“chatbots”) for brokerage customers.
5. A potential risk to financial stability could arise from the increased use of Fintech because:
   A. cyberattacks will likely increase.
   B. there is a great risk of job losses.
   C. it may introduce correlated risks.
   D. regulation will become ineffective.

KEY CONCEPTS

LO 93.a

The growing use of Fintech, including AI and ML, is driven by the cost savings and increased revenue for financial firms. Supply factors that have spurred adoption of AI and ML include increased computing power, increasing availability of big data, and decreasing costs of data storage. Demand factors are driven by the desire for increased profitability, such as lower costs for Fintech solutions and using AI and ML for risk management.

LO 93.b

Firms are using AI and ML to evaluate credit quality, optimize capital allocation, assess the market impact of large trades, predict changes in securities prices and price volatility, and perform regulatory functions in financial markets.

LO 93.c

The increasing use of AI and ML algorithms by financial services firms is driven by the cost savings, efficiency gains, and the potential for product improvements. However, increased use of these algorithms could also lead to additional risks, such as negatively impacting financial markets during periods of stress. There is some concern that AI and ML algorithms have “learned” over a period of low volatility, which suggests they may not work well in periods of higher volatility.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 93.1

1. **B** Increases in computing power and the availability of faster processors have driven increases in the supply of AI and ML solutions to financial firms. The other answer choices are examples of demand drivers. (LO 93.a)
2. **C** Overall, increased profits are driving the adoption of Fintech. Product innovation, risk reduction, cost savings, and delivering more value to customers are all possible ways to increase profits. (LO 93.a)
3. **B** If credit evaluation depends on data about consumers that are highly correlated with such characteristics as gender or race, it is almost certain to raise consumer protection concerns. (LO 93.b)
4. **A** Fintech is being used for a wide variety of functions in the financial services industry, including estimating credit risk, supervision and regulation, capital optimization, estimating insurance risks, portfolio management, securities trading, and customer service. (LO 93.b)
5. **C** "Herding" behavior by funds using the same data and similar algorithms may lead to highly correlated risks across firms, a potential risk to financial stability. Regulators are already using Fintech to improve oversight and compliance. Job losses from technological change are common; although it may automate some functions previously performed by workers, the adoption of Fintech solutions is creating many new jobs. Risk management, fraud detection, and protection against cyberattacks can all be improved by using AI. (LO 93.c)

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—International Monetary Fund, Chapter 5.

READING 94: CLIMATE CHANGE: PHYSICAL RISK AND EQUITY PRICES

International Monetary Fund, Chapter 5

EXAM FOCUS

Extreme weather events (i.e., climactic hazards) may result in disasters that cause significant economic disruption. Therefore, climactic hazards are physical risks that may eventually threaten financial stability. This reading focuses on the impact of climate change and risk on both equity prices and equity valuations. The conclusion is that the effects on price and valuation have been minor at best. In addition, in the context of valuation, investors likely have not given much thought to temperature and climate change. Another key takeaway is that greater insurance penetration and sovereign financial strength are crucial for ensuring financial stability.

MODULE 94.1: CLIMATE CHANGE

LO 94.a: From the perspective of physical risk, describe the channels through which climate change can affect financial stability.

Current Climactic Disasters (Channel 1)

Climactic hazards are expected to increase in both severity and frequency in the coming decades. Climactic hazards may become climactic disasters should they occur where there is significant exposure and vulnerability. A disaster may profoundly and negatively impact individuals, nonfinancial entities, and governments through the destruction of physical capital and the loss of human capital.

With financial entities, insurers could suffer from underwriting losses, banks could face losses from lending defaults (*credit* and *underwriting risk*), and both could suffer significant declines in the values of their securities portfolios (*market risk*). Banks and other deposit-taking institutions could face *operational risks* in terms of their IT systems and personnel, for example, and *liquidity risk* if there is a sudden run on deposits resulting from a disaster. Insurers bear the brunt of the fallout from disasters despite their ability to transfer some risks through reinsurance.

Fortunately, for insurers, governments are often able to offer some insurance, as well as financial bailouts to those affected by a disaster. However, the resulting effect on the government (e.g., fewer assets, more liabilities) could have a negative impact on government stability.

Future Climactic Disasters (Channel 2)

From an investment pricing perspective, investors derive future expectations about physical risk and insurance coverage. In that regard, investors place a premium on assets that face physical risk(s) due

to climate change. The result is a higher discount rate for valuation purposes, resulting in a lower value for such assets, all things being equal.

In simple terms, the above makes sense but the complexities of long-term risk must be considered along with the numerous interactions with other factors that are not easily modeled. This means that the pricing of future physical risk is subject to significant valuation error, which can lead to suboptimal capital allocation.

In terms of financial stability, an abrupt change in how investors feel about future physical risk due to climate change could result in a significant decline in asset value that has wide-reaching effects on both individuals and financial entities. In addition, it is suggested that climate change could result in reduced growth in productivity (e.g., 5% to 10% in the coming decades to the end of the 21st century), which has not necessarily been fully accounted for in asset prices.

LO 94.b: Explain how climate change and climate risk have affected equity prices and equity valuations.

Impact on Equity Prices

An important question to ask is whether major climactic events have significant impacts on equity prices, which may negatively influence financial stability. One way to analyze this issue is to look at stock market indices that would account for any systemic effects of disasters on equity prices. Another way would be to look at the movement in financial institutions' equity prices to determine the extent to which they are impacted by disasters. Note that both banks and insurers are subject to credit risk, market risk, and operational risk. Additionally, banks are specifically subject to liquidity risk, and insurers are specifically subject to underwriting risk.

Overall, the impact of significant climactic disasters on stock prices has been small, although there has been wide variability between disasters. In looking at the period 21 trading days before to 40 trading days after a major disaster, the average abnormal return was approximately –1%. Some major disasters resulted in virtually no change in the relevant stock index, while others saw declines of about 8% shortly after the disaster to a cumulative drop of nearly 30% after 40 trading days.

With financial entities in developed economies, major disasters have a noticeable impact on non-life insurers with average abnormal returns moving downward for approximately 50 trading days after and reaching an absolute minimum near –2%. In contrast, in emerging and developing economies, no such impact occurs. There are three possible explanations: (1) domestic insurers do not underwrite many climate disaster policies, (2) domestic insurers reinsure most of their climate disaster risks, and/or (3) much of the climate disaster insurance in those economies is written through subsidiaries located outside of the economies.

Within the banking sector in both economies, average abnormal returns reach an absolute minimum of approximately –1.5% on the 25th trading day after a disaster occurs.

Impact on Equity Valuations

From a valuation perspective, there is extreme difficulty for investors to account for incremental physical risk in their investment portfolios because very specific future information (e.g., production sites, location of customers) is required. Compounding that difficulty is projecting the

risk to a reasonably correct investment horizon. As a result, there is very little empirical evidence regarding the consideration of future physical risk in equity valuations.

Analysis of price-to-earnings ratios, climate change measures (e.g., Climate Change Hazard Index), and predicted changes in climactic hazard occurrence (e.g., extreme heat exposure, extreme precipitation, drought likelihood, heat wave likelihood, sea level rise index) has shown that there is no relation between changes in climactic hazard occurrence and equity valuations. Going further, a projection of increased hazard risk and increased sensitivity to climate change (e.g., Climate Change Sensitivity Index) did not lead to lower valuations. A projection of increased hazard risk and decreased ability to adapt to climate change (e.g., Climate Change Adaptive Capacity Index) yielded the same results. In all cases, the regression analyses indicated the regression coefficients were positive (e.g., same direction as climate change physical risk), but the coefficients were not statistically significant.

With evidence suggesting that equity valuations do not consider climate change physical risk, it may mean such valuations are overstated. On the other hand, other asset classes such as bonds do appear to account for changes in physical risk, especially with long-term valuations.

Alternatively, a study of temperature could be performed to determine how equity investors price temperature into their investment decisions. For example, a recent study involved examining 27 economies between 1998 and 2017 and whether a pricing anomaly exists in those economies with regard to stocks that are very sensitive to temperature. Specifically, the question asked was whether they have inferior performance to other stocks, all other things being equal. The results indicated that over half of the economies have such a pricing anomaly and for almost 40% of those economies, the top 20% of the stocks most sensitive to temperature had inferior performance of 0.5% per month or more during the period of analysis. The conclusion here is that investors have not sufficiently considered climate change and climate risk in equity valuations.

Insurance Penetration and Economic Development

LO 94.c: Discuss how country characteristics such as insurance penetration and economic development impact the extent to which climatic disasters affect equity prices.

The concept of distributing risks through financial markets using insurance, weather derivatives, and catastrophe bonds is meant to minimize disaster losses suffered primarily by nonfinancial entities. That, in turn, is meant to reduce the negative effects on stock prices. **Insurance penetration** is calculated as the multiple of non-life insurance premiums over gross domestic product (GDP), and there is significant dispersion amongst economies, ranging from 0 to 5. There is also a significant protection gap (responsibility for uninsured losses) for climate disasters, with even well-developed economies having about one-third of such losses being uninsured.

The same minimization of negative effects on stock prices applies to a more developed economy, which would allow the government to provide financial assistance and funds for reconstruction in the event of a major disaster.

Empirical evidence supports the above expectation. In fact, greater insurance penetration and a higher sovereign credit rating do reduce the potential negative impacts on stock prices arising from major disasters. For the overall stock market and specifically the financial and nonfinancial sectors,

there is a strong correlation between the level of insurance penetration and stock market returns immediately after a major disaster.

The results are even more pronounced when looking at very large losses, or left tail risk. For example, a 1% rise in non-life insurance penetration increased banking and industrial returns by an average of 1.5%. When moving further out in the left tail, the same returns increased by an average of 3.5%.

With **sovereign ratings** (using a scale of 1 to 21), a one-point improvement increased overall market returns by about 0.2% and banking and industrial returns by about 0.3%. Moving further out in the left tail, equity returns increased by about 0.8% for the overall market and the banking and industrial sectors, and about double that for the non-life insurance sector.

Combined, the two effects are important given that overall abnormal returns relating to disasters are in the 1% to 2% range. It should be obvious from the analysis that insurance protection and sovereign financial strength are crucial for ensuring financial stability.

MODULE QUIZ 94.1

1. Current climactic disasters are least likely to directly impact which of the following risks?
   A. Legal risk.
   B. Credit risk.
   C. Market risk.
   D. Liquidity risk.
2. Over the next several decades, climactic hazards are expected to:
   A. remain stable in both frequency and severity.
   B. increase in frequency but remain stable in severity.
   C. remain stable in frequency but increase in severity.
   D. increase in both frequency and severity.
3. Which of the following risks resulting from disasters is specific to banks as opposed to insurers?
   A. Credit risk.
   B. Liquidity risk.
   C. Market risk.
   D. Operational risk.
4. On average, the impact on stock prices resulting from major climactic disasters has generally been:
   A. very small.
   B. small.
   C. moderate.
   D. significant.
5. Which of the following statements regarding sovereign financial strength or insurance penetration is most accurate?
   A. In well-developed economies, the protection gap for climate disasters is about 67%.
   B. The level of insurance penetration is reasonably consistent across different economies.
   C. Improvements in sovereign ratings have a greater effect on banking sector returns than on the general market.
   D. The effects of insurance penetration and sovereign financial strength have greater statistical significance when dealing with the right tail of equity return distributions.

KEY CONCEPTS

LO 94.a

There are two channels through which climate change can affect financial stability: current climactic disasters and future climactic disasters. Current climactic disasters affect credit, underwriting, market, operational, and liquidity risks. Changes in expectations and focus on future climactic disasters may impact the discount rate and, therefore, impact current asset values.

LO 94.b

Overall, the impact of significant climactic disasters on stock prices has been small, although there has been wide variability between disasters. With financial entities in developed economies, major disasters have a noticeable impact on non-life insurers. In contrast, in emerging and developing economies, no such impact occurs.

Analysis of price-to-earnings ratios, climate change measures, and predicted changes in climactic hazard occurrence has shown that there is no relation between changes in climactic hazard occurrence and equity valuations. With evidence suggesting that equity valuations do not consider climate change physical risk, it may mean that such valuations are overstated. Alternatively, a study of temperature could be performed to determine how equity investors price temperature into their investment decisions. A recent study on temperature concluded that investors have not sufficiently considered climate change and climate risk in equity valuations.

LO 94.c

Greater insurance penetration and higher sovereign credit ratings reduce the potential negative impacts on stock prices arising from major disasters. For the overall stock market and specifically the financial and nonfinancial sectors, there is a strong correlation between the level of insurance penetration and stock market returns immediately after a major disaster.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 94.1

1. **A** Current climactic disasters directly impact credit, underwriting, market, operational, and liquidity risks. They are far less likely to directly impact legal risk, although there may be indirect impacts. (LO 94.a)

2. **D** Over the next several decades, climactic hazards are expected to increase in both frequency and severity, and that may have an impact in future equity prices. (LO 94.a)

3. **B** Banks are subject to credit risk, market risk, operational risk, and liquidity risk arising from disasters. Insurers are subject to credit risk, market risk, operational risk, and underwriting risk arising from disasters. (LO 94.b)

4. **A** Although the impacts do vary widely between disasters, the general change in stock prices resulting from major climactic disasters is very small. Cumulative average abnormal returns have been about –1% for a 60-day period surrounding the disaster. (LO 94.b)

5. **C** On average, a one-notch increase in sovereign rating increased overall market returns by 0.2% but increased banking sector returns by 0.3%.

   The protection gap for climate disasters in well-developed economies is about 33%; in other words, only about 67% of losses are insured. The level of insurance penetration varies widely across economies. The effects of insurance penetration and sovereign financial strength have greater statistical significance when dealing with the *left* tail of equity return distributions. (LO 94.c)

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Bank for International Settlements.

READING 95: THE GREEN SWAN – CENTRAL BANKING AND FINANCIAL STABILITY IN THE AGE OF CLIMATE CHANGE

Bank for International Settlements

EXAM FOCUS

This reading begins by discussing the notion of a "green swan" as a further development of a "black swan." From that foundation, focus on the concepts of physical risk and transition risk in the context of climate change and how they interact with each other. Also, understand the concept of the "tragedy of the commons" and how a long-term approach to climate change is essential.

MODULE 95.1: THE GREEN SWAN

LO 95.a: Describe the concept of "green swan", how it differs from "black swan" and why climate change is considered a "green swan" event.

Climate Change as a Green Swan

The concept of a "green swan" is derived from the idea of "black swan" events. A black swan event has the following features:

- Unexpected and rare, so it falls beyond the normal range of expectations.
- Overwhelming and huge impacts.
- Cannot be predicted or discussed in advance.

Examples of black swan events include weather-related catastrophes and terrorist attacks. Black swan events are characterized by fat tails and large negative skew; therefore, they do not assume a normal probability distribution.

A green swan can be thought of as a climate-related version of a black swan. For example, physical and transition risks have much uncertainty and nonlinearity that could be extreme and cannot be predicted based on past events. In other words, the usual assumption of the past being indicative of the future and the assumption of normality are no longer valid.

Differences Between Green Swans and Black Swans

Admittedly, the outcome of climate change is very uncertain, but unlike black swans, there is certainty that significant steps need to be taken to counteract climate change, even though the timing and ultimate impact is unknown.

