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2016 SchweserNotes™ Part II

FRM® Exam Prep

Operational and Integrated Risk Management

eBook 3

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Sincerely,

Timothy Smaby

Timothy Smaby, PhD, CFA, FRM
Vice President, Advanced Designations, Kaplan Schweser

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Reading Assignments and Learning Objectives

The following material is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by the Global Association of Risk Professionals.

Reading Assignments

38. "Principles for the Sound Management of Operational Risk," (Basel Committee on Banking Supervision Publication, June 2011). (page 1)

39. Brian Nocco and René Stulz, "Enterprise Risk Management: Theory and Practice," *Journal of Applied Corporate Finance 18*, No. 4 (2006): 8–20. (page 16)

40. "Observations on Developments in Risk Appetite Frameworks and IT Infrastructure," Senior Supervisors Group, December 2010. (page 26)

    Marcelo G. Cruz, Gareth W. Peters, and Pavel V. Shevchenko, Fundamental Aspects of Operational Risk and Insurance Analytics: A Handbook of Operational Risk (Hoboken, NJ: John Wiley & Sons, 2015).

41. "OpRisk Data and Governance," Chapter 2 (page 36)

    Philippa X. Girling, *Operational Risk Management: A Complete Guide to a Successful Operational Risk Framework* (Hoboken: John Wiley & Sons, 2013).

42. "External Loss Data," Chapter 8 (page 54)

43. "Capital Modeling," Chapter 12 (page 66)

44. "Operational Risk—Supervisory Guidelines for the Advanced Measurement Approaches," (Basel Committee on Banking Supervision Publication, June 2011). (page 80)

    Michel Crouhy, Dan Galai and Robert Mark, *The Essentials of Risk Management, 2nd Edition* (New York: McGraw- Hill, 2014).

45. "Model Risk," Chapter 15 (page 97)

46. "Risk Capital Attribution and Risk-Adjusted Performance Measurement," Chapter 17 (page 109)

47. "Range of Practices and Issues in Economic Capital Frameworks," (Basel Committee on Banking Supervision Publication, March 2009). (page 127)

48. "Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice," Board of Governors of the Federal Reserve System, August 2013. (page 143)

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Bruce Tuckman, Angel Serrat, *Fixed Income Securities: Tools for Today's Markets, 3rd Edition* (New York: Wiley, 2011)

49. "Repurchase Agreements and Financing," Chapter 12 (page 157)

Kevin Dowd, *Measuring Market Risk, 2nd Edition* (West Sussex, England: John Wiley & Sons, 2005).

50. "Estimating Liquidity Risks," Chapter 14 (page 171)

Allan Malz, *Financial Risk Management: Models, History, and Institutions* (Hoboken, NJ: John Wiley & Sons, 2011).

51. "Assessing the Quality of Risk Measures," Chapter 11 (page 185)

52. "Liquidity and Leverage," Chapter 12 (page 196)

53. Darrell Duffie, 2010. "Failure Mechanics of Dealer Banks," *Journal of Economic Perspectives* 24:1, 51–72. (page 217)

54. "Stress Testing Banks," Til Schuermann, prepared for the Committee on Capital Market Regulation, Wharton Financial Institutions Center (April 2012). (page 228)

John Hull, *Risk Management and Financial Institutions, 4th Edition* (Hoboken, NJ: John Wiley & Sons, 2015).

55. "Basel I, Basel II, and Solvency II," Chapter 15 (page 239)

56. "Basel II.5, Basel III, and Other Post-Crisis Changes," Chapter 16 (page 262)

57. "Fundamental Review of the Trading Book," Chapter 17 (page 279)

58. "Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework—Comprehensive Version," (Basel Committee on Banking Supervision Publication, June 2006). (page 288)

59. "Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems—Revised Version," (Basel Committee on Banking Supervision Publication, June 2011). (page 316)

60. "Basel III: The Liquidity Coverage Ratio and Liquidity Risk Monitoring Tools," (Basel Committee on Banking Supervision Publication, January 2013). (page 335)

61. "Revisions to the Basel II Market Risk Framework—Updated as of 31 December 2010," (Basel Committee on Banking Supervision Publication, February 2011). (page 349)

62. "Basel III: The Net Stable Funding Ratio." (Basel Committee on Banking Supervision Publication, October 2014). (page 357)

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Learning Objectives

38. Principles for the Sound Management of Operational Risk

After completing this reading, you should be able to:

1. Describe the three "lines of defense" in the Basel model for operational risk governance. (page 1)
2. Summarize the fundamental principles of operational risk management as suggested by the Basel committee. (page 2)
3. Evaluate the role of the Board of Directors and senior management in implementing an effective operational risk structure per the Basel committee recommendations. (page 3)
4. Describe the elements of a framework for operational risk management. (page 6)
5. Identify examples of tools which can be used to identify and assess operational risk. (page 7)
6. Describe features of an effective control environment and identify specific controls which should be in place to address operational risk. (page 8)
7. Describe the Basel committee's suggestions for managing technology risk and outsourcing risk. (page 8)
8. Describe and outline business resiliency and continuity plans for banks under the Basel Committee framework. (page 6)
9. Identify and discuss the role of a bank's public disclosures. (page 6)

39. Enterprise Risk Management: Theory and Practice

After completing this reading, you should be able to:

1. Define enterprise risk management (ERM). (page 16)
2. Explain how implementing ERM practices and policies can create shareholder value both at the macro and the micro level. (page 16)
3. Explain how a company can determine its optimal amount of risk through the use of credit rating targets. (page 18)
4. Describe the development and implementation of an ERM system. (page 18)
5. Describe the role of and issues with correlation in risk aggregation, and describe typical properties of a firm's market risk, credit risk, and operational risk distributions. (page 19)
6. Distinguish between regulatory and economic capital, and explain the use of economic capital in the corporate decision making process. (page 20)

40. Observations on Developments in Risk Appetite Frameworks and IT Infrastructure

After completing this reading, you should be able to:

1. Describe the concept of a risk appetite framework (RAF), identify the elements of an RAF and explain the benefits to a firm of having a well-developed RAF. (page 26)
2. Describe best practices for a firm's Chief Risk Officer (CRO), Chief Executive Officer (CEO), and Board of Directors in the development and implementation of an effective RAF. (page 27)
3. Explain the role of a RAF in managing the risk of individual business lines within a firm. (page 28)
4. Describe the classes of risk metrics to be communicated to managers within the firm. (page 29)
5. Explain the benefits to a firm from having a robust risk data infrastructure, and describe key elements of an effective IT risk management policy at a firm. (page 29)

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6. Describe factors which could lead to poor or fragmented IT infrastructure at an organization. (page 30)
7. Calculate the financing advantage of a bond trading special when used in a repo transaction. (page 31)

41. OpRisk Data and Governance

After completing this reading, you should be able to:

1. Describe the seven Basel II event risk categories and identify examples of operational risk events in each category. (page 36)
2. Summarize the process of collecting and reporting internal operational loss data, including the selection of thresholds, the timeframe for recoveries, and reporting expected operational losses. (page 39)
3. Explain the use of a Risk Control Self-Assessment (RCSA) and key risk indicators (KRIs) in identifying, controlling, and assessing operational risk exposures. (page 41)
4. Describe and assess the use of scenario analysis in managing operational risk, and identify biases and challenges which can arise when using scenario analysis. (page 44)
5. Compare the typical operational risk profiles of firms in different financial sectors. (page 46)
6. Compare different organizational designs for a risk management framework. (page 49)

42. External Loss Data

After completing this reading, you should be able to:

1. Explain the motivations for using external operational loss data and common sources of external data. (page 54)
2. Explain ways in which data from different external sources may differ. (page 57)
3. Describe the challenges which can arise through the use of external data. (page 58)
4. Describe the Société Générale operational loss event and explain the lessons learned from the event. (page 59)

43. Capital Modeling

After completing this reading, you should be able to:

1. Compare the basic indicator approach, the standardized approach, and the alternative standardized approach for calculating the operational risk capital charge and calculate the Basel operational risk charge using each approach. (page 66)
2. Describe the modeling requirements for a bank to use the Advanced Measurement Approach (AMA). (page 71)
3. Describe the loss distribution approach to modeling operational risk capital. (page 72)
4. Explain how frequency and severity distributions of operational losses are obtained, including commonly used distributions and suitability guidelines for probability distributions. (page 72)
5. Explain how Monte Carlo simulation can be used to generate additional data points to estimate the 99.9^{th} percentile of an operational loss distribution. (page 74)
6. Explain the use of scenario analysis and the hybrid approach in modeling operational risk capital. (page 74)
7. Describe the AMA guidelines for the use of insurance in reducing a bank's operational risk capital charge. (page 75)