Weather-related disasters go far beyond financial losses contemplated by black swans as these disasters threaten the future of humanity. Excessive carbon dioxide buildup in the atmosphere may result in irreversible damage, while losses suffered during a financial crisis can be reversed in the future with stronger performance.

Finally, the complexities involved in climate change transcend those of black swans because there are many interrelated and spillover events arising from physical and transition risks. They encompass a wide range of environmental, political, social, and economic impacts.

Threat to Price Stability

LO 95.b: Explain why climate change is a threat to price stability.

Climate change may instigate supply-side shocks for certain agricultural and energy products that can lead to abrupt price changes and volatility spikes. In the future, such unfavorable inflationary or stagflationary (e.g., high inflation together with low GDP growth) impacts may become more common and severe. Limited studies suggest that natural disasters and extreme weather events cause short-term price increases in the immediate period following such events.

Climate change may also result in supply shocks that lower output and demand shocks that lower individual wealth and consumption. As a result, the overall impact of climate change on inflation is uncertain because the shocks could cause inflation and output to be negatively correlated. As a result, central banks would have to carefully balance between moderating inflation and moderating output changes.

With climate change, the irreversible nature of certain aspects has the following implications on price stability:

- The long-term nature of climate change might cause stagflationary supply shocks that monetary policy may not be able to fully correct.
- Inflation shocks caused by climate shocks need to be solved globally because it would not likely be effective for a single country or monetary zone to do so.
- Assuming central banks can achieve price stability again in the aftermath of a climate inflationary shock, it is questionable whether they could adequately hedge against green swan events.

Threat to Financial Stability

LO 95.c: Explain why climate change is a threat to financial stability by describing the ways physical and transition risks can materialize.

Climate change can impact financial stability through physical risks and transition risks. Liability risk related to climate change is usually included in physical or transition risk.

Physical Risk

Physical risk manifests in the negative financial impacts of a greater occurrence and impact of weather events brought on by climate change, such as floods and heatwaves. It also includes the negative impacts of long-term climate change, such as higher sea levels and acid content in oceans.

Firms may suffer resulting losses in all asset classes of their portfolios, thereby making them more financially vulnerable.

The overall losses of wealth and reduced profits by firms may cause a shift in wealth for individuals. For example, higher sea levels may cause secondary-level financial impacts of climate change in the form of declines in demand for real estate and the declines in real estate values for geographic areas at risk. Specifically, assume two equivalent homes with a similar view of the ocean. The expectation of future losses would cause the home more directly exposed to rising sea levels to be priced at a (steep) discount to the one that is not.

With the greater frequency of weather-related disasters occurring, noninsured losses (about 70% of weather-related losses) may cause bankruptcy for individuals, companies, governments, and ultimately financial institutions. Insured losses must be covered by insurance and reinsurance companies, and a rise in the number and amount of claims may also lead to the threat of bankruptcy. In general, the increasing erosion of the worldwide asset base due to damage caused by climate change is a key concern.

With regard to financial institutions, because of the non-normal and fat-tailed probability distribution of climate variables, extreme events are a distinct possibility. Unfortunately, it means that some financial institutions will be unable to cover weather-related losses. Similar to the 2007–2009 financial crisis, physical risks may lead to global contagion that results in severe and pervasive reductions in asset values.

Transition Risk

Transition risk refers to the unknown (often negative) and monetary impacts arising from the switch to low carbon products. The issues involve impacts on regulations, reputation, technology, consumer preferences, and cultural norms. A sudden and large-scale move toward a lower carbon footprint could result in unextracted fossil fuels (e.g., oil and gas reserves) that essentially become “stranded assets.” It is possible that such stranded assets could suffer value impairments if there is a sharp decline in demand for fossil fuels. Overall, financial stability is threatened in the form of financial losses and low economic growth if the transition to a low-carbon world occurs too quickly.

In addition to the industries directly impacted by the carbon reduction (e.g., fossil fuel companies), the related industries, such as the automobile industry, are likely indirectly impacted by the drastic reduction in oil consumption and a greater consumer demand for electric vehicles. This will require the automobile industry to adapt and evolve to new technologies to meet changing consumer tastes.

Although the complexities of physical and transition risks mean that they are often examined independently of each other, they are interrelated. For example, a drastic and rapid response to climate change might place a cap on physical risk but increase transition risk. Or a minor and slow response to climate change still might not completely eradicate transition risk but will most likely increase physical risk in the form of more global warming (higher average temperatures) and higher-impact catastrophic disasters. The most likely outcome of a slow response to climate change followed by sudden responses later on (to make up for lost time) would be increased physical and transition risks. Over time, the uncertain and irreversible nature of physical and transition risks will become more interrelated and may result in unforeseen spillover effects.

Secondary Impacts of Physical and Transition Risk

Physical and transition risks can become financial risks in the following ways:

Credit risk may increase because the negative effects of climate change may cause borrowers to have fewer funds available to service their liabilities. This will increase the probability of default (PD) and loss given default (LGD). At the same time, the falling asset values reduce collateral quality, which also increases credit risk.

Market risk could be measured as climate value at risk (VaR), and it may increase if the transition to low carbon occurs too quickly and there are large amounts of stranded assets. Investors may view certain assets as no longer being profitable, thereby resulting in sharp drops in value and prompting a flurry of dispositions (e.g., fire sales). The end result is a potential market crisis.

Liquidity risk may increase for financial institutions. Those that suffer the impacts of market and credit risks (e.g., reduced asset values) might not be able to refinance and liquidate those depressed assets in the short-term.

Operational risk may increase if climate change effects increase the physical risks for a financial institution's offices or data operations, for example. That may necessitate potentially costly operational changes for the financial institution and other entities impacted by the affected financial institution.

Insurance risk may increase for insurance and reinsurance companies if physical risks result in larger than anticipated insurance payouts. In addition, unexpected transition risks may cause insurance for green technologies to be underpriced.

Climate Change Measures

LO 95.d: Discuss the measures that should be considered by members of the financial safety net under the risk, time horizon and system resilience approaches as well as the limitations of these measures.

Risk

In identifying and managing climate risks, such risks should be accounted for in setting regulations and financial stability oversight to the extent that there are reliable models for predicting future conditions. Unfortunately, there are challenges relating to methodology that make it impossible to derive consistent scenarios. For example, how would one choose an appropriate scenario that accurately captures how technology, policy, individual behavior, economics, politics, and climate changes would all play out in the future? Furthermore, there would be significant challenges in converting those scenarios into tangible measures and amounts given the inherent uncertainties involved with climate change. In addition, climate risks are likely to be mainly unhedgeable in the absence of large-scale changes in the climate change environment. For example, attempting to hedge transition risk could be done, in theory, by taking a long position in "green" assets that are not subject to climate risk. However, green assets and technologies are still in the infancy stage and have not developed sufficiently to serve as hedges. Better modeling processes and analytical tools are needed to overcome the uncertainty and complexity involved with climate change risks.

Time Horizon

A long-term approach is taken to counteract the notion that the catastrophic impact of climate change will impose a cost to future generations that the current generation has no incentive to remedy (a.k.a. “tragedy of the commons”). Measures to be taken include accounting for environmental, social, and governance (ESG) factors in bank investment portfolios and, as appropriate, integrating ESG when formulating financial stability regulations.

Central banks that act on their own would not be able to reallocate the massive amounts of capital (e.g., from carbon-intensive to low-carbon) at the rapid pace needed to overcome the tragedy of the commons. Although carbon pricing and internalization of externalities (e.g., carbon taxes, emission standards) are positive measures, they are not enough to overhaul the current attitudes and move firmly toward a low-carbon global economy.

System Resilience

To successfully transition to a low-carbon global economy requires an understanding of the great uncertainty involved in the process of maintaining long-term climate and financial stability. The consideration of new policy mixes (fiscal, monetary, and prudential) and nonequilibrium and nonquantitative models may be appropriate to better account for how climate and socioeconomic systems interact. It would also be necessary to start thinking of financial and climate stability as two interconnected public goods. Climate stability should be thought of as an important international public good, and maintaining climate stability will require key changes in the global monetary and financial system.

MODULE QUIZ 95.1

1. Which of the following statements regarding black swans and/or green swans is most accurate?
   A. Black swan events are expected but reasonably common.
   B. Both black swan and green swan risks fit fat-tailed distributions.
   C. The complexity involved with black swans and green swans is similar.
   D. For green swans, there is a high degree of uncertainty that some combination of physical and transition risks will occur in the future.
2. Climate-related shocks are most likely to impact prices through:
   A. supply-side shocks only.
   B. demand-side shocks only.
   C. both supply-side and demand-side shocks.
   D. neither supply-side nor demand-side shocks.
3. Based on studies that examine the impact of climate-related shocks on inflation, what is the most likely impact on food prices following a natural disaster?
   A. They increase in the short term only.
   B. They increase in the long term only.
   C. They increase in both the short term and the long term.
   D. They remain unchanged in the short term only.
4. Insured losses constitute approximately what percentage of weather-related losses?
   A. 10%.
   B. 30%.
   C. 50%.
   D. 70%.
5. The sudden decline in the value of investment assets resulting from a climate change event is least likely to impact which of the following risks?
   A. Credit risk.

B. Liquidity risk.
C. Market risk.
D. Operational risk.

KEY CONCEPTS

LO 95.a

A green swan can be thought of as a climate-related version of a black swan. For example, physical and transition risks have much uncertainty and nonlinearity that could be extreme and cannot be predicted based on past events. In other words, the usual assumption of the past being indicative of the future and the assumption of normality are no longer valid.

LO 95.b

Climate change may instigate supply-side shocks for certain agricultural and energy products that can lead to abrupt price changes and volatility spikes. In the future, such unfavorable inflationary or stagflationary impacts may become more common and severe.

LO 95.c

Physical risk manifests in the negative financial impacts of a greater occurrence and impact of weather events brought on by climate change. It also includes the negative impacts of long-term climate change. Firms may suffer resulting losses in all asset classes of their portfolios, thereby making them more financially vulnerable. The overall losses of wealth and reduced profits by firms may cause a shift in wealth for individuals. Similar to the 2007–2009 financial crisis, physical risks may lead to global contagion that results in severe and pervasive reductions in asset values.

Transition risk refers to the unknown and monetary impacts arising from the switch to low carbon products. The issues involve impacts on regulations, reputation, technology, consumer preferences, and cultural norms. A sudden and large-scale move toward a lower carbon footprint could result in unextracted fossil fuels that essentially become stranded assets. Overall, financial stability is threatened in the form of financial losses and low economic growth if the transition to a low-carbon world occurs too quickly.

Physical and transition risks may lead to secondary risks such as credit risk, market risk, liquidity risk, operational risk, and insurance risk.

LO 95.d

In identifying and managing climate risks, such risks should be accounted for in setting regulations and financial stability oversight to the extent that there are reliable models for predicting future conditions.

A long-term approach is taken to counteract the tragedy of the commons. Measures to be taken include accounting for environmental, social, and governance (ESG) factors in bank investment portfolios and, as appropriate, integrating ESG when formulating financial stability regulations.

To successfully transition to a low-carbon global economy requires new policy mixes (fiscal, monetary, and prudential) and nonequilibrium and nonquantitative models. It would also be necessary to start thinking of financial and climate stability as two interconnected public goods; maintaining climate stability will require key changes in the global monetary and financial system.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 95.1

1. **B** Black swan and green swan risks usually fit fat-tailed probability distributions and they have a high degree of skew compared to a normal distribution.

   Black swan events are rare. Green swans are inherently more complex than black swans. For green swans, there is a high degree of *certainty* that some combination of physical and transition risks will occur in the future. (LO 95.a)

2. **C** Climate-related shocks are likely to impact monetary policy through supply-side and demand-side shocks. (LO 95.b)

3. **A** Some studies show that prices usually increase in the short term after a natural disaster. (LO 95.b)

4. **B** Noninsured losses constitute 70% of weather-related losses; therefore, insured losses constitute 30% of weather-related losses. (LO 95.c)

5. **D** Operational risk focuses on operational procedures, so it is least likely to be affected by falling asset values.

   Credit risk is impacted by falling asset prices due to the reduction in the value of collateral. Market risk is clearly impacted by falling asset prices because investment portfolio values would decrease. Liquidity risk is impacted by falling asset values because low asset values may make refinancing impossible in the short-term. (LO 95.c)

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Haddad, Moreira, and Mui.

READING 96: WHEN SELLING BECOMES VIRAL: DISRUPTIONS IN DEBT MARKETS IN THE COVID-19 CRISIS AND THE FED'S RESPONSE

Haddad, Moreira, and Mui

EXAM FOCUS

This reading focuses on the impact of the Fed's announcements in March to April 2020 on dislocated bond markets during the early months of the COVID-19 crisis. The analysis begins with a discussion on the credit default swap (CDS)–bond basis under both a time-series and cross-sectional analysis. For the exam, be able to differentiate between the impacts of the current crisis and the impacts of the 2007 to 2009 financial crisis, including the impact on liquid investment grade bonds versus illiquid high-yield bonds. The analysis follows by looking at the reasons, including market frictions and arbitrage limits, as to why dealers did not engage in significant arbitrage to improve market disruptions despite widespread dislocations. Finally, be able to discuss the various event studies and analyses of bond reactions to the Fed announcements and draw appropriate conclusions.

MODULE 96.1: WHEN SELLING BECOMES VIRAL

Changes in Bond and CDS Prices

LO 96.a: Describe the evolution of bond and CDS prices during March-April 2020.

During the March to April 2020 period, there were significant price dislocations observed in debt securities. Those dislocations were significant in the corporate bond and bond exchange-traded fund (ETF) markets, particularly in investment grade securities. The dislocations were large enough that they could not be fully absorbed by the financial markets. Data indicates that the price movements were largely synchronous and concentrated in March and impacted the various categories of debt securities in a similar fashion.

Analyzing bond prices and CDS prices provides important information about price disruptions during the March to April period. Bond spreads and CDS spreads under normal (and frictionless) markets should be equal. If they are not equal, it could indicate either selling pressure in bonds or an inability by arbitrageurs to bring the prices closer together. The **CDS-bond basis** is then calculated by subtracting the underlying bond spread from the CDS spread. A negative basis indicates a larger bond spread relative to the CDS spread, implying that bonds are cheap relative to the CDS index.

Time Series Analysis

For this study, analysts looked at the spreads of the investment-grade CDS index (CDX IG) and the high-yield index (CDX HY) because those were considered to be the most liquid indices. The proxy for investment-grade bonds was the iShares Liquid ETF and for high-yield the iShares HYD ETF.

An interesting pattern emerged between March 2 and March 20. In the investment-grade market, bond spreads rose sharply to over 500 bps, while CDS spreads remained much flatter. As a result, by March 20, the basis widened to –280 bps, representing a 14% price decline in the bonds. About 75% of the price decline was due to the basis and attributable to market disruption. At the same time, high-yield bonds also saw significant price decreases (spread increases); however, in this case, the corresponding CDS spreads also rose by a similar magnitude. As a result, the basis for high-yield bonds did not change materially.

Similar observations could also be made when comparing bond spreads against broad market indices rather than single-name CDS, because those broad indices adjust for any liquidity concerns of single-name CDS spreads. The experience that investment-grade bond spreads increased much more than high-yield spreads differs significantly from the experience during the 2007 to 2009 financial crisis in which risky bonds experienced a much larger increase in the basis.

Cross-Sectional Analysis

Observing individual bonds rather than bond portfolios in a cross-sectional analysis also offers similar results. The analysis compares the change in spread of both investment-grade bonds and high-yield bonds against the spread change in CDS contracts. The data for high-yield bonds indicates a largely similar magnitude change in bond spreads and CDS spreads for each bond. This contrasts significantly from investment-grade bonds, which indicate a significantly larger spread than the CDS spread for each bond. In addition, a significant number of investment-grade bonds had large bond spread changes, but virtually no CDS spread changes during the same period (February 28 to March 20).

Those spread changes imply that bond prices deviated from market fundamentals and were more likely a result of liquidity needs by investors to sell the bonds quickly. Because the dislocations persisted, arbitrage was not a significant factor in moving prices closer together.

Challenges to the Interpretations

The conclusions drawn here may be challenged if the bond price declines and corresponding increase in the basis is due to other trading activity, including trading freezes, which could show artificially low or dislocated prices. However, data indicates this was not case; in fact, trading volumes in late March slightly exceeded the trading volumes in late February. That said, trading frictions may still exist, including higher trading costs.

Debt Market Crises

LO 96.b: Compare the developments in debt markets during the Great Financial Crisis of 2008-2009 and during the COVID-19 crisis.

The level and speed of market disruption during the first two months of the **COVID-19 crisis** were similar to the disruptions caused by the 2007 to 2009 **Great Financial Crisis (GFC)**. Both events resulted in significant asset price declines across many asset categories. However, not all asset

categories experienced similar price changes. During the GFC, high-yield bonds and stocks both had similar price declines of about 40%, while investment-grade bonds declined by only 15% to 20%. In contrast, during the COVID-19 crisis, both investment-grade and high-yield bonds declined by a similar magnitude.

The speed at which events unfolded also differed significantly between asset price movements during the GFC and the COVID-19 crisis. During the GFC, credit risk in the subprime mortgage market was already evident in mid-2007; however, larger stock market declines did not occur until late 2008, and markets did not bottom until March 2009. By contrast, markets experienced rapid declines during the first two weeks of March 2020 alone. The price appreciation of Treasury securities was also much slower during the GFC but much quicker during March 2020.

Financial Frictions

LO 96.c: Explain the effects of frictions and arbitrage limitations on price movements in debt markets during March-April 2020.

Explanations of security price movements during the early COVID-19 market disruptions in March to April 2020 include theories of both frictionless markets (e.g., no taxes, transaction costs) and financial frictions with arbitrage limitations. Theories of frictionless markets focus on cash flows and market premiums, but they are less successful at explaining these disruptions. Theories of financial frictions and arbitrage limitations are more successful, although they tend to focus on the bond market and not on other asset categories.

Dealer Positions

Theories of financial frictions, including limitations on arbitrage, are more successful at explaining price dislocations because they allow for deviations from fundamental considerations, including the law of one price. Price dislocations occur either because of a lack of investor appetite to buy some assets or because arbitrageurs do not get involved and allow price deviations to persist. That also explains the widening price differentials between liquid bonds, which were easy to sell, and CDS indices, which do not provide liquidity.

Dealers have historically played important roles as intermediaries in bond markets. During the GFC, dealers had weak balance sheets but made up a significant portion of the investment-grade bond markets. During 2008, dealers actively increased their positions in investment-grade bonds from 7% to 11%. By early 2020, as banks' capitalizations have improved markedly, dealer positions have shrunk to just 0.1% of the investment-grade bond markets. There are several explanations of the reduced dealer positions, including post-GFC financial regulations involving leverage and liquidity that made these holdings less attractive, while other markets (including Treasuries) provided more profitable opportunities. As a result, dealer positions have not meaningfully increased since and, in fact, shrunk during the first few weeks in March 2020, indicating that despite any potential gains, dealers did not view those markets as attractive.

However, the explanation that dealer constraints allowed price disruptions to persist is challenged by three observations:

1. Dealers' intermediation costs are typically higher for high-yield bonds and lower for investment-grade bonds. Given that dealers did not engage in investment-grade bonds, this

may imply that intermediation costs have increased for those bonds.

2. The Fed directly intervened by relaxing dealers' collateral requirements on March 17 by allowing a wider range of securities, including corporate bonds. On April 1, the Fed announced further interventions by relaxing dealers' balance sheet requirements, and it excluded Treasuries and deposits from leverage calculations. Despite those actions, intermediation has not increased significantly and dealer positions have not changed meaningfully.
3. The Fed's announcements, including on the corporate bond buying facilities, was insufficient on its own to significantly improve bond prices. In addition, there is a significant lag between announcement and implementation, indicating a persistence in price dislocations. The announcements also did not meaningfully impact trading costs.

Those three observations do not necessarily contradict the existence of dealer frictions. Instead, they imply that the cost of dealer intervention, both in terms of direct costs and time, increased sharply during the March to April 2020 period. In order to provide meaningful intermediation, dealers would have needed to engage in **asset warehousing** by holding on to assets for a significant period of time. That would have been very costly and may have required very large positions relative to dealers' traditional intermediation in the short-term markets.

Selling Pressure

During stressed times, investors often sell securities for cash. Given that the easiest securities to sell are the most liquid ones, those liquid securities experience the largest price declines and greatest spread increases following selloffs. In terms of order of liquidity, investment-grade bonds are more liquid than high-yield bonds, and bond ETFs are more liquid than the underlying bonds. Therefore investment-grade bonds and bond ETFs have experienced the greatest price pressures. Nevertheless, if investors believed that the current disruption may be followed by an even more acute disruption in the near future, they would be less likely to sell immediately and would hold on to these bonds for a longer period. The theory could explain the significant investor activity in the early days of COVID-19 when the pandemic was assumed to be short-lived, as evidenced by short-term lockdowns only.

The initial liquidation of corporate bonds during the early days of the COVID-19 pandemic also created disruption in bond mutual funds. The large volume of bond sales impacted the value of the rest of the mutual funds, creating large redemptions of those funds. To satisfy the increased redemptions, the most liquid assets in those funds were sold first. The funds, in return, experienced larger price declines and, therefore, spread increases.

At the same time, other institutional investors also experienced liquidity stresses, including life insurance companies and corporations. Those institutional players have significant holdings of corporate bonds and also use investment grade and high-yield ETFs for liquidity management. Life insurance companies experienced liquidity stresses due to losses in their variable annuities, which increased the companies' need for liquidity. Corporations, on the other hand, typically have a higher need for debt issuance in times of stress, and the expectation by the market of future debt issues could result in lower prices. Observations confirmed the theory because corporations that issued debt after the crisis experienced larger bond spreads in March 2020.

These explanations of selling pressures also support the rationale of why the events of March to April 2020 differ from the events of the GFC. On the one hand, investors' need for liquidity was a key driver, which coincided with a liquidity supply shock, including dealers' capacity to intervene. On the other hand, the structure of financial markets has changed. Mutual funds became larger players in bond investing; however, their large redemptions increased the liquidity stress.

An alternative explanation for the sharp decrease in bond prices involves the concept of **liquidity inversion**, a scenario in which the prices of liquid assets decline below the prices of illiquid assets. This was evident when investment-grade bond prices fell below those of high-yield bonds, and when the prices of bond ETFs fell below the prices of the underlying bonds. Despite price distortion already apparent in the market in the early days of the pandemic, investors relied on their traditional approach of selling liquid, investment-grade bonds first, as well as bond ETFs. This caused price distortions between investment-grade and high-yield securities and between bond ETFs and the underlying bonds.

Fed Interventions in Debt Markets

LO 96.d: Explain the Fed's interventions in debt markets during March-April 2020 as well as the rationale for and effects of these interventions.

The Fed's interventions in March 2020 initially focused on short-term funding in money markets and mimicked similar liquidity interventions during the GFC. The earliest intervention in mid-March came in the form of swap lines with core central banks, followed shortly by commercial paper (CP) and primary dealer lending facilities, swap lines with periphery (non-core) central banks, and certifying large foreign institutions to be eligible for treasury repos with the Fed. In early April, the Fed also moved to exclude treasuries and deposits from the leverage calculations of holding companies.

Beyond those early liquidity operations, however, the Fed also moved to ease credit concerns on March 23 by directly taking on credit risk. That was done through establishing facilities to directly buy riskier securities, including investment-grade corporate debt, asset-backed securities, and short-term municipal securities. On April 9, the Fed broadened its operations in corporate securities from nearly $300 million to $850 million, by adding high-yield securities, which included fallen angels (previously investment-grade bonds) and high-yield bond ETFs, and established a corporate lending facility through several banks. However, those facilities took a long time to set up and to begin purchasing meaningful quantities of securities.

Studies on Policy Effectiveness

Price Effects on ETFs

An event study with very frequent observations can help determine the impact of the Fed's intervention on securities prices from other unrelated news. Given that intraday observations are needed, bond ETFs are best suited for the event study. The event study observed price changes following the Fed's March 23 and April 9 credit-related announcements. Because the announcements were made overnight, the study looked at the relative price difference between the closing prices of the previous day and the opening price on the day of the announcements.

The March 23 announcement created a sharp rise in the price of investment-grade corporate bond ETFs (rising by 6% relative to the March 20 closing price); however, securities not impacted by the announcement—including equities and high-yield bonds—did not experience a price increase. The 6% increase in the corporate bond ETF represented a recovery of nearly a quarter of the price drop during the previous month. It also corresponded to a yield decrease of around 70 bps. The short-term corporate bond ETF experienced a similar price gain of 6%. However, given its much shorter duration, the corresponding yield decline was much larger and exceeded 200 bps. The material yield decline of the short-term ETF is in line with the Fed program's objective to target short-term corporate bonds with maturities of five years or less.

The April 9 announcement resulted in a general price increase across all securities, which contrasted to the more segmented price response of the March 23 announcement. The largest price increase was in high-yield debt, which increased by 6% and corresponded to a yield decline of nearly 150 bps. Those results are also consistent with the Fed's intended actions of creating wider stability in the market. Other Fed policy announcements during the March and April 2020 period did not result in similarly large increases in securities prices.

Price Effects on Credit Default Swaps

Observing the investment-grade and high-yield CDS spreads (using the CDX baskets) helps complement the above analysis. Those securities are traded continuously and, therefore, provide valuable price data even when markets are closed, without waiting for the price reaction at market open. At the time of both Fed announcements, which were made shortly before markets opened, the CDS spreads immediately dropped significantly, implying large price increases.

CDS spreads also provide valuable information about the CDS-bond basis, including differences in reaction by investment-grade and high-yield CDS to the Fed announcements. Following the March 23 announcement, the decline in investment-grade spreads (20 bps) was twice the size of the decline in high-yield spreads (10 bps); however, those were both much smaller than changes in bond yields. As a result, the CDS-bond basis narrowed. Following the April 9 announcement, both investment-grade and high-yield CDS spreads declined by similar amounts (25 bps), in line with a broader market recovery.

A broader event study on investment-grade and high-yield ETFs was also done to measure their reactions to not just the March 23 and April 9 Fed announcements to purchase securities but also to other announcements made by the Fed between March and June 2020 aimed to ease dealer constraints. The event study indicates that ETF prices moved significantly following the Fed's announcements of direct bond purchases (March 23 and April 9) but moved very little following announcements aimed mainly at improving dealer constraints.

Bond Reactions to the Fed Announcements

The Fed announcements' impact on bonds can be viewed from multiple angles, including their impact from a rating perspective (investment-grade vs. high-yield), maturity, bond inclusion (whether bonds are included in ETFs or not), and impact on market disruptions.

From a ratings perspective, the Fed's March 23 announcement had the largest impact on investment-grade bonds, and the impact was largest for the highest rating categories. The April 9

announcement had a broader impact across all rating categories, however, the impact on high-yield bonds rated just below investment grade (fallen angels) saw the largest spread declines.

Bond reactions can also be analyzed from a maturity perspective, and whether bonds are included or not included in the ETFs. The March 23 announcement most impacted the shorter maturity (under five years) investment-grade bonds that qualify for Fed purchases, consistent with the bond group targeted by the Fed intervention. Consistent with our earlier analysis, the April 9 announcement resulted in a similar magnitude impact across all bonds; however, high-yield bonds included in the high-yield ETFs experienced a larger spread decline (by 10%) relative to other high-yield bonds. Investment-grade bonds showed no differentiation.

Finally, the Fed announcements can also be viewed from the perspective of their impact on easing market disruptions. From this perspective, the March 23 announcement had the greatest impact on investment-grade bonds with the largest basis before the intervention, which saw the largest spread declines. High-yield bonds did not experience similar changes. The April 9 announcement shows a more uniform response in the basis for both investment-grade and high-yield bonds. In summary, the magnitude of disruptions in the bond market prior to the Fed announcements was strongly correlated with the impact on bond spreads.

MODULE QUIZ 96.1

1. A very large negative CDS-bond basis most likely implies that:
   A. CDS prices have declined materially.
   B. bonds outperformed the CDS contracts.
   C. bonds are cheap relative to the CDS index.
   D. the CDS spread is significantly larger than the underlying bond spread.
2. In contrast to the 2007 to 2009 financial crisis, the COVID-19 crisis resulted in:
   A. positive basis for safe bonds.
   B. smaller basis in the high-yield market.
   C. risky bonds having a larger basis than safer bonds.
   D. investment-grade bonds having a larger basis than high-yield bonds.
3. Which of the following factors best supports the argument that dealers could have been more active arbitrage participants during the COVID-19 crisis?
   A. Trade execution costs declined significantly during March to April 2020.
   B. The Fed relaxed dealers' collateral requirements and allowed a wider range of securities.
   C. Dealers' arbitrage interventions in investment-grade bonds have increased sharply in recent years.
   D. Dealer positions in investment-grade bonds have increased significantly since the 2007 to 2009 financial crisis.
4. Liquidity inversion implies that:
   A. illiquid securities become more liquid during times of stress.
   B. the prices of liquid assets decline below the prices of illiquid assets.
   C. the spreads of both liquid and illiquid securities increase during times of stress.
   D. the change in spreads between high-yield bonds and investment-grade bonds increases.
5. The largest bond spread decline following the Fed's March 23, 2020, announcement has been observed in:
   A. the highest investment-grade bond category.
   B. the lowest investment-grade bond category.
   C. the highest high-yield bond category.
   D. the lowest high-yield bond category.

KEY CONCEPTS

LO 96.a

Price dislocations in debt securities during March to April 2020 caused the prices of investment-grade bonds to diverge from high-yield bonds. Spread changes imply a need for liquidity by investors who rapidly sold the most liquid bonds. Because the market distortions lasted for a prolonged time, arbitrage was not a major factor in normalizing the market.

Analysis of those dislocations can be done either on a time series or a cross-sectional basis. Time series analysis focuses on observing bond spreads against CDS spreads during March 2020. The CDS-bond basis is then computed by subtracting the underlying bond spread from the CDS spread; a large negative basis indicates significant spread differences. Those spread differences were largest in the investment-grade bond sector and much smaller in the high-yield sector, indicating a greater dislocation in investment-grade bonds.

Cross-sectional analysis focuses on point-in-time observations of individual bonds, including plotting the spread change of individual firms' investment-grade and high-yield bonds against the change in CDS spreads. Cross-sectional data resulted in similar observations to time series analysis.