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44. Operational Risk—Supervisory Guidelines for the Advanced Measurement Approaches

After completing this reading, you should be able to:

1. Summarize key guidelines for verification and validation of a bank's operational risk management framework (ORMF) and its operational risk management system (ORMS), including the use test and experience. (page 81)
2. Describe key guidelines for the selection of a bank's Operational Risk Categories (ORCs). (page 89)
3. Describe commonly used distributions used to model the frequency and severity of a bank's operational loss events. (page 86)
4. Explain key guidelines for modeling the distribution of losses within individual ORCs, including the selection of thresholds, necessary adjustments, and selection of statistical tools and probability distributions. (page 90)
5. Describe techniques used to get an aggregated loss distribution from frequency and severity distributions. (page 88)
6. Explain supervisory guidelines for modeling dependence and correlation effects between operational risk factors across different operational risk categories. (page 92)
7. Describe the four required data elements in an AMA model and the guidelines for combining data from each element in modeling the capital charge. (page 84)

45. Model Risk

After completing this reading, you should be able to:

1. Identify and explain errors in modeling assumptions that can introduce model risk. (page 97)
2. Explain how model risk can arise in the implementation of a model. (page 99)
3. Explain methods and procedures risk managers can use to mitigate model risk. (page 100)
4. Explain the impact of model risk and poor risk governance in the 2012 London Whale trading loss and the 1998 collapse of Long Term Capital Management. (page 101)

46. Risk Capital Attribution and Risk-Adjusted Performance Measurement

After completing this reading, you should be able to:

1. Define, compare, and contrast risk capital, economic capital, and regulatory capital, and explain the motivations for using economic capital. (page 109)
2. Describe the RAROC (risk-adjusted return on capital) methodology and its benefits. (page 111)
3. Compute and interpret the RAROC for a project, loan, or loan portfolio, and use RAROC to compare business unit performance. (page 111)
4. Explain the impact of changing assumptions used in calculating economic capital, including choosing a time horizon, measuring default probability, and choosing a confidence level. (page 114)
5. Calculate the hurdle rate and apply this rate in making business decisions using RAROC. (page 116)
6. Compute the adjusted RAROC for a project to determine its viability. (page 117)
7. Explain challenges in modeling diversification benefits, including aggregating a firm's risk capital and allocating economic capital to different business lines. (page 117)
8. Explain best practices in implementing a RAROC approach. (page 119)

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47. Range of Practices and Issues in Economic Capital Frameworks

After completing this reading, you should be able to:

1. Within the economic capital implementation framework describe the challenges that appear in:
   - Defining risk measures
   - Risk aggregation
   - Validation of models
   - Dependency modeling in credit risk
   - Evaluating counterparty credit risk
   - Assessing interest rate risk in the banking book (page 127)
2. Describe the BIS recommendations that supervisors should consider to make effective use of risk measures not designed for regulatory purposes. (page 137)
3. Describe the constraints imposed and the opportunities offered by economic capital within the following areas:
   - Credit portfolio management
   - Risk based pricing
   - Customer profitability analysis
   - Management incentives (page 138)

48. Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice

After completing this reading, you should be able to:

1. Describe the Federal Reserve's Capital Plan Rule and explain the seven principles of an effective capital adequacy process for bank holding companies (BHCs) subject to the Capital Plan Rule. (page 143)
2. Describe practices which can result in a strong and effective capital adequacy process for a BHC in the following areas:
   - Risk identification
   - Internal controls, including model review and valuation
   - Corporate governance
   - Capital policy, including setting of goals and targets and contingency planning
   - Stress testing and stress scenario design
   - Estimating losses, revenues, and expenses, including quantitative and qualitative methodologies
   - Assessing the impact of capital adequacy, including RWA and balance sheet projections (page 145)

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49. Repurchase Agreements and Financing

After completing this reading, you should be able to:

1. Describe the mechanics of repurchase agreements (repos) and calculate the settlement for a repo transaction. (page 157)
2. Explain common motivations for entering into repos, including their use in cash management and liquidity management. (page 158)
3. Explain how counterparty risk and liquidity risk can arise through the use of repo transactions. (page 160)
4. Assess the role of repo transactions in the collapses of Lehman Brothers and Bear Stearns during the 2007-2008 credit crisis. (page 161)
5. Compare the use of general and special collateral in repo transactions. (page 162)
6. Describe the characteristics of special spreads and explain the typical behavior of US Treasury special spreads over an auction cycle. (page 164)
7. Calculate the financing advantage of a bond trading special when used in a repo transaction. (page 165)

50. Estimating Liquidity Risks

After completing this reading, you should be able to:

1. Define liquidity risk and describe factors that influence liquidity, including the bid-ask spread. (page 171)
2. Define exogenous and endogenous liquidity. (page 172)
3. Describe the challenges of estimating liquidity-adjusted VaR (LVaR). (page 172)
4. Describe and calculate LVaR using the constant spread approach and the exogenous spread approach. (page 173)
5. Describe endogenous price approaches to LVaR, their motivation and limitations, and calculate the elasticity-based liquidity adjustment to VaR. (page 176)
6. Describe liquidity at risk (LaR) and compare it to VaR, describe the factors that affect future cash flows, and explain challenges in estimating and modeling LaR. (page 178)
7. Explain the role of liquidity in crisis situations and describe approaches to estimating crisis liquidity risk. (page 179)

51. Assessing the Quality of Risk Measures

After completing this reading, you should be able to:

1. Describe ways that errors can be introduced into models. (page 185)
2. Describe how horizon, computational and modeling decisions can impact VaR estimates. (page 186)
3. Explain how model risk and variability can arise through the implementation of VaR models and the mapping of risk factors to portfolio positions. (page 186)
4. Identify reasons for the failure of the long-equity tranche, short-mezzanine credit trade in 2005 and describe how such modeling errors could have been avoided. (page 188)
5. Identify two major defects in model assumptions which led to the underestimation of systematic risk for residential mortgage backed securities (RMBS) during the 2008-2009 financial downturn. (page 190)

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52. Liquidity and Leverage

After completing this reading, you should be able to:

1. Differentiate between sources of liquidity risk, including balance sheet/funding liquidity risk, systematic funding liquidity risk, and transactions liquidity risk, and explain how each of these risks can arise for financial institutions. (page 196)
2. Summarize the asset-liability management process at a fractional reserve bank, including the process of liquidity transformation. (page 197)
3. Explain the liquidity characteristics and risks of structured credit products. (page 198)
4. Describe specific liquidity challenges faced by money market mutual funds and by hedge funds, particularly in stress situations. (page 199)
5. Describe transactions used in the collateral market and explain risks that can arise through collateral market transactions. (page 200)
6. Describe the relationship between leverage and a firm's return profile and calculate the leverage effect. (page 202)
7. Explain the impact on a firm's leverage and its balance sheet of the following transactions: purchasing long equity positions on margin, entering into short sales, and trading in derivatives (page 204)
8. Explain methods to measure and manage funding liquidity risk and transactions liquidity risk. (page 208)
9. Calculate the expected transactions cost and the spread risk factor for a transaction, and calculate the liquidity adjustment to VaR for a position to be liquidated over a number of trading days. (page 209)
10. Explain interactions between different types of liquidity risk and explain how liquidity risk events can increase systemic risk. (page 196)

53. The Failure Mechanics of Dealer Banks

After completing this reading, you should be able to:

1. Describe the major lines of business in which dealer banks operate and the risk factors they face in each line of business. (page 217)
2. Identify situations that can cause a liquidity crisis at a dealer bank and explain responses that can mitigate these risks. (page 221)
3. Compare a liquidity crisis at a dealer bank to a traditional bank run. (page 223)
4. Describe policy measures that can alleviate firm-specific and systemic risks related to large dealer banks. (page 224)

54. Stress Testing Banks

After completing this reading, you should be able to:

1. Compare and contrast the features and scope of stress tests before and after the Supervisory Capital Assessment Program (SCAP). (page 229)
2. Explain challenges in designing stress test scenarios, including the problem of coherence in modeling risk factors. (page 230)
3. Identify and explain challenges in modeling a bank's losses and revenues over a stress test horizon period. (page 231)
4. Explain the challenges in modeling a bank's balance sheet over a stress test horizon period. (page 232)
5. Compare and contrast the 2009 SCAP stress test, the 2011 and 2012 CCAR, and the 2011 EBA Irish and EBA European stress tests in their methodologies and key findings. (page 232)

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55. Basel I, Basel II, and Solvency II

After completing this reading, you should be able to:

1. Explain the motivations for introducing the Basel regulations, including key risk exposures addressed, and explain the reasons for revisions to Basel regulations over time. (page 239)
2. Explain the calculation of risk-weighted assets and the capital requirement per the original Basel I guidelines. (page 240)
3. Describe and contrast the major elements—including a description of the risks covered—of the two options available for the calculation of market risk:
   - Standardized Measurement Method
   - Internal Models Approach (page 243)
4. Calculate VaR and the capital charge using the internal models approach, and explain the guidelines for backtesting VaR. (page 244)
5. Describe and contrast the major elements of the three options available for the calculation of credit risk:
   - Standardized Approach
   - Foundation IRB Approach
   - Advanced IRB Approach (page 246)
6. Describe and contrast the major elements of the three options available for the calculation of operational risk: basic indicator approach, standardized approach, and the Advanced Measurement Approach. (page 252)
7. Describe the key elements of the three pillars of Basel II: minimum capital requirements, supervisory review, and market discipline. (page 252)
8. Define in the context of Basel II and calculate where appropriate:
   - Probability of default (PD)
   - Loss given default (LGD)
   - Exposure at default (EAD)
   - Worst-case probability of default (page 246)
9. Differentiate between solvency capital requirements (SCR) and minimum capital requirements (MCR) in the Solvency II framework, and describe the repercussions to an insurance company for breaching the SCR and MCR. (page 254)
10. Compare the standardized approach and the internal models approach for calculating the SCR in Solvency II. (page 254)

56. Basel II.5, Basel III, and Other Post-Crisis Changes

After completing this reading, you should be able to:

1. Describe and calculate the stressed value-at-risk measure introduced in Basel 2.5, and calculate the market risk capital charge. (page 262)
2. Explain the process of calculating the incremental risk capital charge for positions held in a bank's trading book. (page 264)
3. Describe the comprehensive risk measure (CRM) for positions which are sensitive to correlations between default risks. (page 264)
4. Define in the context of Basel III and calculate where appropriate:
   - Tier 1 capital and its components
   - Tier 2 capital and its components
   - Required Tier 1 equity capital, total Tier 1 capital, and total capital (page 266)
5. Describe the motivations for and calculate the capital conservation buffer and the countercyclical buffer introduced in Basel III. (page 267)

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6. Describe and calculate ratios intended to improve the management of liquidity risk, including the required leverage ratio, the liquidity coverage ratio, and the net stable funding ratio. (page 268)
7. Describe the mechanics of contingent convertible bonds (CoCos) and explain the motivations for banks to issue them. (page 271)
8. Explain the major changes to the U.S. financial market regulations as a result of Dodd-Frank. (page 272)

57. Fundamental Review of the Trading Book

After completing this reading, you should be able to:

1. Describe the proposed changes to the Basel market risk capital calculation and the motivations for these changes, and calculate the market risk capital under this method. (page 279)
2. Compare the various liquidity horizons proposed by the FRTB for different asset classes and explain how a bank can calculate its expected shortfall using the various horizons. (page 281)
3. Explain proposed modifications to Basel regulations in the following areas:
   - Classification of positions in the trading book compared to the banking book
   - Treatment of credit spread and jump-to-default risk, including the incremental default risk charge (page 283)

58. Basel II: International Convergence of Capital Measurement and Capital Standards

After completing this reading, you should be able to:

1. Describe the key elements of the three pillars of Basel II: minimum capital requirements, supervisory review and market discipline. (page 307)
2. Describe and contrast the major elements of the three options available for the calculation of credit risk: Standardized Approach, Foundation IRB Approach and Advanced IRB Approach. (page 297)
3. Describe and contrast the major elements of the three options available for the calculation of operational risk: Basic Indicator Approach, Standardized Approach and Advanced Measurement Approach. (page 306)
4. Describe and contrast the major elements—including a description of the risks covered—of the two options available for the calculation of market risk: Standardized Measurement Method and Internal Models Approach. (page 304)
5. Define in the context of Basel II and calculate where appropriate:
   - Capital ratio
   - Capital charge
   - Tier 1 capital and its components
   - Tier 2 capital and its components
   - Tier 3 capital and its components
   - Probability of default (PD)
   - Loss given default (LGD)
   - Exposure at default (EAD)
   - Maturity (M)
   - Stress tests
   - Concentration risk
   - Residual risk (page 295)

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59. Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems

After completing this reading, you should be able to:

1. Describe reasons for the changes implemented through the Basel III framework. (page 316)
2. Describe changes to the regulatory capital framework, including changes to:
   - The measurement, treatment, and calculation of Tier 1 and Tier 2 capital
   - Risk coverage, the use of stress tests, the treatment of counter-party risk with credit valuation adjustments, the use of external ratings, and the use of leverage ratios (page 318)
3. Explain changes designed to dampen the pro-cyclical amplification of financial shocks and to promote countercyclical buffers. (page 327)
4. Describe changes intended to improve the handling of systemic risk. (page 328)
5. Describe changes intended to improve the management of liquidity risk, including liquidity coverage ratios, net stable funding ratios, and the use of monitoring metrics. (page 329)

60. Basel III: The Liquidity Coverage Ratio and Liquidity Risk Monitoring Tools

After completing this reading, you should be able to:

1. Define and describe the minimum liquidity coverage ratio. (page 336)
2. Describe the characteristics of high quality liquid assets (HQLA) and operational requirements for assets to qualify as HQLA. (page 336)
3. Differentiate between Level 1, Level 2A, and Level 2B assets, and define the respective cap for each asset class as a percentage of total HQLA. (page 338)
4. Define how total net cash outflows are calculated for the minimum liquidity coverage ratio. (page 339)
5. Describe additional metrics to be used by supervisors as monitoring tools when assessing the liquidity risk of a bank. (page 341)

61. Revisions to the Basel II Market Risk Framework

After completing this reading, you should be able to:

1. Describe the objectives for revising the Basel II market risk framework. (page 349)
2. Define the capital charge for specific risk and general market risk. (page 349)
3. Explain the relationship regulators require between market risk factors used for pricing versus those used for calculating value-at-risk, and the risks captured by the value-at-risk model. (page 350)
4. Explain and calculate the stressed value-at-risk measure and the frequency which it must be calculated. (page 351)
5. Explain and calculate the market risk capital requirement. (page 351)
6. Describe the qualitative disclosures for the incremental risk capital charge. (page 352)
7. Describe the quantitative disclosures for trading portfolios under the internal models approach. (page 352)
8. Describe the regulatory guidance on prudent valuation of illiquid positions. (page 352)

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62. Basel III: The Net Stable Funding Ratio

After completing this reading, you should be able to:

1. Define and discuss the net stable funding ratio (NSFR). (page 357)
2. Define and discuss the amount of available stable funding (ASF). (page 358)
3. Define and discuss the required stable funding (RSF) for assets and off-balance sheet exposures. (page 359)
4. Explain the application issues for the NSFR. (page 361)

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

Principles for the Sound Management of Operational Risk

Topic 38

Exam Focus

This is a descriptive topic that addresses the principles of sound operational risk management as proposed by the Basel Committee on Banking Supervision. The committee describes a three lines of defense approach, which includes business line management, independent operational risk management, and independent reviews. The committee suggests that a bank should have a corporate operational risk function (CORF) that is commensurate with the size and complexity of the banking organization. For the exam, understand the 11 principles of operational risk management as outlined by the Basel Committee. Know the specific responsibilities of the board of directors and senior managers as they relate to the 11 principles of operational risk management. Be able to explain the critical components of the bank's operational risk management framework documentation, and know the features of an effective control environment. Lastly, understand the committee's recommendations for managing technology and outsourcing.

Operational Risk Governance

LO 38.1: Describe the three "lines of defense" in the Basel model for operational risk governance.

The Basel Committee on Banking Supervision defines **operational risk** as "the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events." The committee states that the definition excludes strategic and reputational risks but includes legal risks. Operational risk is inherent in banking activities. Risks range from those arising from national disasters, such as hurricanes, to the risk of fraud. The committee intends to improve operational risk management throughout the banking system.

Sound operational risk management practices cover governance, the risk management environment, and the role of disclosure. Operational risk management must be fully integrated into the overall risk management processes of the bank.

The three common "lines of defense" employed by firms to control operational risks are:

1. **Business line management**. Business line management is the first line of defense. Banks now, more than ever, have multiple lines of business, all with varying degrees of operational risk. Risks must be identified and managed within the various products, activities, and processes of the bank.

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2. An **independent operational risk management function**. This is the second line of defense and is discussed in the next section.

3. **Independent reviews** of operational risks and risk management. The review may be conducted internally with personnel independent of the process under review or externally. Independent review will be discussed in detail in Topic 44.