LO 96.b

During the 2007 to 2009 GFC, the high-yield bond market experienced price declines that were more than double the price declines of investment-grade bonds. In March to April 2020, both investment-grade and high-yield bonds experienced similar price declines and, therefore, spread increases. During the COVID-19 crisis, events also unfolded much quicker than during the GFC.

LO 96.c

Theories of financial frictions and arbitrage limitations in explaining the price dislocations in March to April 2020 focus on both dealer positions and selling pressure.

Lack of dealer involvement through arbitrage allowed price deviations to persist, leading to widening spread differentials between liquid bonds (which are easy to liquidate) and CDS indices. This lack of arbitrage can be explained by revised leverage and liquidity regulations, which made holdings in these bonds less attractive relative to other markets.

Nevertheless, recent regulatory changes and the Fed's direct involvement made dealer participation easier. The fact that, despite these favorable changes, dealers have still not intervened suggests that the dealers' costs increased significantly during the March to April 2020 period. Also, for meaningful intervention, dealers would have required very large positions, which they did not want to take.

The theory of selling pressure implies that the easiest securities to sell during a crisis are the most liquid ones, leading to the largest price decline and greatest spread increases in liquid assets. Because investment-grade bonds are more liquid than high-yield bonds, investors sold them first, which led to reduced prices. Similarly, bond ETFs are more liquid than the underlying bonds. At the same time, liquidations of individual bonds within bond mutual funds led to the value decline of those funds. In addition, other institutional investors also experienced liquidity stresses, including

life insurance companies and corporations. These investors have significant holdings of corporate bonds, which they sold to satisfy the increased liquidity demand.

The rationale for selling pressures also supports the rationale for why the stresses of the COVID-19 pandemic differ from the events of the GFC. In 2020, the need for liquidity was a key driver, while dealers' capacity to intervene was reduced. Further, the structure of financial markets has changed, leading to large redemptions by market participants that increased the liquidity stress.

Liquidity inversion implies that the prices of liquid assets decline below the prices of illiquid assets, and this could be observed in March 2020. Nevertheless, investors experiencing liquidity stress relied on their traditional approach of selling liquid bonds first, creating further price distortions in the market.

LO 96.d

The Fed's early interventions in March 2020 focused on short-term funding in money markets and liquidity interventions. The Fed later broadened them to take on credit risk by directly buying riskier securities and by easing dealer constraints.

Event studies focus on both the price impact on ETFs and on CDSs. Studies on ETFs focus on the relative price difference between the previous closing prices and the opening price on the day of the announcements. They indicated a sharp rise in the price of investment-grade corporate bond ETFs on March 23, but not in other securities, and a general price increase across all securities following the April 9 announcement. Studies on CDSs show a significantly larger decline in investment-grade spreads than high-yield spreads, and a narrowing of the CDS-bond basis following the March 23 announcement. Following the April 9 announcement, both investment-grade and high-yield CDS spreads declined by similar amounts.

Analyzing bond reactions to the Fed announcements also provides valuable information. Analysis can be done based on differences in ratings, maturity, bond inclusion, and impact on market disruptions:

- The rating impact analysis shows that the Fed's March 23 announcement had the largest impact on investment-grade bonds, while the April 9 announcement had a broader impact across all rating categories.
- The maturity/inclusion in ETFs analysis shows that the under five-year maturity investment-grade bonds saw the greatest spread declines following the March 23 announcement, while the April 9 announcement resulted in similar magnitude impact across all bonds, although high-yield bonds included in ETFs had larger spread declines than bonds not included in the ETFs.
- Analysis based on how well the Fed interventions eased market disruptions showed similar conclusions to other studies.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 96.1

1. **C** The CDS-bond basis captures the yield spread differential between the CDS contracts and the underlying bonds, and is calculated by subtracting the underlying bond yield spread from the CDS spread. A large negative basis implies a larger bond yield spread than CDS spread. This indicates that bonds are cheap relative to the CDS index. (LO 96.a)

2. **D** One of the key differences between the 2007 to 2009 financial crisis and the COVID-19 crisis was that the COVID-19 crisis resulted in a much larger price decline in investment grade bonds. The price decline increased spreads and caused a large deviation between investment-grade bond spreads and CDS spreads (which did not change significantly), resulting in a very large negative basis. (LO 96.b)

3. **B** The Fed relaxed dealers' collateral requirements on March 17, 2020 by allowing a wider range of securities as collateral, including corporate bonds. The Fed also relaxed balance sheet requirements on April 1 by excluding Treasuries and deposits from leverage calculations. (LO 96.c)

4. **B** Liquidity inversion implies that the prices of liquid assets decline below the prices of illiquid assets; in other words, the spreads of liquid bonds exceed the spreads of illiquid bonds. This was observed during March to April 2020. (LO 96.c)

5. **A** The Fed's March 23, 2020 announcement resulted in the largest spread decline for investment grade bonds, and the impact was largest for the highest rating categories. (LO 96.d)

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—International Monetary Fund, Chapter 1.

READING 97: GLOBAL FINANCIAL STABILITY OVERVIEW: MARKETS IN THE TIME OF COVID-19

International Monetary Fund, Chapter 1

EXAM FOCUS

This reading begins with a discussion of the market corrections that occurred because of the pandemic. Many commodities and risky securities saw their values plummet suddenly with varying degrees of subsequent recovery, while some less risky securities rose in value due to the flight-to-safety phenomenon. For the exam, understand the mechanics of market stress and the methods of injecting liquidity into the market. Also, be able to discuss the impact differences between developed economies versus emerging and frontier market economies. Finally, know the worldwide financial risks that became heightened because of the economic slowdown and be able to identify policy responses to date and possible futures ones.

MODULE 97.1: MARKET DEVELOPMENTS DURING THE COVID-19 CRISIS

LO 97.a: Describe the developments in financial and commodity markets during March-April 2020.

Sharp Market Correction

There has been an abrupt decline in economic activity with the overall worldwide growth rate estimated to fall by 3% in 2020 (more than during the financial crisis over 10 years ago). In addition, there is no certainty at this time regarding the shape of the economic recovery and when it will occur.

With the worldwide spread of COVID-19, risky assets and commodities saw drastic price declines (in some cases more than 25%) while safer assets saw price increases in response to the flight to safety and liquidity. Stock markets had the most rapid decline in history (e.g., S&P 500 fell 20% over 16 trading days), and implied volatility increased significantly in all asset classes. Luckily, quick policy decisions helped to appease investors and mitigate those losses.

Additionally, the OPEC+ nations were unable to agree on cuts to oil output to maintain price stability. Although oil spot prices fell the most, futures prices suggest the expectation of low oil prices for the foreseeable future.

With the greater demand for safer assets, government bond yields fell because of lower term premiums and because of the expectation of central banks to lower their policy rates (e.g., closer to zero in some developed countries). Lower interest rates were further confirmed with the dramatically increased likelihood of the inflation rate being less than 1% in any given year in the

coming five years because of the economic slowdown caused by COVID-19 and lower oil prices. At the end of 2019, about 40% of government bonds had yields of less than 1% and that increased to about 80% just three months later.

Credit Market Stress Amplification

Corporate investment-grade bond spreads widened, especially due to BBB-rated bonds being exposed to downgrades and greater leverage. Although there was a drop in European issuances in the primary market, it did rise in the U.S. because of a greater demand for cash that could not be fully satisfied by bank credit lines and commercial paper. To counteract the widening corporate bond spreads, some central banks introduced additional credit facilities and liquidity support for corporate debt and commercial paper.

With speculative grade or risky bonds, their spreads generally widened significantly, especially for energy and transportation firms that were most negatively impacted by COVID-19. Leveraged loan prices saw large declines. In an environment of higher credit risk due to high leverage and lower expected earnings, rating agencies amended their forecasts of default to levels consistent with a recession. Default rates in the U.S. for high-yield bonds increased to the range of 8% to 10%, and worldwide there was a cessation in issuing high-yield bonds and a sharp drop in issuing leveraged loans. When the U.S. Federal Reserve announced assistance to the corporate debt market, the spreads for speculative grade bonds began to narrow.

Pressures in the Short-Term Funding Market

The U.S. commercial paper (CP) market became stagnant and spreads became large. There were two reasons for these developments. First, money market funds needed cash and liquidity reserves to meet investor redemptions, so money market funds cashed out their CP holdings. Second, the sudden excess supply of CP was not absorbed by dealer banks due to their own risk restrictions. The same thing occurred with U.S. municipal bonds, as well as in short-term funding markets in other developed countries. As a result, the respective central banks responded with some relief measures.

Global U.S. dollar funding experienced similar problems. The interbank lending rate (LIBOR) and the risk-free rate spread widened significantly. The same occurred with the cross-currency basis (a premium paid to exchange local currency for U.S. dollars) for many currencies. The funding problem was the worst for countries with high U.S. dollar funding requirements but without swap lines with the U.S. Federal Reserve. As a result, some central banks managed to obtain greater liquidity by enhancing their current swap lines or establishing new temporary swap lines. Those measures seem to have reduced the problems in the global U.S. dollar funding markets.

Financial Deleveraging and Strained Market Liquidity

Leveraged investors also felt the pressure of needing to liquidate some of their holdings to satisfy margin calls (due to falling asset values) and to adjust more of their portfolio holdings to cash. Those actions likely helped trigger further asset value declines. As an example, volatility-targeting investors had to reduce their holdings when volatilities and correlations between asset classes rose dramatically. Those investors still had to maintain their target volatilities, which required the liquidation of some volatility-based investments.

Those leveraged investors who were basis trading in U.S. Treasuries (e.g., long positions in off-the-run cash Treasuries with higher yields and short positions in Treasury futures with lower yields) found themselves in loss positions when, after monetary easing actions, Treasury yields fell sharply and further below the futures-implied yield. As a result, those investors had to sell their Treasuries, which resulted in many dealers having large inventories of Treasuries that they could not unload. Those dealers found themselves unable to inject liquidity into the U.S. Treasury market, which resulted in a sudden drying up of liquidity in the market.

The Federal Reserve was forced to step in to improve liquidity. Actions included easing reserve requirements for banks and allowing for more open-market transactions for the government to buy Treasuries, thereby adding more liquidity to the market.

Overall, market liquidity declined significantly in most markets. It began at the end of February 2020 and improved (together with market sentiment) starting about a month later.

Magnified Asset Price Declines

In general, many assets were likely priced at far beyond their fair values, and that amplified the effects of all the sell transactions. Equity markets saw P/E ratios at a high point at the end of 2019 and into the COVID-19 period. With equity prices falling substantially in March 2020, there was a widespread overvaluation correction (e.g., prices dropped more than valuations), although in the U.S. equity market, fundamentals-based value dropped even more than prices. The significant increase in dispersion of earnings forecasts (a measure of risk), which occurred during the COVID-19 outbreak, resulted in lower fundamentals-based values. In theory, once the dispersion of earnings forecasts falls, values will increase and there should be less overvaluation. There have been large revisions in EPS growth forecasts, but they probably do not completely account for how much EPS growth is really expected to drop.

There was a similar situation with overvaluation in bond markets prior to the pandemic, with very tight corporate bond spreads that were below those justified by fundamentals. However, with the onset of the pandemic, many of the spreads subsequently widened and eliminated the overvaluations.

Emerging and Frontier Markets

The extraordinary impact of combining the COVID-19 pandemic, decline in oil prices, and risk of global recession have seen stock prices in emerging markets drop about 20% from mid-January 2020 onwards. Emerging market countries that primarily produce commodities saw their currencies drop in value by over 20% against the U.S. dollar in the first quarter of 2020. Other emerging market countries were not as badly impacted given their lesser exposures and more robust currency support.

U.S. dollar-denominated sovereign bonds in emerging market countries saw their spreads widen to almost 700 basis point at the end of March, but those spreads have fallen subsequently. Overall, there was a record number of distressed sovereign issuers (located in less-developed emerging market countries) with spreads exceeding 1,000 basis points. Countries that import oil benefited from the lower oil prices but suffered from lower exports and less external financing.

Portfolio outflows (e.g., investment withdrawals) by nonresidents in emerging market countries were at an all-time high in the first quarter of 2020, especially in Asia and in equity markets resulting from weak growth projections. However, bond outflows had also increased substantially. The *breadth* of outflows refers to the number of countries, which was the highest since the financial crisis of 2007–2009. The *depth* of outflows was over 1% of GDP in a period of two months in countries hardest hit, such as South Africa and Thailand. Such outflows have the potential to lead to local currency downgrades that would fuel further outflows. Outflows tended to be highest with individual investors, but institutional ones were often required to withdraw funds for risk management reasons. Bond outflows were generally spread over different bond types, but they impacted currency-based bonds the most.

Obviously, with the huge negative impacts on the domestic economies, the respective governments have had to provide currency and liquidity support, as well as establish swap lines with U.S. and European banking authorities.

MODULE QUIZ 97.1

1. As COVID-19 spread globally during the months of March and April 2020, the prices of safe-haven assets such as gold and U.S. Treasuries:
   A. increased.
   B. decreased.
   C. remained unchanged.
   D. increased then decreased, but remained stable overall.
2. Which of the following statements regarding spot and futures prices for oil in March 2020 is most accurate?
   A. Spot prices remained stable and futures prices fell.
   B. Spot prices fell and futures prices remained stable.
   C. Both spot and futures prices fell.
   D. Both spot and futures prices remained stable.

MODULE 97.2: FINANCIAL VULNERABILITIES AND POLICY RESPONSES

LO 97.b: Discuss the global financial vulnerabilities intensified by the slowdown in economic activity and tightened financial conditions following the COVID-19 outbreak.

Sharp Tightening of Global Financial Conditions

For many developed and emerging market countries, March 2020 saw rapidly declining stock prices and rapidly widening bond spreads. Those negative effects were only slightly mitigated with lower interest rates. Other emerging market countries besides China saw their external funding costs rise substantially.

Overall, the 2020 worldwide growth estimate was amended from 3.3% to –3%. Going deeper and examining the distribution of values, on an annualized basis, there is a 5% chance of worldwide growth being less than –7.4%; that amount would have been closer to 2% in more normal times. Furthermore, the chance of worldwide growth being positive in 2020 is estimated at about 4%. **Growth-at-risk (GaR)** is the metric used here to examine the impact at the far-left end (e.g., 5%) of the growth distribution as economic conditions and risks evolve.

With continued lockdown measures due to COVID-19, the policy alternatives start to narrow and investors get even more nervous. Less-developed countries will face the difficulty of recovering from the negative domestic impact of all the foreign investment outflows. Especially if financial institutions in those countries face an overall decline, the recovery will take much more time. One scenario contemplates a worsening of the pandemic in 2020 and 2021, with continuously falling output to about 8% below normal in 2021.

Further Tightening of Financial Conditions

Some countries will need to contend with a more prolonged and damaging economic slowdown, which will result in much greater than expected losses for banks. Consequently, that could ultimately reduce the amount of available credit for general borrowers.

Many nonfinancial firms are heavily indebted (and even more so than 10 years ago). Therefore, the combined effects of an economic slowdown and a higher cost of capital may result in widespread business failures. A similar situation exists with asset managers (especially in China and the U.S.) with elevated levels of leverage and asset-liability mismatches in terms of maturity and liquidity. The situation is less worrisome in Europe and other developed countries.

Banks are generally moderately vulnerable, although vulnerability is higher in China and has increased in Europe and in some emerging market countries.

With insurers, there is less vulnerability overall, but there are pockets of vulnerability, such as in the U.S. and China with large liquidity mismatches. In addition, credit risk is high for insurers in the U.S. and Europe. In other developed countries, currency mismatches also tend to play a role.

Asset Managers

Due to increased redemptions, asset managers had to sell assets, thereby contributing further to falling prices. To date, cash buffers (about 7% of assets for safer open-end bond funds and declining for riskier ones) have been able to handle redemptions. However, there is the risk of ongoing and increasing redemptions that would decimate the cash buffers and require selling additional assets (liquid and nonliquid), thereby adding to the price declines. The price declines could be made less severe with proper liquidity management tools such as using available credit lines and bond purchases by central banks.

Some funds projected deteriorating liquidity and responded ahead of time by disposing more illiquid and credit risky assets to increase overall portfolio liquidity. The liquidations may have contributed to the fall in price of riskier assets. Additional redemptions may jeopardize those funds that do not have sufficient liquidity protection. To date, there has been minimal need to halt redemptions, and in situations where they occurred, they were very temporary.

Banks

Similar to the most recent global financial crisis, during the COVID-19 pandemic, there remains the risk that banks may need to curtail their lending activities because of the lack of liquidity and ongoing losses. Mitigating that risk is the fact that banks are now much more resilient because of larger capital buffers and higher levels of liquidity.

The economic impact of COVID-19 to the banks will probably be mark-to-market and credit losses. Obviously, falling asset prices will negatively impact the banks' holdings of risky assets (e.g., mortgage-backed securities). Some of those losses could be mitigated by gains on less risky assets (e.g., government bonds).

The more prolonged the economic slowdown, the greater the risk that banks will suffer defaults on retail and business loans. For example, 50% to 70% of debt owed on commercial real estate is to commercial banks, and continued lockdown measures and work-at-home arrangements will likely lead to lower demand for commercial real estate and potential defaults on commercial real estate loans. Oil prices have tumbled, which increases the risk of loan defaults from energy firms. In addition, banks could suffer retail loan losses from defaults by individuals who work(ed) in industries that were negatively affected.

As a general point, with banks reporting reduced profits in some countries, they will be less able to absorb large pandemic-related losses.

The projected losses to banks for a one-year period are greater than those assumed for stress tests; the projected losses for two years are not as high compared with those assumed for stress tests. A noteworthy point is that the stress tests assume a strong negative correlation between economic growth and loan impairments when, in fact, the relationship may not be so negative because there is now much more support from central banks, for example.

Bank stock prices fell by an average of 35% (and almost 60%, in some cases) between mid-January and April 2020. Substituting market values for book values in determining capital ratios, most banks would have very low capitalization levels compared with those during the global financial crisis. As a result, it is necessary to implement clear and effective policies to allow banks to continue lending activities, especially during an economic slowdown when there is a demand by borrowers for funds.

Insurance Companies

Stock prices for many insurance companies in key countries fell over 30% prior to recovering somewhat in the weeks between late March and early April 2020. Together with other financial institutions, credit default swap spreads widened similarly. Given that insurance companies are heavily invested in long-term government and corporate bonds, higher spreads and yields on those long-duration assets led to large investment losses. Assistance provided by the U.S. Federal Reserve in late March and early April provided some relief for U.S. insurance companies.

Further portfolio losses could occur with downgrades of riskier bonds at the cusp of sub-investment grade (e.g., BBB-rated). Coupled with those losses are more onerous capital requirements, which will tie up more funds and reduce liquidity.

Emerging and Frontier Markets

Many emerging and frontier market countries were negatively impacted by the economic slowdown and the sudden fall in oil prices. Additionally, at the start of the pandemic, those countries were in worse financial condition than during the 2007–2009 financial crisis in three key ways. First, emerging market bond issuers (e.g., China) are considerably more leveraged, there are new issuers who are highly dependent on oil and commodity prices, and there are more low-rated issuers from

frontier market countries. Second, many emerging market countries already have very low policy rates (lower than in 2008), which means there is very little room to lower them for stimulus purposes. From a fiscal policy perspective, many countries have larger budget deficits than in 2008. Finally, many emerging and frontier market countries have become more dependent on foreign investment and funding over the past 10 years.

The sudden economic slowdown, together with the abrupt rise of interest rates, made it challenging for those countries that are more leveraged and/or depend on external financing. The productivity declines (e.g., oil) and/or lower demand (e.g., electricity) hurt many commodity-based countries and resulted in numerous downgrades. Some systemic state-owned enterprises (e.g., commodities) became more at risk as a result. Only those countries with plenty of foreign currency reserves and other protective mechanisms could withstand the assaults.

Banks in countries that have assets consisting of a large percentage of defaulting loans, loans to state-owned enterprises, and significant portfolio investments in government bonds are at risk for losses from the sovereign-financial sector feedback loop.

With a potentially prolonged reduction in productivity, small- and medium-sized banks will have less loan assets on their books because the banks have less funds to lend to small businesses, which may go out of business. The property development industry is likely to see more loan defaults due to falling sales and lack of liquidity. Insurance companies may see significant outflows from anxious investors, which may be difficult to service due to high debt and large liquidity and maturity mismatches (e.g., low duration liabilities that cannot be easily serviced by high duration assets).

In frontier market countries, borrowing spreads have risen dramatically and some countries have had to restructure their debt as a result. Implementing monetary policies to stimulate the economy is complicated by low financial depth and smaller investor bases in those countries.

LO 97.c: Explain the various monetary and financial policy responses to COVID-19 as well as the future steps that should be taken.

Policy Responses to Date

In response to the pandemic, governments frequently implemented quick, specific, and temporary financial solutions to help individuals and businesses. Wage subsidies, cash payouts to low-income individuals, additional unemployment benefits, deferred tax payments, deferred loan payments, and restructured loan terms are some examples of the solutions provided so far.

Liquidity

In terms of stabilizing the financial system, three main actions have occurred. First, central banks have loosened monetary policy primarily through reducing policy rates by 50 to 150 basis points, especially in countries that are of significant financial importance. On a related note, they have also engaged in additional financial asset purchases (e.g., bankers' acceptances, commercial paper, money market securities, corporate bonds) to increase liquidity in short-term funding markets and to help keep borrowing rates low for individuals and businesses. Second, many central banks have injected liquidity into the banking system by relaxing bank reserve requirements and collateral

requirements, for example. Finally, some central banks have provided more U.S. dollar liquidity via swap line arrangements.

Foreign Currency

Central banks in emerging market countries have had to deal with foreign currency funding problems and huge capital outflows from nonresidents. Solutions include foreign currency intervention to reduce the volatility of domestic currencies, lowering foreign currency reserve requirements, and engaging in more foreign currency swap and repo transactions.

Regulations

From a regulatory perspective, in some countries, banks have been allowed to ease their countercyclical capital buffers and their domestic capital buffers, or capital and liquidity buffers (from Basel III) have been used by the banks, thereby being subject to less onerous liquidity provisions. Additionally, some countries have allowed some concessions for banks, such as deferring stress tests or reducing risk weights for nonperforming loans when determining capital adequacy. Liquidity can also be enhanced somewhat by temporarily reducing or eliminating dividend payments to shareholders.

On the insurance side, regulators have allowed for a deferral period for policyholders to make their premium payments and some deferrals for insurers' reporting requirements. Similar to banks, the recommendation was made to temporarily reduce or eliminate dividend payments for the mutual benefit of the insurer and the insured.

For asset managers, there have been liquidity enhancements such as temporary provisions to allow open-end mutual funds to borrow from related parties and funds. Regulatory filing deadlines have also been deferred in some countries.

Short selling restrictions attempt to contain price declines and maintain adequate liquidity. Circuit breakers have been amended and activated as a means of temporarily suspending trading to prevent out-of-control situations from emerging.

Next Steps

It appears that the early stimulus policies described previously have had some positive effects in terms of better market functioning and avoiding liquidity crunches. In the foreseeable future, continued monetary, fiscal, and other policies will be required to maintain global financial stability.

Specifically, policy rates in many countries are near 0% so it would not be practical to lower them much further, if at all. Therefore, asset purchases by central banks to inject liquidity into the markets becomes the main monetary action available. Prior to the pandemic, a low percentage of countries had accumulated sufficient countercyclical capital buffers, so releasing those buffers is not an option for many countries.

Many players in the financial markets have been able to benefit from stimulus actions of the central banks, but there are some niches in the bond market that have not benefited as much. For example, spreads between investment-grade and non-investment-grade bonds have continued to widen. Therefore, if a higher rate of credit downgrades and defaults emerge, then it will be necessary to implement policies that benefit a larger portion of the bond market.

Guiding Principles for Financial Sector Policies

Three competing and interrelated objectives need to be balanced: maintaining financial stability, ensuring the continued solvency of financial institutions, and promoting economic growth.

Financial institutions should be encouraged to restructure loans for those individuals and businesses who deserve and require temporary relief. Methods such as extending loan amortization periods or temporary measures such as suspending repayments or requiring interest-only payments could be used. Given the restructurings, it would be necessary to determine if there is any subsequent credit deterioration and provision for them accordingly as soon as it is practical.

In determining expected credit loss (ECL) under IFRS 9, future-oriented ECL estimates must be justifiable and consider the probable short-term nature of the pandemic shock, as well as government and central bank stimulus initiatives.

Banks should first use their capital and liquidity buffers to cover the costs of loan restructurings. Should such costs be substantial and impact long-term capital adequacy, then banks may need to provide detailed capital restoration strategies. The government may also need to intervene and assist debtors with partial loan forgiveness and/or tax deductions to ease the challenges of repayment. Alternatively, they could provide banks with loan guarantees.

Some relaxing of regulations for insurance companies is likely needed in the short term. Approval should not be automatic, and insurance companies should be required to provide supported documentation to provide reasonable assurance that they will remain a going concern and have sufficient funds to protect policyholders. Although oversight activities of insurance companies are focused on maintaining strong liquidity positions, care must be taken not to overemphasize liquidity because the result may be losses for the insurance companies due to the sale of assets for unreasonably low proceeds.

For asset managers, it would be good to promote the use of methods to preserve liquidity such as gates, deferred redemptions, or even short-term moratoriums on redemptions when they are necessary.

In financial markets, the use of circuit breakers and volatility controls must be properly quantified, defined, and communicated. Also, for temporary restrictions such as for short selling, consideration must be given to the trade-off between maintaining price stability versus reduced liquidity and market efficiency. Such restrictions should only be for the short term

Central banks would function to provide liquidity to allow markets to continue to function without significant disruptions. For example, dealers would need to be able to buy and sell securities at normal prices without undue volatility. In terms of injecting liquidity via lending, reverse repo agreements and foreign exchange swaps (e.g., receive fixed/floating) could be utilized. Asset purchases would involve buying securities or foreign exchange to add liquidity to the market. Collateral requirements may need to be relaxed to allow a greater variety of acceptable collateral for lending and purchase transactions.

Emerging and Frontier Markets

Many emerging market countries are experiencing capital outflows, which makes them more vulnerable to volatile markets. Therefore, swap lines may be helpful to reduce problems related to

foreign currency funding. Other countries have sufficient foreign currency reserves, so exchange rate intervention helps to reduce exchange rate volatility. Any exchange rate intervention should consider the need for a short-to-medium-term time frame. Additionally, it may be possible to ease any foreign currency reserve requirements to reduce funding pressures.

Outflow capital flow management measures (CFMs) may be required to reduce capital outflows, but they should only be used after macroeconomic adjustments (e.g., fiscal and monetary policy) are exhausted. Examples of CFMs include: reserve requirements, limit/approval requirements, surrender/repatriation requirements, bans, and limits. In addition, the use of CFMs is subject to the country's global liabilities and is meant to be used on a short-term basis only to avoid crisis situations.

Emerging market countries should ready themselves for potentially long-term external funding disruptions. For example, if given a choice of available and continued financing versus higher interest rates, continued financing is much more important given the potentially severe negative impacts if financing were to be suddenly withdrawn altogether. Deploying accumulated cash reserves may occur as a replacement for lost financing. In some cases, a proposal from the debtor to the creditor to restructure or seek partial or full loan forgiveness may occur.

International Policy Coordination

The implications to worldwide health require a cooperative approach between countries to ensure that critical medical supplies can flow with minimal restrictions and at reasonable prices. Additional swap lines could be established for additional emerging market countries. A more coordinated effort across borders would likely minimize capital flow disruptions. Finally, the actions to date to further regulate markets on an international level must be ongoing and individual countries should not take separate actions that would undermine the collective accomplishments to date. The International Monetary Fund (IMF) has $1 trillion to support member countries in the form of lending with expanded emergency funding available for those countries (e.g., low-income) that require it.

MODULE QUIZ 97.2

1. As a result of the impact of COVID-19 on global economic activity, banks are most likely to incur which of the following losses?
   A. Credit losses only.
   B. Mark-to-market losses only.
   C. Both credit and mark-to-market losses.
   D. Neither credit nor mark-to-market losses.
2. Insurance company investment portfolios have a large allocation toward:
   A. short-term sovereign and short-term corporate bonds.
   B. short-term sovereign and long-term corporate bonds.
   C. long-term sovereign and long-term corporate bonds.
   D. long-term sovereign and short-term corporate bonds.
3. Which of the following items is least likely to be considered an easing of regulatory requirements for a financial institution?
   A. Delaying stress tests.
   B. Extending filing deadlines.
   C. Reducing dividend payments.
   D. Providing flexibility in classifying nonperforming loans.

KEY CONCEPTS

LO 97.a

There has been an abrupt decline in economic activity, with the overall worldwide growth rate estimated to fall by 3% in 2020 and no certainty as to when and what degree of recovery there will be. With the worldwide spread of COVID-19, risky assets and commodities saw drastic price declines while safer assets saw price increases in response to the flight to safety and liquidity.

Corporate investment-grade bond spreads widened, especially due to BBB-rated bonds being exposed to downgrades and greater leverage. The spreads of speculative grade or risky bonds generally widened significantly, especially for energy and transportation firms that were most negatively impacted by COVID-19. Leveraged loan prices saw large declines.

The U.S. commercial paper market became stagnant and spreads became large during the crisis. Global U.S. dollar funding experienced similar problems. The interbank lending rate (LIBOR) and the risk-free rate spread widened significantly. The same occurred with the cross-currency basis for many currencies. Leveraged investors also felt the pressure of needing to liquidate some of their holdings to satisfy margin calls and to adjust more of their portfolio holdings to cash. Those actions likely helped trigger further asset value declines.

In general, many assets were likely priced far beyond their fair values and that amplified the effects of all the sell transactions. With equity prices falling substantially in March 2020, there was a widespread overvaluation correction. There was a similar situation with overvaluation in bond markets.

The extraordinary impact of combining the COVID-19 pandemic, decline in oil prices, and risk of global recession have seen stock prices in emerging markets drop significantly. Emerging market countries that primarily produce commodities saw their currencies drop in value significantly against the U.S. dollar in the first quarter of 2020. Portfolio outflows by nonresidents in emerging market countries were at an all-time high in the first quarter of 2020. The breadth of outflows refers to the number of countries, and the depth of outflows is often measured as a percentage of GDP.

LO 97.b

For many developed and emerging market countries, March 2020 saw rapidly declining stock prices and rapidly widening bond spreads. Those negative effects were only slightly mitigated with lower interest rates. Overall, the 2020 worldwide growth estimate was amended from 3.3% to -3%.