Corporate Operational Risk Function (CORF)

The bank's specific business lines monitor, measure, report, and manage operational and other risks. The corporate operational risk function (CORF), also known as the corporate operational risk management function, is a functionally independent group that complements the business lines' risk management operations. The CORF is responsible for designing, implementing, and maintaining the bank's operational risk framework. Responsibilities of the CORF may include:

- Measurement of operational risks.
- Establishing reporting processes for operational risks.
- Establishing risk committees to measure and monitor operational risks.
- Reporting operational risk issues to the board of directors.

In general, the CORF must assess and challenge each business line's contributions to risk measurement, management, and reporting processes.

Larger, more complex banking institutions will typically have a more formalized approach to the implementation of the lines of defense against operational risks, including the implementation of the CORF. For example, a large bank may have a fully staffed group skilled specifically in operational risk management, while a smaller bank may simply fold operational risk management into the broader risk management function of the bank.

Principles of Operational Risk Management

LO 38.2: Summarize the fundamental principles of operational risk management as suggested by the Basel committee.

Operational risks must be proactively managed by a bank's board of directors and senior managers as well as its business line managers and employees. The 11 fundamental principles of operational risk management suggested by the Basel Committee are:

1. The maintenance of a **strong risk management culture** led by the bank's board of directors and senior managers. This means that both individual and corporate values and attitudes should support the bank's commitment to managing operational risks.

2. The operational risk framework (referred to as the "Framework" in this topic) must be **developed and fully integrated into the overall risk management processes** of the bank.

3. The board should **approve and periodically review** the Framework. The board should also oversee senior management to ensure that appropriate risk management decisions are implemented at all levels of the firm.

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4. The board must identify the types and levels of operational risks the bank is willing to assume as well as approve **risk appetite** and **risk tolerance statements.**

5. Consistent with the bank's risk appetite and risk tolerance, senior management must **develop a well-defined governance structure** within the bank. The structure must be implemented and maintained throughout the bank's various lines of business, its processes, and its systems. The board of directors should approve this governance structure.

6. Senior management must **understand the risks, and the incentives related to those risks, inherent in the bank's business lines and processes.** These operational risks must be identified and assessed by managers.

7. New lines of business, products, processes, and systems should require an **approval process that assesses the potential operational risks.** Senior management must make certain this approval process is in place.

8. A **process for monitoring operational risks** and **material exposures to losses** should be put in place by senior management and supported by senior management, the board of directors and business line employees.

9. Banks must put strong **internal controls, risk mitigation, and risk transfer strategies** in place to manage operational risks.

10. Banks must have plans in place to survive in the event of a major business disruption. **Business operations must be resilient.**

11. Banks should make **disclosures** that are clear enough that outside stakeholders can assess the bank's approach to operational risk management.

The Role of the Board and Senior Management

LO 38.3: Evaluate the role of the Board of Directors and senior management in implementing an effective operational risk structure per the Basel committee recommendations.

The attitudes and expectations of the board of directors and senior management are critical to an effective operational risk management program.

With respect to Principle 1, the board of directors and/or senior management should:

- **Provide a sound foundation for a strong risk management culture** within the bank. A strong risk management culture will generally mitigate the likelihood of damaging operational risk events.

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- **Establish a code of conduct (or ethics policy) for all employees** that outlines expectations for ethical behavior. The board of directors should support senior managers in producing a code of conduct. Risk management activities should reinforce the code of conduct. The code should be reflected in training and compensation as well as risk management. There should be a balance between risks and rewards. Compensation should be aligned not just with performance, but also with the bank's risk appetite, strategic direction, financial goals, and overall soundness.
- **Provide risk training** throughout all levels of the bank. Senior management should ensure training reflects the responsibilities of the person being trained.

With respect to Principle 2, the board of directors and/or senior management should:

- **Thoroughly understand both the nature and complexity of the risks** inherent in the products, lines of business, processes, and systems in the bank. Operational risks are inherent in all aspects of the bank.
- Ensure that the **Framework is fully integrated in the bank's overall risk management plan** across all levels of the firm (i.e., business lines, new business lines, products, processes, and/or systems). Risk assessment should be a part of the business strategy of the bank.

With respect to Principle 3, the board of directors and/or senior management should:

- **Establish a culture and processes** that help bank managers and employees understand and manage operational risks. The board must develop comprehensive and dynamic oversight and control mechanisms that are integrated into risk management processes across the bank.
- **Regularly review the Framework.**
- **Provide senior management with guidance** regarding operational risk management and approve policies developed by senior management aimed at managing operational risk.
- Ensure that the Framework is subject to **independent review.**
- **Ensure that management is following best practices** in the field with respect to operational risk identification and management.
- **Establish clear lines of management responsibility** and establish strong internal controls.

With respect to Principle 4, the board of directors and/or senior management should:

- **Consider all relevant risks** when approving the bank's risk appetite and tolerance statements. The board must also consider the bank's strategic direction. The board should approve risk limits and thresholds.
- **Periodically review** the risk appetite and tolerance statements. The review should specifically focus on:
  - Changes in the market and external environment.
  - Changes in business or activity volume.
  - Effectiveness of risk management strategies.
  - The quality of the control environment.
  - The nature of, frequency of, and volume of breaches to risk limits.

With respect to Principle 5, the board of directors and/or senior management should:

- **Establish systems to report and track operational risks** and maintain an effective mechanism for resolving problems. Banks should demonstrate the effective use of the three lines of defense to manage operational risk, as outlined by the Basel Committee.

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- Translate the Framework approved by the board into **specific policies and procedures** used to manage risk. Senior managers should clearly assign areas of responsibility and should ensure a proper management oversight system to monitor risks inherent in the business unit.
- Ensure that operational risk managers **communicate clearly** with personnel responsible for market, credit, liquidity, interest rate, **and** other risks and with those procuring outside services, such as insurance or outsourcing.
- Ensure that CORF managers should have **sufficient stature** in the bank, commensurate with market, credit, liquidity, interest rate, and other risk managers.
- Ensure that the staff is **well trained in operational risk management**. Risk managers should have independent authority relative to the operations they oversee.
- Develop a **governance structure of the** bank **that is commensurate with the size and complexity** of the firm. Regarding the governance structure, the bank should consider:
  - *Committee structure*: for large, complex banks, a board-created firm level risk committee should oversee all risks. The management-level operational risk committee would report to the enterprise level risk committee.
  - *Committee composition*: committee members should have business experience, financial experience, and independent risk management experience. Independent, non-executive board members may also be included.
  - *Committee operation*: committees should meet frequently enough to be productive and effective. The committee should keep complete records of committee meetings.

With respect to Principle 6, the board of directors and/or senior management should:

- **Consider both internal and external factors** to identify and assess operational risk. Examples of tools that may be used to identify and assess risk are described in LO 38.5.

With respect to Principle 7, the board of directors and/or senior management should:

- **Maintain a rigorous approval process for new products and processes.** The bank should make sure that risk management operations are in place from the inception of new activities because operational risks typically increase when a bank engages in new activities, new product lines, enters unfamiliar markets, implements new business processes, puts into operation new technology, and/or engages in activities that are geographically distant from the main office.
- Thoroughly **review new activities and product lines**, reviewing inherent risks, potential changes in the bank's risk appetite or risk limits, necessary controls required to mitigate risks, residual risks, and the procedures used to monitor and manage operational risks.

With respect to Principle 8, the board of directors and/or senior management should:

- **Continuously improve the operational risk reporting.** Reports should be manageable in scope but comprehensive and accurate in nature.
- Ensure that **operational risk reports are timely**. Banks should have sufficient resources to produce reports during both stressed **and** normal market conditions. Reports should be provided to the board and senior management.
- Ensure that operational risk reports include:
  - Breaches of the bank's risk appetite and tolerance statement.
  - Breaches of the bank's thresholds and risk limits.
  - Details of recent operational risk events and/or losses.
  - External events that may impact the bank's operational risk capital.
  - Both internal and external factors that may affect operational risk.

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With respect to Principle 9, the board of directors and/or senior management should have a sound internal control system as described in LO 38.6 (an effective control environment) and LO 38.7 (managing technology and outsourcing risks).

Banks may need to transfer risk (e.g., via insurance contracts) if it cannot be adequately managed within the bank. However, sound risk management controls must be in place and thus **risk transfer should be seen as a complement to, rather than a replacement for, risk management controls.** New risks, such as counterparty risks, may be introduced when the bank transfers risk. These additional risks must also be identified and managed.

LO 38.8: Describe and outline business resiliency and continuity plans for banks under the Basel Committee framework.

With respect to Principle 10, the board of directors and/or senior management should:

- **Establish continuity plans** to handle unforeseen disruptive events (e.g., disruptions in technology, damaged facilities, pandemic illnesses that affect personnel, and so on). Plans should include impact analysis and plans for recovery. Continuity plans should identify key facilities, people, and processes necessary for the business to operate. The plan must also identify external dependencies such as utilities, vendors, and other third party providers.
- **Periodically review continuity** plans. Personnel must be trained to handle emergencies and, where possible, the bank should perform disaster recovery and continuity tests.

LO 38.9: Identify and discuss the role of a bank's public disclosures.

With respect to Principle 11, the board of directors and/or senior management should:

- Write public disclosures such that stakeholders can assess the bank's operational risk management strategies.
- **Write public disclosures that are consistent** with risk management procedures. The disclosure policy should be established by the board of directors and senior management and approved by the board of directors. The bank should also be able to verify disclosures.

Operational Risk Management Framework

LO 38.4: Describe the elements of a framework for operational risk management.

The operational risk management framework (i.e., the Framework) must define, describe, and classify operational risk and operational loss exposure. The Framework helps the board and managers understand the nature and complexities of operational risks inherent in the bank's products and services. The components of the Framework should be fully integrated into the bank's overall risk management plan. The Framework must be documented in the board of directors' approved policies.

Framework documentation, which is overseen by the board of directors and senior management, should:

- Describe reporting lines and accountabilities within the governance structure used to manage operational risks.

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- Describe risk assessment tools.
- Describe the bank's risk appetite and tolerance.
- Describe risk limits.
- Describe the approved risk mitigation strategies (and instruments).
- With respect to inherent and residual risk exposures, describe the bank's methods for establishing risk limits and monitoring risk limits.
- Establish risk reporting processes and management information systems.
- Establish a common language or taxonomy of operational risk terms to create consistency of risk identification and management.
- Establish a process for independent review of operational risk.
- Require review of established policies and procedures.

Tools for Identifying and Assessing Operational Risk

LO 38.5: Identify examples of tools which can be used to identify and assess operational risk.

Tools that may be used to identify and assess operational risk include:

- **Business process mappings**, which do exactly that, map the bank's business processes. Maps can reveal risks, interdependencies among risks, and weaknesses in risk management systems.
- **Risk and performance indicators** are measures that help managers understand the bank's risk exposure. There are *Key Risk Indicators* (KRIs) and *Key Perfor ance Indicators* (KPIs). KRIs are measures of drivers of risk and exposures to risk. KPIs provide insight into operational processes and weaknesses. Escalation triggers are often paired with KRIs and KPIs to warn when risk is approaching or exceeding risk thresholds.
- **Scenario analysis** is a subjective process where business line managers and risk managers identify potential risk events and then assess potential outcomes of those risks.
- **Measurement** involves the use of outputs of risk assessment tools as inputs for operational risk exposure models. The bank can then use the models to allocate economic capital to various business units based on return and risk.
- **Audit findings** identify weaknesses but may also provide insights into inherent operational risks.
- Analysis of **internal operational loss data**. Analysis can provide insight into the causes of large losses. Data may also reveal if problems are isolated or systemic.
- Analysis of **external operational loss data** including gross loss amounts, dates, amount of recoveries and losses at other firms.
- **Risk assessments**, or *risk self-assess ents* (RSAs), address potential threats. Assessments consider the bank's processes and possible defenses relative to the firm's threats and vulnerabilities. *Risk Control Self-Assessments* (RCSA) evaluate risks before risk controls are considered (i.e., inherent risks). Scorecards translate RCSA output into metrics that help the bank better understand the control environment.
- **Comparative analysis** combines all described risk analysis tools into a comprehensive picture of the bank's operational risk profile. For example, the bank might combine audit findings with internal operational loss data to better understand the weaknesses of the operational risk framework.

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Features of an Effective Control Environment

LO 38.6: Describe features of an effective control environment and identify specific controls which should be in place to address operational risk.

An effective control environment must include the following five components:

1. A control environment.
2. Risk assessment.
3. Control activities.
4. Information and communication.
5. Monitoring activities.

Senior managers should conduct top-level reviews of progress toward stated risk objectives, verify compliance of standards and controls, review instances of non-compliance, evaluate the approval system to ensure accountability, and track reports of exceptions to risk limits and management overrides and deviations from risk policies and controls. Managers should also ensure that duties are segregated and conflicts of interest are identified and minimized.

Specific controls that should be in place in the organization to address operational risk include:

- Clearly established lines of authority and approval processes for everything from new products to risk limits.
- Careful monitoring of risk thresholds and limits.
- Safeguards to limit access to and protect bank assets and records.
- An appropriately sized staff to manage risks.
- An appropriately trained staff to manage risks.
- A system to monitor returns and identify returns that are out of line with expectations (e.g., a product that is generating high returns but is supposed to be low risk may indicate that the performance is a result of a breach of internal controls).
- Confirmation and reconciliation of bank transactions and accounts.
- A vacation policy that requires officers and employees to be absent for a period not less than two consecutive weeks.

Managing Technology and Outsourcing Risk

LO 38.7: Describe the Basel committee's suggestions for managing technology risk and outsourcing risk.

Technology can be used to mitigate operational risks. For example, automated procedures are generally less prone to error than manual procedures. However, technology introduces its own risks. The Basel Committee recommends an integrated approach to identifying, measuring, monitoring, and managing technology risks.

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Technology risk management tools are similar to those suggested for operational risk management and include:

- Governance and oversight controls.
- Policies and procedures in place to identify and assess technology risks.
- Written risk appetite and tolerance statements.
- Implement a risk control environment.
- Establish risk transfer strategies to mitigate technology risks.
- Monitor technology risks and violations of thresholds and risk limits.
- Create a sound technology infrastructure (i.e., the hardware and software components, data and operating environments).

Outsourcing involves the use of third parties to perform activities or functions for the firm. Outsourcing may reduce costs, provide expertise, expand bank offerings, and/or improve bank services. The board of directors and senior management must understand the operational risks that are introduced as a result of outsourcing. Outsourcing policies should include:

- Processes and procedures for determining which activities can be outsourced and how the activities will be outsourced.
- Processes for selecting service providers (e.g., due diligence).
- Structuring the outsourcing agreement to describe termination rights, ownership of data, and confidentiality requirements.
- Monitor risks of the arrangement including the financial health of the service provider.
- Implement a risk control environment and assess the control environment at the service provider.
- Develop contingency plans.
- Clearly define responsibilities of the bank and the service provider.

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Key Concepts

LO 38.1

The Basel Committee on Banking Supervision defines operational risk as, "the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events."

The Basel Committee recognizes three common lines of defense used to control operational risks. These lines of defense are: (1) business line management, (2) independent operational risk management function, and (3) independent reviews of operational risks and risk management.

LO 38.2

The 11 fundamental principles of operational risk management suggested by the Basel Committee are:

1. The maintenance of a strong risk management culture led by the bank's board of directors and senior management.

2. The operational risk framework (i.e., the "Framework") must be developed and fully integrated in the overall risk management processes of the bank.

3. The board should approve and periodically review the Framework. The board should also oversee senior management to ensure that appropriate risk management decisions are implemented at all levels of the firm.

4. The board must identify the types and levels of operational risks the bank is willing to assume as well as approve risk appetite and risk tolerance statements.

5. Consistent with the bank's risk appetite and risk tolerance, senior management must develop a well-defined governance structure within the bank.

6. Operational risks must be identified and assessed by managers. Senior management must understand the risks, and the incentives related to those risks, inherent in the bank's business lines and processes.

7. New lines of business, products, processes, and systems should require an approval process that assesses the potential operational risks.

8. A process for monitoring operational risks and material exposures to losses should be put in place by senior management and supported by senior management, the board of directors, and business line employees.

9. Banks must put strong internal controls and risk mitigation and risk transfer strategies in place to manage operational risks.

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10. Banks must have plans in place to survive in the event of a major business disruption. Business operations must be resilient.

11. Banks should make disclosures that are clear enough that outside stakeholders can assess the bank's approach to operational risk management.

LO 38.3

The board of directors and senior management must be engaged with operational risk assessment related to all 11 of the fundamental principles of operational risk management.

LO 38.4

The operational risk management framework must define, describe, and classify operational risk and operational loss exposure. The Framework must be documented in the board of directors approved policies.

LO 38.5

There are several tools that may be used to identify and assess operational risk. The tools include business process mappings, risk and performance indicators, scenario analysis, using risk assessment outputs as inputs for operational risk exposure models, audit findings, analyzing internal and external operational loss data, risk assessments, and comparative analysis.