Some countries will need to contend with a more prolonged and damaging economic slowdown, which will result in much greater than expected losses for banks. Consequently, that could ultimately reduce the amount of available credit for general borrowers.

Due to increased redemptions, asset managers had to sell assets, thereby contributing further to falling prices. To date, cash buffers have been able to handle redemptions. However, there is the risk of ongoing and increasing redemptions that would decimate the cash buffers and require selling additional assets, thereby adding to the price declines.

Similar to the most recent global financial crisis, during the COVID-19 pandemic, there remains the risk that banks may need to curtail their lending activities because of the lack of liquidity and

ongoing losses. Mitigating that risk is the fact that banks are now much more resilient because of larger capital buffers and higher levels of liquidity. The economic impact of COVID-19 to the banks will probably be mark-to-market and credit losses.

Stock prices for many insurance companies in key countries fell significantly before recovering somewhat later on. Together with other financial institutions, credit default swap spreads widened similarly. Given that insurance companies are heavily invested in long-term government and corporate bonds, higher spreads and yields on those long duration assets led to large investment losses.

At the start of the pandemic, many emerging and frontier market countries were in worse financial condition than during the 2007–2009 financial crisis in three key ways. First, emerging market bond issuers are considerably more leveraged, there are new issuers who are highly dependent on oil and commodity prices, and there are more low-rated issuers from frontier market countries. Second, many emerging market countries already have very low policy rates, which means there is very little room to lower them for stimulus purposes. From a fiscal policy perspective, many countries have larger budget deficits than in 2008. Finally, many emerging and frontier market countries have become more dependent on foreign investment and funding over the past 10 years.

LO 97.c

In response to the pandemic, governments frequently implemented quick, specific, and temporary financial solutions to help individuals and businesses.

Central banks have loosened monetary policy primarily through reducing policy rates by 50 to 150 basis points. Many central banks have injected liquidity into the banking system by relaxing bank reserve requirements and collateral requirements, for example. Also, some central banks have provided more U.S. dollar liquidity via swap line arrangements.

Foreign currency solutions include intervention to reduce the volatility of domestic currencies, lowering foreign currency reserve requirements, and engaging in more foreign currency swap and repo transactions.

From a regulatory perspective, the various types of financial institutions have been granted numerous liquidity and capital concessions to avoid the onerous provisions and aid in recovery. Reducing dividend payments has been a frequent temporary suggestion to boost liquidity. Short selling restrictions have also been used in an attempt to contain price declines and maintain adequate liquidity.

It appears that the early stimulus policies have had some positive effects in terms of better market functioning and avoiding liquidity crunches. In the foreseeable future, continued monetary, fiscal, and other policies will be required to maintain global financial stability.

Three competing and interrelated objectives need to be balanced: maintaining financial stability, ensuring the continued solvency of financial institutions, and promoting economic growth.

Many emerging market countries are experiencing capital outflows, which makes them more vulnerable to volatile markets. Therefore, swap lines may be helpful to reduce problems related to foreign currency funding. Capital flow management measures (CFMs) may be required to reduce capital outflows, but they should only be used after macroeconomic adjustments are exhausted.

Emerging market countries should ready themselves for potentially long-term external funding disruptions.

The implications to worldwide health require a cooperative approach between countries to ensure that critical medical supplies can flow with minimal restrictions and at reasonable prices.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 97.1

1. **A** Safe-haven assets increased in value as investors favored safety and liquidity. (LO 97.a)
2. **C** Spot prices for oil fell the most, but the whole oil futures curve shifted down, which indicated an expectation of low oil prices for the longer term. (LO 97.a)

Module Quiz 97.2

1. **C** Although banks are now stronger than they were during the global financial crisis of 2007–2009, banks are likely to incur both mark-to-market and credit losses resulting from the economic slowdown caused by COVID-19. (LO 97.b)
2. **C** Insurance company investment portfolios heavily favor long-term sovereign and long-term corporate bonds. That is meant to match the liability durations, which tend to be long term as well. Widening spreads on sovereign bonds, especially corporate bonds, have resulted in large losses during the initial stages of the pandemic. (LO 97.b)
3. **C** Dividend payments are not regulatory requirements—they are paid at the discretion of the company's board of directors. However, authorities can recommend that dividend payments be restricted. The other items all pertain to regulatory requirements for financial institutions. (LO 97.c)

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Financial Stability Institute.

READING 98: FINANCIAL CRIME IN TIMES OF COVID-19 – AML AND CYBER RESILIENCE MEASURES

Financial Stability Institute

EXAM FOCUS

This reading highlights the notable increase in cyber threats observed from the global pandemic to date. Compliance with anti-money laundering (AML) and combating the financing of terrorism (CFT) requirements continue to be important and must be balanced with a financial institution's other duties required to stay in business. For the exam, be familiar with the methods to strengthen cyber resilience. Also, understand what measures have been taken to mitigate money laundering (ML) and terrorist financing (TF) risks, together with some examples of exceptions made to the AML/CFT requirements in demonstrating flexibility.

MODULE 98.1: FINANCIAL CRIME IN TIMES OF COVID-19

Increase of Cyber Threats

LO 98.a: Explain the increase of cyber threats faced by financial institutions because of the Covid-19 crisis.

Perhaps almost 90% of financial institution employees are working remotely (i.e., at home) through the pandemic. Employees log in to the company site remotely, participate in videoconference meetings, and access private/proprietary information through the internet. As a parallel, customers are also doing more banking online, so the online world has become a greater reality. With that comes greater opportunities for cyber criminals to target weak remote access controls and naïve employees.

Cyber threats have risen notably with regard to malicious domains, malware, and ransomware. There has also been a rise in the risk of money laundering (ML) and terrorist financing (TF) related to crimes pertaining to COVID-19. Specifically, there may be more inappropriate use of online banking to transfer and hide illegal funds and to misappropriate domestic government or foreign aid.

Examples of COVID-19 cyber threats include email scams to provide medical aid that have the appearance of originating from trusted sources. Such threats target weaknesses in software and remote working tools. Overall, COVID-19 cyber crime attempts to obtain personal information, cause victims to download malicious software, and engage in fraudulent activity.

Ransomware attacks increased almost 150% in March 2020 compared with February 2020. The finance industry was the most targeted with an almost 40% increase in cyberattacks. During a study of COVID-19 malicious emails between the beginning of March 2020 and the end of April 2020, malicious emails peaked in mid-April. As a result, many financial institutions were suddenly forced to address their cyber resilience vulnerabilities in view of the surge in online activities resulting from the global lockdown.

Unfortunately, the pandemic has allowed for new opportunities for ML activities now that the onboarding (e.g., "welcome package") and identity verification processes for new customers are usually done remotely. Particularly susceptible to ML are financial institutions with weak controls for identity verification due to allocating fewer staff to deal with anti-money laundering (AML) issues. On the regulatory side, AML audits and reporting are being deferred and there is much more reliance on remote monitoring. Particularly worrisome is the trend of more cash outflows from financial institutions during the pandemic, but when the pandemic is over, the change to cash inflows will be fertile ground for ML.

Cyber Resilience Measures Taken

LO 98.b: Explain the cyber resilience measures taken by international and national financial authorities in response to the increased cyber threats since the outbreak of Covid-19.

Both the International Criminal Police Organization (INTERPOL) and national authorities have provided some guidance on how to reduce the impact of criminal activities related to COVID-19. For example, both the U.S. and U.K. cybersecurity authorities have provided a list of warning signs for information system vulnerabilities, as well as recommendations to strengthen controls in areas such as remote working and virtual private networks (VPNs), as well as malware and ransomware threats in the context of threats stemming from COVID-19.

The Singapore Computer Emergency Response Team (SingCERT) has also released guidelines on improving cybersecurity with regard to remote working. There are four key points:

- Regular updates to remote access systems (e.g., patches, security configurations, antivirus).
- Periodic checks on sensitive/confidential domains.
- Dialogue with employees on cyber threats and how to avoid being victimized from them.
- Determination of appropriate incident response and recovery procedures given the remote work scenario.

Cybersecurity risks are viewed in the context of maintaining the uninterrupted provision of key financial services. In that regard, in the U.S., the IT security staff of financial institutions are considered essential financial workers in the COVID-19 environment.

Increased Awareness of Cyber Crime

In some countries, regulatory agencies have publicly requested financial institutions and their staff to be on extra alert to ML and TF risks. Other agencies, such as the Bank of Italy and the Institute for the Supervision of Insurance (IVASS), have provided specific forms of cyber resilience measures to be taken. They have also looked at three specific issues with cyber security in a COVID-19 world:

- Risks arising from more employees working remotely.
- Additional monitoring activities to learn more about COVID-19-related cyber risks.
- Use of information exchanges.

Key Cyber Resilience Areas

Other agencies have targeted the risks pertaining to IT networks and private/proprietary information. For example, the New York State Department of Financial Services (DFS) has focused on the following:

- Using secure VPN connections that always encrypt transferred data.
- Using multifactor authentication methods with additional precautions for sensitive or large-dollar-value transactions.
- Having strong controls in place for company devices used by employees offsite to access the company's IT system and data.
- Designing video and audioconferencing tools to allow for authorized access only.
- Putting in place strong controls to protect the integrity of private/proprietary information.

Additionally, the DFS considers it important to look at the incremental COVID-19-related risks arising from the use of third-party vendors by financial institutions. Appropriate action may be required to reduce or mitigate risks if they are deemed unacceptable.

Changes to cybersecurity incident response plans may be required to specifically account for the added cyber risks due to COVID-19. The Abu Dhabi Global Market's (ADGM) Financial Services Regulatory Authority (FSRA) focused on that area to ensure that financial institutions can execute appropriate incident response plans, given the size and scope of their operations. The Financial Stability Board (FSB) is working on compiling a set of best practices for financial institutions to consider before, during, and after any cyber incidents.

Employee training and understanding is another area of concern. The Financial Industry Regulatory Authority (FINRA) has suggested that employees receive guidance on secure connections to the office while working remotely, as well as guidance on how to avoid being victimized by texting and email scams and other fraudulent activities. FINRA has also brought special attention to IT employees to be equipped to spot fraudulent requests for password changes/resets or lost hardware.

Information Sharing

Sharing information on COVID-19-related cyber issues domestically between financial institutions promotes efficiency. Security bulletins, webinars, and other methods of training may be utilized. A wide range of topics could be covered, including how to detect and react to a cyber incident or the proper at-home use of company hardware.

Internationally, the Euro Cyber Resilience Board (ECRB) and the Cyber Resilience Coordination Centre (CRCC) are the key entities involved in information sharing on COVID-19-related cyber risks. The ECRB focuses on the preventive and diagnostic aspects pertaining to cyber threats. The CRCC focuses on a disciplined manner of collaboration on cyber resilience between central banks.

AML/CFT Measures Taken

LO 98.c: Explain the anti-money laundering (AML) and anti-terrorism financing (ATF) measures taken by international and national financial authorities in response to the increased ML and TF risks since the outbreak of Covid-19.

The Financial Action Task Force (FATF) has stated that businesses should be on alert for risks related to ML and TF with the following recommendations:

- Maintain flexibility using the FATF risk-based approach when dealing with the current COVID-19 situation.
- Utilize robust procedures for customer onboarding in providing online financial services.
- Collaborate with peers and share pertinent information.
- Provide efficient ways to alert the authorities to crimes arising from COVID-19.

Other authorities throughout the world have followed suit and, in some cases, have referenced the FATF statement.

Flexibility Required

The existence and evolution of COVID-19-related financial crime must be highlighted to the general public, and it is crucial that AML/CFT requirements remain satisfied. Financial institutions may need to employ some sort of trade-off between allocating enough staff to manage COVID-19-related ML and TF risks and allocating staff to other operational areas to cope with the negative impacts of COVID-19. Ultimately, the financial institution needs to remain in business in the long term, so flexibility is key at this time.

As a result, the AML/CFT risk-based framework is being applied flexibly in some jurisdictions so that some exceptions or minor "failures" may inevitably occur with somewhat less stringent controls over or monitoring of ML and TF risks. Some examples of flexibility include exemptions from having to verify ownership for new loans provided to existing clients or allowing for minor delays in completing regulatory filings and other compliance duties.

Some flexibility is also required in applying tools, such as machine learning, in checking for ML. However, with the dramatic changes in client behavior resulting from COVID-19, the past may not be indicative of the future. As a result, machine learning might not be as accurate in spotting ML activity.

Customer Due Diligence

In view of little or no in-person interaction with customers, financial institutions must adapt their due diligence process in terms of new customers. For example, in Luxembourg, the Commission de Surveillance du Secteur Financier (CSSF) takes the position that real-time video conversations serve as a valid means of customer identity confirmation.

In other places, additional time is provided for document verification. For example, the Swiss Financial Market Supervisory Authority (FINMA) extended an initial 30-day requirement to 90 days regarding the verification of the authenticity of identity documents. Assuming the customer is assessed as "low risk" based on other factors, the customer can be provisionally accepted for up to 90 days with only basic identification required.

Information Sharing

Sharing information related to new types of fraud and ML/TF risks emerging from COVID-19 is crucial, and it is going beyond financial institutions to include firms in the private sector. More opportunities are being set up to allow victims to report COVID-19-related fraud. Additionally, for financial institutions, discussion forums have been established to assist in the sensitive trade-off between managing the business effectively in a COVID-19 environment and satisfying AML/CFT regulatory requirements.

MODULE QUIZ 98.1

1. Which of the following actions is least likely to be one of the key objectives of COVID-19-related cyber crime?
   A. Identity theft.
   B. Seeking illegal gains.
   C. Manipulating information.
   D. Spreading malicious software.
2. Which of the following amounts is closest to the estimated percentage of banking and insurance employees who are working remotely during the COVID-19 pandemic?
   A. 25%.
   B. 50%.
   C. 75%.
   D. 90%.
3. Sharing information on COVID-19-related threats by authorities with financial institutions is occurring primarily at which level(s)?
   A. Local level.
   B. National level.
   C. International level.
   D. National and international level.
4. Which of the following statements regarding cyber resilience measures for financial institutions is most accurate?
   A. Multifactor authentication is required to encrypt all data in transit.
   B. All financial institution staff are usually considered essential financial workers.
   C. IT support staff require additional training above regular staff with regard to COVID-19-related issues.
   D. Greater priority should be given to security over limiting access to corporate nonpublic data versus security regarding configuration of corporate video conferences.
5. One of the exceptions allowed by the Swiss Financial Market Supervisory Authority (FINMA) allows new banking relationships up to how much time to authenticate identity documents from low-risk new customers?
   A. 30 days.
   B. 60 days.
   C. 90 days.
   D. 120 days.

KEY CONCEPTS

LO 98.a

Cyber threats have risen notably with regard to malicious domains, malware, and ransomware. There has also been a rise in the risk of ML and TF related to crimes pertaining to COVID-19. Specifically, there may be more inappropriate use of online banking to transfer and hide illegal funds and misappropriation of domestic government or foreign aid.

Overall, COVID-19 cyber crime attempts to obtain personal information, cause victims to download malicious software, and engage in fraudulent activity.