LO 38.6

An effective control environment should include the following five components: (1) a control environment, (2) risk assessment, (3) control activities, (4) information and communication, and (5) monitoring activities.

LO 38.7

Technology can be used to mitigate operational risks but it introduces its own risks. The Basel Committee recommends an integrated approach to identifying, measuring, monitoring, and managing technology risks. Technology risk management tools are similar to those suggested for operational risk management.

Outsourcing involves the use of third parties to perform activities or functions for the firm. Outsourcing may reduce costs, provide expertise, expand bank offerings, and/or improve bank services. The board of directors and senior management must understand the operational risks that are introduced as a result of outsourcing.

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LO 38.8

With respect to business resiliency and continuity plans for banks, the board of directors and/or senior management should: (1) establish continuity plans to handle unforeseen disruptive events and (2) periodically review continuity plans. Plans should include impact analysis and plans for recovery.

LO 38.9

With respect to the role of a bank's public disclosures, the board of directors and/or senior management should: (1) create disclosures that allow stakeholders to assess the bank's operational risk management strategies, and (2) create disclosures that are consistent with risk management procedures.

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Concept Checkers

1. Griffin Riehl is a risk manager at Bluegrass Bank and Trust, a small, independent commercial bank in Kentucky. Riehl has recently read the Basel Committee on Banking Supervision's recommendations for sound operational risk management and would like to put several controls in place. He would like to start with the three lines of defense suggested by the committee. Which of the following is not one of the three common "lines of defense" suggested by the Basel Committee for operational risk governance?
   A. Business line management.
   B. Board of directors and senior management risk training programs.
   C. Creating an independent operational risk management function in the bank.
   D. Conducting independent reviews of operational risks and risk management operations.

2. Garrett Bridgewater, a trader at a large commercial bank, has continued to increase his bonus each year by producing more and more profit for the bank. In order to increase profits, Bridgewater has been forced to increase the riskiness of his positions, despite the written risk appetite and tolerance statements provided to all employees of the bank. The bank seems happy with his performance so Bridgewater takes that as a sign of approval of his methods for improving profitability. Which of the following pairs of the 11 fundamental principles of risk management has the bank most clearly violated in this situation?
   A. Principle 1 (a strong risk management culture) and Principle 11 (the bank should make clear disclosures of operational risks to stakeholders).
   B. Principle 2 (develop an integrated approach to operational risk management) and Principle 7 (establish a rigorous approval process for new lines of business).
   C. Principle 3 (approve and review the operational risk framework) and Principle 4 (develop risk appetite and tolerance statements).
   D. Principle 5 (develop a well-defined governance structure) and Principle 6 (understand the risk and incentives related to risk inherent in the bank's business lines and processes).

3. Gary Hampton is providing descriptions of the operational risk management assessment tools, reporting lines, and accountabilities to the board of directors. Hampton is most likely working on:
   A. Framework documentation.
   B. A corporate operational risk function (CORF) handbook of operations.
   C. An outline of the fundamental principles of operational risk management.
   D. An open group operational framework diagram.

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4. George Mathis works in risk analysis and management at a large commercial bank. He uses several tools to identify and assess operational risk. He has asked several business line managers to identify some risk events that would disrupt business. Each manager has also provided their thoughts on what would happen given worst case operational failures. The risk assessment tool Mathis is most likely using in this case is(are):
   A. risk indicators.
   B. comparative analysis.
   C. scenario analysis.
   D. business process mappings.

5. A risk management officer at a small commercial bank is trying to institute strong operational risk controls, despite little support from the board of directors. The manager is considering several elements as potentially critical components of a strong control environment. Which of the following is not a required component of an effective risk control environment as suggested by the Basel Committee on Banking Supervision?
   A. Information and communication.
   B. Monitoring activities.
   C. A functionally independent corporate operational risk function.
   D. Risk assessment.

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Concept Checker Answers

1. B The three common "lines of defense" suggested by the Basel Committee on Banking Supervision and employed by firms to control operational risks are: (1) business line management, (2) an independent operational risk management function, and (3) independent reviews of operational risks and risk management.

2. D Based on the choices provided, the best match for the scenario is a violation of Principles 5 and 6. It is clear that the bank has not considered the incentives that are related to risk taking in the bank. Bridgewater has been given the risk appetite and tolerance statements but senior managers keep rewarding Bridgewater for high returns and seem to be ignoring the fact that they are the result of higher risks. Thus, there are incentives linked to increasing risk. The governance structure may or may not be well defined, but regardless, is not being adhered to.

3. A The operational risk management framework (i.e., the Framework) must define, describe, and classify operational risk and operational loss exposure. Hampton is likely working on Framework documentation. Framework documentation is overseen by the board of directors and senior management.

4. C Mathis is asking for managers to identify potential risk events, which he will use to assess potential outcomes of these risks. This is an example of scenario analysis. Scenario analysis is a subjective process where business line managers and risk managers identify potential risk events and then assess potential outcomes of those risks.

5. C A functionally independent corporate operational risk function is desirable in a bank but is not necessary for an effective control environment. This is especially true for a small bank, which might roll all risk management activities into one risk management group (i.e., not segregated by type of risk). An effective control environment should include the following five components: (1) a control environment, (2) risk assessment, (3) control activities, (4) information and communication, and (5) monitoring activities.

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

Enterprise Risk Management: Theory and Practice

Topic 39

Exam Focus

Enterprise risk management (ERM) is the process of managing all of a corporation's risks within an integrated framework. This topic describes how ERM can be implemented in a way that enables a company to manage its total risk-return tradeoff in order to better carry out its strategic plan, gain competitive advantage, and create shareholder value. Key issues include why it may be optimal to hedge diversifiable risk and how to differentiate between core risks the firm should retain and noncore risks the firm should layoff. Also discussed is the determination of the optimal amount of corporate risk and the importance of ensuring that managers at all levels take proper account of the risk-return tradeoff. For the exam, understand the framework for developing and implementing ERM.

LO 39.1: Define enterprise risk management (ERM).

A business can manage its risks separately, one at a time, or all together in a cohesive framework. **Enterprise risk management** (ERM) is the process of managing all of a corporation's risks within an integrated framework.

The benefit of ERM is that a comprehensive program for managing risk allows the business to achieve its ideal balance of risk and return.

Creating Value With ERM

LO 39.2: Explain how implementing ERM practices and policies can create shareholder value both at the macro and the micro level.

Macro Level

At the macro level, ERM allows management to optimize the firm's risk/return tradeoff. This optimization assures access to the capital needed to execute the firm's strategic plan.

The perfect markets view of finance implies that a company's cost of capital is unrelated to its diversifiable risk. Rather, the cost of capital is determined by the firm's **systematic risk** (also referred to as nondiversifiable, market, or beta risk). According to this view, efforts to hedge diversifiable risk provide no benefit to shareholders, who can eliminate this risk by diversifying their portfolios.

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However, reducing diversifiable risk can be beneficial when markets are imperfect. Suppose a firm experiences a large and unexpected drop in its operating cash flow and does not have funds sufficient to fund valuable investment opportunities. In perfect markets, the firm would be able to raise funds on fair terms to fund all of its value-creating projects. When markets are not perfect (i.e., investors' information about project values is incomplete), the firm may not be able to raise the needed funds on fair terms. This can lead to the "underinvestment problem," where the company passes up valuable strategic investments rather than raise equity on onerous terms. The inability to fund strategic investments on a timely basis can result in a permanent reduction in shareholder value, even if the cash shortfall is temporary. By hedging diversifiable risks, the company reduces the likelihood of facing the underinvestment problem. Thus, the primary function of corporate risk management is to protect the company's strategic plan by ensuring timely investment. The ability to carry out the strategic plan in a timely manner confers an advantage over competitors who are unable to do so.

Micro Level

In order for ERM to achieve the objective of optimizing the risk/return tradeoff, each project must be evaluated not only for the inherent risk of the project but also for the effect on the overall risk of the firm. Thus, ERM requires that managers throughout the firm be aware of the ERM program. This decentralization of evaluating the risk/return tradeoff has two components:

- Any managers evaluating new projects must consider the risks of the project in the context of how the project will affect the firm's total risk.
- Business units must be evaluated on how each unit contributes to the total risk of the firm. This gives the individual managers an incentive to monitor the effect of individual projects on overall firm risk.

There are three reasons why decentralizing the risk-return tradeoff in a company is important:

1. *Transformation of the risk management culture:* A consistent, systematic assessment of risks by all business units ensures that managers consider the impact of all important risks.