LO 98.b

Cyber resilience measures taken globally include the following:

- Providing a list of warning signs for information system vulnerabilities, as well as recommendations to strengthen controls regarding topics such as remote working and virtual private networks (VPNs) and malware and ransomware threats.
- Releasing guidelines on improving cybersecurity with regard to remote working.
- Targeting the risks pertaining to IT networks and private/proprietary information.
- Increasing awareness of incremental COVID-19-related risks arising from the use of third-party vendors by financial institutions.
- Recommending changes to cybersecurity incident response plans to specifically account for the added cyber risks due to COVID-19. Additionally, publishing a list of best practices for financial institutions to consider before, during, and after any cyber incidents.
- Increased employee training and understanding of COVID-19-related risks of working remotely, as well as guidance on how to avoid being victimized by scams. Additionally, IT employees are to be equipped to spot fraudulent requests.

LO 98.c

The Financial Action Task Force (FATF) has stated that businesses should be on alert for risks related to ML and TF with the following recommendations:

- Maintain flexibility using the FATF risk-based approach when dealing with the current COVID-19 situation.
- Use robust procedures for customer onboarding in providing online financial services.
- Collaborate with peers and share pertinent information.
- Provide efficient ways to alert the authorities to crimes arising from COVID-19.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 98.1

1. **C** COVID-19-related cyber crime has the following primary objectives: (1) theft of personal information, (2) causing individuals to download malicious software, (3) engaging in fraud, and (4) seeking illegal gains. (LO 98.a)

2. **D** Up to 90% of banking and insurance employees are estimated to be working from home during the pandemic. There is remote login to company websites, meetings via videoconferencing, and access to private/sensitive data through the internet. (LO 98.a)

3. **D** At the national/domestic level, some authorities are using established domestic networks to share information with financial institutions. At the international level, the ECRB and CRCC are the two primary authorities involved in sharing information. (LO 98.b)

4. **C** In addition to the regular training provided to all staff, IT support staff must be properly trained to spot threats such as fraudulent requests for password resets or fraudulent requests for misplaced computer equipment. These examples of fraud are likely to arise more frequently in a COVID-19 environment that involves many more remote workers.

   Secure VPN connections (not multifactor authentication) is required to encrypt all data in transit. Not all financial institution staff would be considered essential workers; such a designation applies more specifically to the information security staff. Corporate nonpublic data could include sensitive and proprietary data, and corporate videoconferences could involve discussion of the same. Therefore, they should be treated with similar priority due to the potential for sensitive information to be accessed in both instances. (LO 98.b)

5. **C** FINMA extended the 30-day requirement to authenticate identity documents to 90 days for sufficiently low-risk new customers. (LO 98.c)

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Cecchetti and Schoenholtz.

READING 99: REPLACING LIBOR

Cecchetti and Schoenholtz

EXAM FOCUS

This reading examines the upcoming transition out of the London Interbank Offered Rate (LIBOR) and likely into the secured overnight financing rate (SOFR) at the end of 2021. For the exam, focus on the current state of the transition and the risks/implications of not having a proper transition plan out of LIBOR. Also, be familiar with the strengths and weaknesses of SOFR as the proposed replacement.

MODULE 99.1: REPLACING LIBOR

Ending LIBOR

LO 99.a: Explain the key issues that could cause systemic disruption when LIBOR ends.

The **London Interbank Offered Rate (LIBOR)** is most likely to be discontinued after the end of 2021. Currently, LIBOR is still the key international benchmark interest rate used for contracts with notional values of about $400 trillion (as of mid-2018). As of now, the U.S. has developed a potential replacement in the form of the **secured overnight financing rate (SOFR)**, but it has yet to gain widespread use.

There are two key risks to consider when ending LIBOR. One of them involves legacy LIBOR contracts that do not have sufficient fallback provisions; such contracts may see dramatic decreases in value. These losses could result in significant capital impairment and call into question the going concern for large financial institutions, as well as the financial system in general. All of that could lead to the drying up of available credit to borrowers. The other risk is the uncertainty surrounding whether an appropriate alternative to LIBOR will exist that permits financial institutions to be funded in a liquid market and to be able to offer funding.

Currently, a substantial amount of legacy LIBOR contracts still exists, extending beyond 2021 and, in some cases, extending beyond 2025. The problem is compounded by the ongoing creation of LIBOR-based contracts. With regard to those contracts, there does not appear to be much (if any) fallback language and that would result in significant uncertainty regarding the contract values. Luckily, the International Swaps and Dealers Association (ISDA) is currently devising fallback language that could be relied upon as needed. In addition, the Alternative Reference Rates Committee (ARRC) has provided guidance on fallback language for business loans, floating rate notes, securitizations, and adjustable-rate mortgages. However, in light of those developments, it is unknown to what degree firms are renegotiating legacy contracts with insufficient fallback language and to what degree firms are adopting the ARRC guidance.

Although SOFR has been identified and promoted as the successor to LIBOR, there remains very limited time to test the robustness of SOFR before the end of 2021. There is still a substantial amount of work to do prior to the completion of the transition.

Current State of the Transition

LO 99.b: Explain the current state of the transition and the challenges that lie ahead.

SOFR satisfies the requirement of having market depth in a liquid market. The notional value of daily SOFR transactions is over $1 trillion and increasing (and is hundreds of times larger than LIBOR transactions). However, although there has been strong growth in SOFR futures trading, it still lags significantly behind LIBOR. With bonds, SOFR is beginning to make strong progress.

Overall, the transition from LIBOR to SOFR has been slow largely because of the over 30-year history of LIBOR (i.e., resistance to change) compared with the introduction of SOFR in April 2018. Additionally, the costs of switching to SOFR are substantial and would relate to: drafting new SOFR contracts, changing investment and risk management plans, changes in computer systems, training staff, and educating clients. Some firms are less willing to absorb such costs, and those firms perceive two reasons to stick with LIBOR: (1) dollar LIBOR provides 10 maturities for periods up to a year, while there is only one for overnight SOFR; and (2) LIBOR accounts for bank funding risk, unlike SOFR. Finally, there are also those entities who are not motivated to make significant changes because they believe LIBOR will continue to be functional from 2022 onward.

The intention is to have SOFR term rates (e.g., 1-month and 3-month rates) prior to the transition to SOFR at the beginning of 2022. However, it is impractical for financial institutions and investors simply to wait for SOFR term rates to be created.

Unsecured funding still exists despite a substantial decline, so funding risk continues to require hedging. Larger financial institutions could have proprietary models to determine premium add-ons to SOFR, while smaller ones could use a market-based rate (e.g., Ameribor). However, given the strong liquidity associated with SOFR, it is the primary substitute to LIBOR.

To avoid the undesirable effects of a delay, regulators throughout the world are actively encouraging LIBOR users to start transitioning to a post-LIBOR financial environment.

Role of Government in the Transition

LO 99.c: Describe the government institutions' role in the transition.

At a basic level, the authorities could continually provide strong warnings regarding the risks of continuing to rely on LIBOR and not preparing for the change. The change from LIBOR will be accelerated if there is even more evidence that LIBOR will be terminated.

Regulators must be satisfied that the most crucial financial institutions and entities are ready for the transition. Those parties must be aware of their LIBOR risks (e.g., LIBOR-related contracts plus fallback language) and have sufficient mechanisms in place to be able to quickly revise their risk measures as needed. In the case of entities that pose a systemic risk, regulators must ensure that, with obsolescence of assets tied to LIBOR, none of those entities will face significant losses or threats to being a going concern.

The amount of current information on LIBOR-related financial instruments is lacking, so it is recommended that regulators find and publicly disclose changes in LIBOR exposure (at a minimum on a quarterly basis). Information on fallback language should be included as well.

Individuals and small businesses are likely to hold loans that are based on LIBOR, so the relevant government agencies should ensure that the public has a clear understanding of the pending change.

The change out of LIBOR is an extraordinarily complex and logistical problem to solve that needs much coordination and buy-in from all market participants. As the time remaining to the eventual transition winds down, a lot of work still needs to be done to fend off the significant risk of major disruption to the financial markets.

MODULE QUIZ 99.1

1. Which of the following statements regarding LIBOR and LIBOR-based contracts is most accurate?
   A. At this point, the creation of LIBOR-based contracts has ceased.
   B. The current dollar amount of LIBOR-based contracts outstanding is minimal.
   C. The creation of a sufficient replacement for LIBOR is nearing completion at this point.
   D. Fallback language for existing LIBOR contracts is being developed that can be adopted on a voluntary basis.
2. The daily value of underlying SOFR transactions currently exceeds which of the following amounts?
   A. $1 billion.
   B. $100 billion.
   C. $500 billion.
   D. $1 trillion.
3. For a 12-month period, how many maturity periods does SOFR currently have?
   A. 1.
   B. 4.
   C. 6.
   D. 12.
4. What is the main reason for the slow transition from LIBOR to SOFR?
   A. High cost.
   B. Complexity.
   C. Lack of training.
   D. Resistance to change.
5. It is recommended that regulators disclose the changes in LIBOR exposure at least:
   A. monthly.
   B. quarterly.
   C. semiannually.
   D. annually.

KEY CONCEPTS

LO 99.a

LIBOR is most likely to be discontinued after the end of 2021, although LIBOR is still the key international benchmark interest rate used. As of now, the U.S. has developed a potential replacement in the form of SOFR, but it has yet to gain widespread use.

There are two key risks to consider: (1) legacy LIBOR contracts that do not have sufficient fallback provisions; such contracts may see dramatic decreases in value; and (2) the uncertainty surrounding whether an appropriate alternative to LIBOR will exist that permits financial institutions to be funded in a liquid market and to be able to offer funding.

LO 99.b

SOFR satisfies the requirement of having market depth in a liquid market. Overall, the transition from LIBOR to SOFR has been slow largely because of the over 30-year history of LIBOR compared with the introduction of SOFR in April 2018. Additionally, the costs of switching to SOFR are substantial and would relate to: drafting new SOFR contracts, changing investment and risk management plans, changes in computer systems, training staff, and educating clients. Finally, there are also those entities that are not motivated to make significant changes because they believe LIBOR will continue to be functional from 2022 onward.

LO 99.c

Regulators must be satisfied that the most crucial financial institutions and entities are ready for the transition. Those parties must be aware of their LIBOR risks and have sufficient mechanisms in place to be able to quickly revise their risk measures as needed. In the case of entities that pose a systemic risk, regulators must ensure that none of those entities will face significant losses or threats to being a going concern.

The change from LIBOR is an extraordinarily complex and logistical problem to solve that needs much coordination and buy-in from all market participants. As the time remaining to the eventual transition winds down, a lot of work still needs to be done to fend off the significant risk of major disruption to the financial markets.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 99.1

1. **D** The International Swaps and Dealers Association (ISDA) is currently working on creating fallback language that dealers and customers may adopt voluntarily.

   At this point, the creation of LIBOR-based contracts *continues* in the industry. The current dollar amount of LIBOR legacy contracts outstanding remains *substantial*. The creation of a sufficient replacement for LIBOR is well on its way, but there is still a substantial amount of work to do prior to its completion. (LO 99.a)

2. **D** The daily value of underlying SOFR transactions currently exceeds $1 trillion and continues to increase. (LO 99.b)

3. **A** SOFR has 1 maturity period (overnight, or one day). In contrast, dollar LIBOR has 10 different maturities for a 12-month period. (LO 99.b)

4. **D** The main barrier to transition from LIBOR to SOFR is the resistance to change by many entities; LIBOR has been used since 1986 and many entities are very familiar with it and are not motivated to make the change.

   Although high cost and complexity are possible other reasons for the slow transition, they are not the main reason. Lack of training is a symptom of the slow transition, not a cause/reason. (LO 99.b)

5. **B** While monitoring institutions and markets, regulators are advised to compile and disclose changes in LIBOR exposure at least quarterly. (LO 99.c)

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Federal Reserve Bank of New York Staff Reports.

READING 100: CYBER RISK AND THE U.S. FINANCIAL SYSTEM: A PRE-MORTEM ANALYSIS

Federal Reserve Bank of New York Staff Reports

EXAM FOCUS

This reading discusses specific aspects of cyberattacks, including the direct and indirect costs. It also examines the possible large-scale effects throughout a financial network due to the technological nature of a cyberattack and the common technology used by banks. It concludes by discussing several innovative policy responses (beyond the traditional ones) that should be carefully noted.

MODULE 100.1: CYBER RISK AND THE U.S. FINANCIAL SYSTEM

Direct Costs and Spillovers

LO 100.a: Explain the direct costs of and the spillovers caused by a cyber-attack.

Compared to other types of entities, cyberattacks on financial institutions are far more frequent. They are likely to be deliberate and malicious in nature in order to cause maximum damage, so they are not random nor are they seasonal in nature. Direct costs to the bank include losses arising from the breach of data *confidentiality* (e.g., sensitive customer data and proprietary data). The bank would also likely incur reputation losses, which may be more indirect. Additionally, from an *availability* perspective, possible impairment of the bank's computer systems and access to its data have both direct and reputational cost. Finally, from an *integrity* of data perspective, there are direct costs involved in restoration of data. There could be additional spillover costs if the integrity event reduces the bank's ability to perform key tasks and if it promotes greater uncertainty as to the bank's ability to resume normal operations again.

Cyberattacks on a financial institution may cause a run on liquidity (e.g., a sudden rush of withdrawals by depositors), followed by threats to solvency. The run may stem from panic or fundamentals. The impacted financial institution bears the direct costs to fund the run on liquidity (e.g., large discounts on proceeds upon liquidating assets), although there are other indirect costs to counterparties in the financial industry and to borrowers in the general marketplace.

A unique aspect of cyberattacks that target the availability or integrity of systems and/or data is that they could reduce the bank's ability to fund withdrawals from depositors. That, in turn, lowers the depositors' desire to withdraw funds. At the same time, banks and financial institutions operate in different markets and provide many services to clients. Therefore, any lack of precision as to the source of the attack and possible impacts on other areas of the affected bank could result in withdrawals from customers from unaffected areas of that bank. Adding to the confusion may be

the lack of precise information provided when the impacted bank discloses the details of the cyberattack(s) to its stakeholders. As a result, other banks may not be certain whether they have been impacted as well. In the context of uncertainty, cyber events have the potential to remain undetected for long periods of time, which increases their damage potential and may hinder recovery.

Overall, cyberattacks could easily impair capital and liquidity, resulting in direct costs for the impacted bank. That would be independent of any run on liquidity or of any actions taken by the bank, its deposit holders, or its counterparties.

Potential for Cyber Shock Amplification

LO 100.b: Explain how cyber shocks can get amplified through financial networks.

A financial institution's network structure has the ability to amplify and spread cyber shocks, similar to those for liquidity and solvency. Cyber shocks have the potential to cause contagion events to occur. For example, the technological nature of a cyberattack may impact other networks via interbank lending or payments in the form of a virus carried through shared service providers.

Cyber shocks have a parallel to solvency shocks in that cyberattacks could lead to correlated impairments because of the reliance on the same networks, which substantially amplifies the systemic risk.

Lack of certainty regarding a cyberattack would likely encourage a network participant to react in a self-preservationist manner (e.g., strategic complementarities), but that could increase systemic risk. For example, a bank may respond in a legitimate manner by trying to improve its liquidity position by not making payments and maximizing its liquidity. The lack of information and significant uncertainty contributes to the amplification of the cyber shock; word may spread as to the impairment of one or more financial institutions that results in a rush to withdraw funds (i.e., run on liquidity) from those financial institutions that are not yet impacted.

Financial networks that are designed to protect against market risk and to promote the pooling of liquidity may suffer from cyber shocks. If redundancies do not exist, financial networks with a core-periphery structure could end up with fast-spreading cyber shocks if the core is initially attacked.

Policy Responses Against Cyber Events

LO 100.c: Discuss the policy responses that can be implemented against cyber events.

Cyber events could benefit from the usual policy tools of providing ex post sources of liquidity (e.g., discount window, open market operations) while having ex ante capital requirements to assist in anticipating and promoting recovery from cyber events. However, because of the unique nature of cyber events, the usual policy tools might not work so well. For example, cyber events that impair network availability or integrity would likely benefit from supplementary responses, including a break to provide additional time to recover from the event. It would also be helpful for liquidity and reserve requirements to be waived in the short-term should the bank be unable to deal with any violations due to technological impairments.

Cyberattacks could be best addressed by the Federal Reserve or other agencies. The provision of dedicated backup facilities in core markets could mitigate the availability and integrity effects of cyberattacks. From a cost-benefit perspective, it does not make sense for each individual bank to bear the full costs, so intervention from the Federal Reserve would help. Upon suffering from a cyber shock, a given bank might not consider that there is a good chance that other banks have suffered from the same shock. Therefore, having backup facilities available and having the assurance that the backup is protected from cyberattacks is key because it significantly reduces uncertainty, which on its own is a huge benefit.

Due to the asymmetric information associated with a cyberattack, establishing regulatory requirements to disclose seemingly harmless cyber events could benefit others. Additionally, requirements for information sharing with other banks regarding cyber threats and backup plans could put all parties in a stronger position by providing greater certainty and education. Identifying impacted banks or certifying banks as not being impacted reduces uncertainty, thereby increasing common knowledge and reducing the risk of coordination failures.

MODULE QUIZ 100.1

1. A significant cyberattack on a financial institution is likely to result primarily in:
   A. liquidity problems only.
   B. solvency problems only.
   C. liquidity and solvency problems.
   D. going concern problems only.
2. In general, cyberattacks are most likely to immobilize:
   A. liquidity only.
   B. capital only.
   C. both liquidity and capital.
   D. profits only.
3. A run on liquidity caused by a cyberattack has direct costs to the impacted financial institution. Which of the following parties will most likely bear other costs, if any, related to the cyberattack?
   A. Borrowers only.
   B. Counterparties only.
   C. Both borrowers and counterparties.
   D. Neither borrowers nor counterparties.
4. In the context of financial institutions, which of the following statements regarding cyberattacks or cyber shocks and their potential amplification effects is most accurate?
   A. Cyberattacks could lead to uncorrelated impairments, thereby resulting in greater systemic risk.
   B. Cyberattacks are more likely to cause initial financial shocks but are less likely to lead to contagion events.
   C. The location of a cyber shock must be known with certainty to significantly reduce its disruptive impacts.
   D. The negative impacts of a cyber shock may be reduced by ensuring that redundancies always exist within financial networks with a core-periphery structure.
5. With regard to cyber events, which policy tool is most likely to be effective in mitigating the negative effects?
   A. Ex ante capital requirements.
   B. Ex post capital requirements.
   C. Ex post liquidity provision.
   D. Provision of dedicated backup facilities.

KEY CONCEPTS

LO 100.a

Cyberattacks on a financial institution may cause a run on liquidity, followed by threats to solvency. The run may stem from panic or fundamentals. The impacted financial institution bears the direct costs to fund the run, although there are other indirect costs to counterparties in the financial industry and to borrowers in the general marketplace.

LO 100.b

A financial institution’s network structure has the ability to amplify and spread cyber shocks, similar to those for liquidity and solvency. Cyber shocks have the potential to cause contagion events to occur. Cyberattacks could lead to correlated impairments because of the reliance on the same networks, which substantially amplifies the systemic risk.

LO 100.c

Due to the unique nature of cyber events, the usual policy tools might not work very well. Alternative policy tools such as a break to provide additional time to recover from the event or waiving liquidity and reserve requirements in the short-term may be more beneficial. Additionally, the provision of dedicated backup facilities could mitigate the availability and integrity effects of cyberattacks. Finally, there may be significant benefits in establishing requirements to disclose seemingly harmless cyber events.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 100.1

1. **C** A significant cyberattack could cause a liquidity run and lead to solvency issues. It may eventually lead to going concern problems, but liquidity and/or solvency problems would have to occur first. The liquidity and/or solvency problem may not be serious enough to result in a going concern problem. (LO 100.a)

2. **C** In general, cyberattacks could result in the immobilization of capital and liquidity, which can be costly. Profits are not immobilized per se, but they may be negatively impacted. (LO 100.a)

3. **C** In addition to direct costs to the impacted financial institution, a cyberattack will likely have additional (indirect) costs within the financial industry (e.g., counterparties) and to the overall economy (e.g., borrowers). (LO 100.a)

4. **D** If redundancies do not exist, financial networks with a core-periphery structure could end up with fast-spreading cyber shocks if the core is initially attacked.

   Cyberattacks could lead to *correlated* impairments, thereby resulting in greater systemic risk. Cyberattacks are likely to cause initial financial shocks, which may likely lead to contagion events. The reading is silent on the impact of a cyber shock when its location is known, but it does emphasize that uncertainty regarding the location of a cyber shock could result in major amplification of its disruptive impacts. (LO 100.b)

5. **D** Cyberattacks could be best addressed by the Federal Reserve or other agencies. The provision of dedicated back-up facilities in core markets could mitigate the network availability and integrity effects of cyberattacks. Because of the unique nature of cyber events, the usual policy tools, such as ex ante capital requirements or ex post liquidity provisions, might not work so well. (LO 100.c)

FORMULAS

READING 80

investor risk premium: $\mathrm{E}\left(\mathrm{R_M}\right) - \mathrm{R_F} = \bar{\gamma} \times \sigma_{\mathrm{M}}^2$

security market line:

$$\mathrm{E}(\mathrm{R_i}) - \mathrm{R_F} = \frac{\mathrm{cov}(\mathrm{R_i}, \mathrm{R_M})}{\mathrm{var}(\mathrm{R_M})} \times [\mathrm{E}(\mathrm{R_M}) - \mathrm{R_F}] = \beta_{\mathrm{i}} \times [\mathrm{E}(\mathrm{R_M}) - \mathrm{R_F}]$$

READING 81

Fama-French three-factor model:

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

Fama-French model with momentum effect:

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

READING 82

fundamental law of active management: $\mathrm{IR} \approx \mathrm{IC} \times \sqrt{\mathrm{BR}}$

READING 83

$\text{risk aversion} = \frac{\text{information ratio}}{2 \times \text{active risk}}$

marginal contribution to value added = (alpha of asset) − [2 × (risk aversion) × (active risk) × (marginal contribution to active risk of asset)]

READING 84

diversified VaR: $\mathrm{VaR_p} = \mathrm{Z_c} \times \sigma_{\mathrm{p}} \times \mathrm{P}$

individual VaR: $\mathrm{VaR_i} = \mathrm{Z_c} \times \sigma_{\mathrm{i}} \times |\mathrm{P_i}| = \mathrm{Z_c} \times \sigma_{\mathrm{i}} \times |\mathrm{w_i}| \times \mathrm{P}$

standard deviation of a two-asset portfolio:

$$\sigma_{\mathrm{P}} = \sqrt{\mathrm{w}_1^2\sigma_1^2 + \mathrm{w}_2^2\sigma_2^2 + 2\mathrm{w}_1\mathrm{w}_2\,\rho_{1,2}\sigma_1\sigma_2}$$

VaR of a two-asset portfolio:

$$\mathrm{VaR_P} = \mathrm{Z_c P}\sqrt{\mathrm{w}_1^2\sigma_1^2 + \mathrm{w}_2^2\sigma_2^2 + 2\mathrm{w}_1\mathrm{w}_2\rho_{1,2}\sigma_1\sigma_2}$$

undiversified VaR: $\mathrm{VaR_P} = \sqrt{\mathrm{VaR_1^2} + \mathrm{VaR_2^2} + 2\mathrm{VaR_1 VaR_2}} = \mathrm{VaR_1} + \mathrm{VaR_2}$

standard deviation of equally weighted portfolio with equal standard deviations and correlations:

$$\sigma_{\mathrm{P}} = \sigma\sqrt{\frac{1}{\mathrm{N}} + \left(1 - \frac{1}{\mathrm{N}}\right)\rho}$$

marginal VaR: $\mathrm{MVaR_i} = \frac{\mathrm{VaR}}{\mathrm{P}} \times \beta_{\mathrm{i}}$

component VaR: $\mathrm{CVaR_i}$ = ($\mathrm{MVaR_i}$) × ($\mathrm{w_i}$ × P) = VaR × β_{i} × $\mathrm{w_i}$

READING 85

surplus = assets − liabilities

Δsurplus = Δassets − Δliabilities

return on the surplus:

$$\mathrm{R_{surplus}} = \frac{\Delta\mathrm{Surplus}}{\mathrm{Assets}} = \frac{\Delta\mathrm{Assets}}{\mathrm{Assets}} - \left(\frac{\Delta\mathrm{Liabilities}}{\mathrm{Liabilities}}\right)\left(\frac{\mathrm{Liabilities}}{\mathrm{Assets}}\right)$$
$$= \mathrm{R_{asset}} - \mathrm{R_{liabilities}}\left(\frac{\mathrm{Liabilities}}{\mathrm{Assets}}\right)$$

READING 86

liquidity duration: $\mathrm{LD} = \frac{\mathrm{Q}}{(0.10 \times \mathrm{V})}$

where:
LD = liquidity duration for the security on the assumption that the desired maximum daily volume of any security is 10%
Q = number of shares of the security
V = daily volume of the security

READING 87

Sharpe ratio: $\mathrm{S_A} = \frac{\overline{\mathrm{R}}_{\mathrm{A}} - \overline{\mathrm{R}}_{\mathrm{F}}}{\sigma_{\mathrm{A}}}$

where:
$\overline{\mathrm{R}}_{\mathrm{A}}$ = average account return
$\overline{\mathrm{R}}_{\mathrm{F}}$ = average risk-free return
σ_{A} = standard deviation of account returns

Treynor measure: $\mathrm{T_A} = \dfrac{\overline{\mathrm{R}}_\mathrm{A} - \overline{\mathrm{R}}_\mathrm{F}}{\beta_\mathrm{A}}$

where:
$\overline{\mathrm{R}}_\mathrm{A}$ = average account return
$\overline{\mathrm{R}}_\mathrm{F}$ = average risk-free return
β_A = average beta

Jensen's alpha: $\alpha_\mathrm{A} = \mathrm{R_A} - \mathrm{E(R_A)}$

where:
α_A = alpha
$\mathrm{R_A}$ = the return on the account
$\mathrm{E(R_A)} = \mathrm{R_F} + \beta_\mathrm{A}[\mathrm{E(R_M)} - \mathrm{R_F}]$

information ratio: $\mathrm{IR_A} = \dfrac{\overline{\mathrm{R}}_\mathrm{A} - \overline{\mathrm{R}}_\mathrm{B}}{\sigma_{\mathrm{A-B}}}$

where:
$\overline{\mathrm{R}}_\mathrm{A}$ = average account return
$\overline{\mathrm{R}}_\mathrm{B}$ = average benchmark return
$\sigma_{\mathrm{A-B}}$ = standard deviation of excess returns measured as the difference between account and benchmark returns

statistical significance of alpha returns: $\mathrm{t} = \dfrac{\alpha - 0}{\sigma/\sqrt{\mathrm{N}}}$

where:
α = alpha estimate
σ = alpha estimate volatility
N = sample number of observations
standard error of alpha estimate = $\sigma/\sqrt{\mathrm{N}}$

APPENDIX

USING THE CUMULATIVE *Z*-TABLE

Probability Example

Assume that the annual earnings per share (EPS) for a large sample of firms is normally distributed with a mean of $5.00 and a standard deviation of $1.50. What is the approximate probability of an observed EPS value falling between $3.00 and $7.25?

If EPS = x = $7.25, then z = (x − μ) / σ = ($7.25 − $5.00) / $1.50 = +1.50

If EPS = x = $3.00, then z = (x − μ) / σ = ($3.00 − $5.00) / $1.50 = –1.33

For z*-value of 1.50:* Use the row headed 1.5 and the column headed 0 to find the value 0.9332. This represents the area under the curve to the left of the critical value 1.50.

For z*-value of –1.33:* Use the row headed 1.3 and the column headed 3 to find the value 0.9082. This represents the area under the curve to the left of the critical value +1.33. The area to the left of –1.33 is 1 − 0.9082 = 0.0918.

The area between these critical values is 0.9332 − 0.0918 = 0.8414, or 84.14%.

Hypothesis Testing—One-Tailed Test Example

A sample of a stock's returns on 36 non-consecutive days results in a mean return of 2.0%. Assume the population standard deviation is 20.0%. Can we say with 95% confidence that the mean return is greater than 0%?

H_0: μ ≤ 0.0%, H_A: μ > 0.0%. The test statistic = *z*-statistic = $\frac{\bar{x}-\mu_0}{\sigma/\sqrt{n}}$

= (2.0 − 0.0) / (20.0 / 6) = 0.60.

The significance level = 1.0 − 0.95 = 0.05, or 5%.

Since this is a one-tailed test with an alpha of 0.05, we need to find the value 0.95 in the cumulative *z*-table. The closest value is 0.9505, with a corresponding critical *z*-value of 1.65. Since the test statistic is less than the critical value, we fail to reject H_0.

Hypothesis Testing—Two-Tailed Test Example

Using the same assumptions as before, suppose that the analyst now wants to determine if he can say with 99% confidence that the stock's return is not equal to 0.0%.

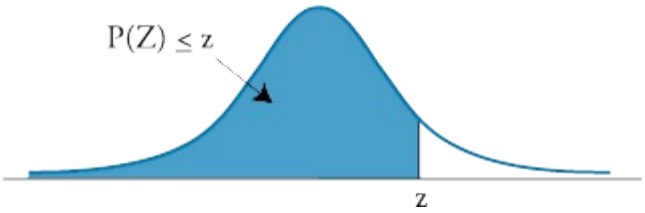
H_0: μ = 0.0%, H_A: μ ≠ 0.0%. The test statistic (*z*-value) = (2.0 − 0.0) / (20.0 / 6)

= 0.60. The significance level = 1.0 − 0.99 = 0.01, or 1%.

Since this is a two-tailed test with an alpha of 0.01, there is a 0.005 rejection region in both tails. Thus, we need to find the value 0.995 (1.0 − 0.005) in the table. The closest value is 0.9951, which

corresponds to a critical *z*-value of 2.58. Since the test statistic is less than the critical value, we fail to reject H_0 and conclude that the stock's return equals 0.0%.

Cumulative *Z*-Table



$P(Z \leq z) = N(z)$ for $z \geq 0$

$P(Z \leq -z) = 1 - N(z)$

z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.989
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974

2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

Student's t-Distribution

	Level of Significance for One-Tailed Test					
df	**0.100**	**0.050**	**0.025**	**0.01**	**0.005**	**0.0005**
	Level of Significance for Two-Tailed Test					
df	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.001**
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.599
3	1.638	2.353	3.182	4.541	5.841	12.294
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.869
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.408
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.768
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646

40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

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