2. *Every risk is owned:* Because performance evaluations are based on risk, managers have an incentive to consider important risks in their decision making.

3. *Risk assessment by those closest to the risk:* Managers in the individual business units have the knowledge and expertise needed to assess and manage the risks of the business unit.

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Development and Implementation

LO 39.3: Explain how a company can determine its optimal amount of risk through the use of credit rating targets.

LO 39.4: Describe the development and implementation of an ERM system.

In developing an ERM, management should follow this framework:

- Determine the firm's acceptable level of risk. The critical component of this determination is selecting the probability of financial distress that maximizes the value of the firm. Financial distress in this context means any time the firm must forego projects with positive net present values, due to inadequate resources. The likelihood of financial distress could be minimized by investing all funds into U.S. Treasury securities, but this should not be the firm's objective. The objective should be maximizing firm value by selecting an appropriate probability of distress. For many firms, the proxy used for measuring the probability of distress is the firm's credit rating assigned by external agencies. Thus, the firm may determine that the objective under ERM is to avoid a minimum credit rating below BBB. If the firm is currently rated AA, for example, the likelihood of falling below BBB can be estimated by average data supplied by the rating agency.
- Based on the firm's target debt rating, estimate the capital (i.e., buffer) required to support the current level of risk in the firm's operations. In other words, how much capital does the firm need to have (on hand or available externally) to ensure that it can avoid financial distress. A company with liquid assets sufficient to fund all of its positive NPV projects would not be exposed to the underinvestment problem when it encountered cash flow deficits. Thus, risk management can be viewed as a substitute for investing equity capital in liquid assets. Keeping a large amount of equity in the form of liquid assets is costly. Instead of maintaining a large liquid asset buffer, a company can institute a risk management program to ensure (at some level of statistical significance) that its operating cash flow will not fall below the level needed to fund valuable projects. That is, the firm can take actions to limit the probability of financial distress to a level that maximizes firm value. The goal of ERM is to optimize (not eliminate) total risk by trading off the expected returns from taking risks with the expected costs of financial distress.
- Determine the ideal mix of capital and risk that will achieve the appropriate debt rating. At this level of capital, the firm will be indifferent between increasing capital and decreasing risk.
- Decentralize the risk/capital tradeoff by giving individual managers the information and the incentive they need to make decisions appropriate to maintain the risk/capital tradeoff.

The implementation steps of ERM are as follows:

Step 1: Identify the risks of the firm. For many banks, risks are classified as falling into one of three categories: market, credit, or operational. Other financial institutions broaden the list to include asset, liability, liquidity, and strategic risks. Identification of risks should be performed both top-down (by senior management) and bottom-up (by individual managers of business units or other functional areas).

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Step 2: Develop a consistent method to evaluate the firm's exposure to the risks identified above. If the methodology is not consistent, the ERM system will fail because capital will be mis-allocated across business units.

Economic Value vs. Accounting Value

Credit ratings are typically based on accounting data, combined with some level of subjective assessment by analysts. Economic value, as determined by management, may very well be a more accurate reflection of the true value of the firm.

In determining whether accounting value or economic value is more relevant, the firm must consider its objective. If the objective is to manage the probability of default, the question of how default is determined becomes important. If default is determined by failure to meet certain accounting measures (e.g., debt ratio, interest coverage), then accounting measures will be a critical component of meeting the objectives.

If the objective is to manage the present value of future cash flows, then economic measures may be more appropriate than accounting measurements that do not accurately capture economic reality. Management must consider that managing economic value may lead to more volatile accounting earnings, which may ultimately affect economic value as well.

Risk Aggregation

LO 39.5: Describe the role of and issues with correlation in risk aggregation, and describe typical properties of a firm's market risk, credit risk, and operational risk distributions.

Firms that use value at risk (VaR) to assess potential loss amounts will ultimately have three different VaR measures to manage. Market risk, credit risk, and operational risk will each produce their own VaR measures. The trick to accurately measuring and managing firm-wide risk, and in turn **firm-wide VaR**, is to understand how these VaR measures interact. Market risks will typically follow a normal distribution; however, the distributions for credit risks and operational risks are usually asymmetric in shape, due to the fat-tail nature of these risks.

Due to diversification effects of aggregating market, credit, and operational risk, firm-wide VaR will be less than the sum of the VaRs from each risk category. This suggests that the correlation among risks is some value less than one. It can be difficult to determine this correlation amount, so firms typically use average correlation values within their respective industry. However, firms should recognize that correlations can be influenced by firm-specific actions as well as external events such as a financial crisis.

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Capital Allocation

LO 39.6: Distinguish between regulatory and economic capital, and explain the use of economic capital in the corporate decision making process.

Regulatory capital requirements may differ significantly from the capital required to achieve or maintain a given credit rating (**economic capital**). If regulatory requirements are less than economic capital requirements, then the firm will meet the regulatory requirements as part of its ERM objectives, and there will be no effect on the firm's activities.

However, if regulatory capital requirements are greater than economic capital requirements, then the firm will have excess capital on hand. If competitors are subject to the same requirements, this excess capital will amount to a regulatory tax. If competing firms are not subject to the excess capital requirement, they will have a competitive advantage.

Because regulatory capital requirements are typically based on accounting capital, rather than economic capital, a firm with economic values in excess of accounting values may be penalized, and may have to maintain higher amounts in liquid assets to cover the shortfall.

The economic capital of the firm must be put to productive use. If a firm accumulates excess economic capital that is not employed productively, investors will reduce the value of the firm. This reduction will be consistent with the failure of existing management to earn the cost of capital on the excess amount.

As a firm takes on new projects, the probability of financial distress increases. One way to offset this increased risk is to raise enough additional capital to bring the risk of financial distress back to the level that existed prior to the new project.

For example, assume that a firm has a value at risk (VaR) measure of $1 billion. As a result of a new expansion project, assume the VaR figure increases to $1.1 billion. In order to offset the risk of the new project, the firm would need to do the following:

1. Raise additional capital of $100 million.

2. Invest this additional capital without increasing the overall risk of the firm.

If the cost of the additional capital is 6%, and the new project is expected to last one year, then the new project would need to generate an additional $6 million to maintain the economic capital of the firm. Looked at another way, the expected benefit of the new project should be reduced by $6 million to compensate for the incremental risk to the firm.

These decisions regarding how the risk of new projects will affect the total risk of the firm are further complicated by the correlations of the expected returns of the projects. If two new projects are less than perfectly correlated, the incremental increase in total risk will be less. One way to account for any possible diversification benefits is to reduce the cost of capital of projects that are expected to have lower correlations with existing operations.

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Risks to Retain and Risks to Layoff

Many risks can be hedged inexpensively with derivatives contracts. Examples include exposures to changes in exchange rates, interest rates, and commodities prices. Rather than face the risk that unexpected cash shortfalls due to these exposures might negatively affect the ability of the firm to carry out its strategic plan, the firm should hedge these exposures.

Other risks cannot be inexpensively hedged. These are risks where the firm's management either has an informational advantage over outsiders or the ability to manage the outcome of the risk-taking activity. A counterparty to a transaction that hedges such risks would require very high compensation to be willing to take on the transferred risks. The firm's business risks fall into this category.

The guiding principle in deciding whether to retain or layoff risks is the **comparative advantage** in risk bearing. A company has a comparative advantage in bearing its strategic and business risks, because it knows more about these risks than outsiders do. Because of this informational advantage, the firm cannot transfer these risks cost effectively. Moreover, the firm is in the business of managing these "core" risks. On the other hand, the firm has no comparative advantage in forecasting market variables such as exchange rates, interest rates, or commodities prices. These "noncore" risks can be laid off. By reducing noncore exposures, the firm reduces the likelihood of disruptions to its ability to fund strategic investments and increases its ability to take on business risks.

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Key Concepts

LO 39.1

Enterprise risk management (ERM) is the process of managing all a corporation's risks within an integrated framework.

LO 39.2

The macro benefit of ERM is that hedging corporate diversifiable risk improves management's ability to invest in value-creating projects in a timely manner and improves the firm's ability to carry out the strategic plan.

The micro benefit of ERM requires decentralizing risk management to ensure that each project's total risk is adequately assessed by project planners during the initial evaluation of the project. The two main components of decentralizing the risk-return tradeoff are consideration of the marginal impact of each project on the firm's total risk and a performance evaluation system that considers unit contributions to total risk.

LO 39.3

The goal of risk management is to optimize (not eliminate) total risk by trading off the expected returns from taking risks with the expected costs of financial distress. Financial distress in this case is defined as circumstances where the firm is forced to forego positive NPV projects.

LO 39.4

The conceptual framework of ERM is a four-step process:

- Determine the firm's risk appetite.
- Estimate the amount of capital needed to support the desired level of risk.
- Determine the optimal combination of capital and risk that achieves the target credit rating.
- Decentralize the management of risk.

LO 39.5

Due to diversification effects of aggregating market, credit, and operational risk, firm-wide VaR will be less than the sum of the VaRs from each risk category. This suggests that the correlation among risks is some value less than one.

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LO 39.6

Regulatory capital requirements may differ significantly from the capital required to achieve or maintain a given credit rating (economic capital).

Because regulatory capital requirements are typically based on accounting capital, rather than economic capital, a firm with economic values in excess of accounting values may be penalized, and may have to maintain higher amounts in liquid assets to cover the shortfall.

The economic capital of the firm must be put to productive use. If a firm accumulates excess economic capital that is not employed productively, investors will reduce the value of the firm.

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Concept Checkers

1. Reducing diversifiable risk creates value:
   A. only when markets are perfect.
   B. because it is costly for shareholders to eliminate diversifiable risk through their own actions.
   C. because reducing diversifiable risk mitigates the underinvestment problem that can occur when investors have imperfect information about the firm's projects.
   D. only when it results in a permanent reduction in cash flow.

2. Effective enterprise risk management includes all of the following except:
   A. centralized evaluation of every project's risk.
   B. a project is only accepted if its return is adequate after considering the cost of the project's contribution to total firm risk.
   C. the project's planners perform the initial evaluation of project risk.
   D. periodic evaluations of the performance of business units consider each unit's contribution to total risk.

3. The goal of enterprise risk management (ERM) can best be described as maximizing firm value by:
   A. eliminating the total risk of the firm.
   B. minimizing the total risk of the firm.
   C. optimizing the total risk of the firm.
   D. eliminating the probability of financial distress.

4. In determining the relative importance of economic value compared to accounting performance in its enterprise risk management program, a firm should:
   A. rely on accounting performance because it will be more accurate.
   B. rely on economic value because it will be more accurate.
   C. base its decision on the input of project-level managers.
   D. base its decision on the objective of the ERM program.

5. Which risk is least likely to be beneficial for a company to layoff?
   A. Currency exchange rate risk.
   B. Business risk.
   C. Commodities price risk.
   D. Interest rate risk.

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Concept Checker Answers

1. C When markets are not perfect (i.e., investors' information about project values is incomplete), the firm may not be able to raise funds on fair terms. For a firm faced with an unexpected drop in operating cash flow, this can lead to the underinvestment problem, where the company passes up valuable strategic investments rather than raise equity on onerous terms. The inability to fund strategic investments can result in a permanent reduction in shareholder value even if the cash shortfall is temporary. Hedging diversifiable risk mitigates the underinvestment problem and creates value, even though shareholders can eliminate diversifiable risk at low cost by diversifying their portfolios.

2. A Central to ERM is the idea that a *decentralized* approach to the evaluation of project risks focuses managers throughout the firm on the importance of properly considering the risk and return implications of projects.

3. C The goal of ERM is to optimize the total risk of the firm. Eliminating total risk is not possible. Minimizing total risk would preclude accepting risky projects that would allow the firm to expand and maximize value. These risky projects will increase the probability of financial distress. The goal of ERM is to optimize the risk of distress relative to the potential returns from the risky projects.

4. D There are certain situations where either accounting values or economic values will more accurately reflect the firm's situation. The determining factor in choosing between economic values and accounting values is the objective of the program. For example, if the objective is maintaining a rating, based in large part on accounting numbers, then accounting numbers will assume more relative importance.

5. B A company has a comparative advantage in bearing its strategic and business risks because it knows more about these risks than outsiders do. The firm is in the business of managing these "core" risks. The firm has no comparative advantage in forecasting market variables such as exchange rates, interest rates, or commodities prices. These "noncore" risks can be laid off.

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

Observations on Developments in Risk Appetite Frameworks and IT Infrastructure

Topic 40

Exam Focus

This topic discusses the concept of a risk appetite framework (RAF). For the exam, understand the elements and benefits of an RAF, and be familiar with best practices for an effective RAF. Also, be able to identify metrics that can be monitored as part of an effective RAF. Finally, understand the elements and benefits of a robust risk data infrastructure as well as best practices relating to data aggregation.

Risk Appetite Framework

LO 40.1: Describe the concept of a risk appetite framework (RAF), identify the elements of an RAF and explain the benefits to a firm of having a well-developed RAF.

A **risk appetite framework** (RAF) is a strategic decision-making tool that represents the firm's core risk strategy. It sets in place a clear, future-oriented perspective of the firm's target risk profile in a number of different scenarios and maps out a strategy for achieving that risk profile. It also specifies which types of risk the firm is willing to take and under what conditions as well as which types of risk the firm is unwilling to take.

An RAF should start with a risk appetite statement that is essentially a mission statement from a risk perspective. This statement should cover some or all of the following elements:

- Desired business mix and balance sheet composition (i.e., capital structure—trade-off between debt and equity).
- Risk preferences (i.e., how much credit or market risk to take on or hedge)
- Acceptable trade-off between risk and reward.
- Acceptable limits for volatility (based on standard deviation).
- Capital thresholds (i.e., regulatory and economic capital).
- Tolerances for post-stress losses.
- Target credit ratings.
- Optimum liquidity ratios.

The benefits of a well-developed RAF are as follows:

- It improves a firm's strategic planning and tactical decision-making.
- The inherent flexibility allows firms to adapt to market changes, especially if appropriate opportunities arise that require adjustments to the RAF.

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- It assists firms in preparing for the unexpected; requires business line strategy reviews and maintains an open dialogue regarding the management of unexpected economic or market events in particular geographies or products.
- It focuses on the future and sets expectations regarding the firm's consolidated risk profile after performing relevant stress tests and scenario analyses. Thus, it helps the firm set up a plan for risk taking, loss mitigation, and use of contingency measures.

Developing and Implementing an Effective RAF

LO 40.2: Describe best practices for a firm's Chief Risk Officer (CRO), Chief Executive Officer (CEO), and Board of Directors in the development and implementation of an effective RAF.

Chief Risk Officer (CRO) Best Practices

Board members involved with risk issues should be able to directly contact the CRO and engage in frequent communication about on-going key risk issues. A best practice could be to create a board risk committee that is directly involved in performance review and compensation decisions regarding the CRO. A strong alliance between the CRO (risk management function) and the CFO (budgetary considerations) is key to spreading the use of the RAF throughout the organization. Specifically, a best practice would be for the CRO and CFO to report to the board at every meeting by commenting on the firm's risk profile in comparison to the RAF. The CRO discussion could be broad and strategic in nature, and the CFO discussion could discuss financial impacts.

Chief Executive Officer (CEO) Best Practices

The CEO should strongly support the RAF and refer/use it to support challenging risk and strategic decisions. The willingness of the CEO to give the CRO the final word on many risk decisions is a best practice since it strengthens the importance of the risk management function. Where any instances of non-compliance with the RAF exist, a best practice would be for the CRO and/or the CEO to advise the board of directors on the corrective measures that will be undertaken.

Board of Directors (Board) Best Practices

The board needs to spend a considerable amount of time conveying the firm's risk appetite statement throughout the firm to ensure it is properly implemented. In challenging management to operate the firm in a way that is congruent with the RAF, the board must focus on strategic and forward-looking issues rather than dwelling on past actions. A best practice would be for the board to state its expectations to management in advance so that management can establish appropriate strategic plans.

When a board challenges management and requires a thorough vetting of the RAF, the end product is more complete and relevant. A best practice is to have the active involvement of the board with senior management in continually revising the RAF until everyone

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is satisfied. Additionally, another best practice is the development of a concrete way of assessing when the RAF needs to be amended to reflect a changing environment.

With regard to technical knowledge of members, there should be a sufficient balance in board composition to ensure all members have a reasonable and congruent understanding of the firm's risks and to avoid situations where there are marked divisions between "experts" and "non-experts." A best practice is to provide detailed technical training to board members on relevant concepts. Additionally, requiring cross-membership amongst the major committees helps ensure that those functions have members with a strong technical base. The training and cross-membership practices should serve as supplements to existing expertise.

Boards must be proactive in stating the nature and frequency of the information they need. As a best practice, reporting to the board should be thorough and broad in scope and not overly simplified. Additionally, communication from management should include a business aspect and not be focused on just technical aspects. Finally, as another best practice, the board should be willing to push back to management if they feel the information provided is not sufficient for their needs.

Reputation risk needs to have a significant amount of the board's attention. As a best practice, the board should set up a reputational risk committee to analyze marketplace changes and approve transactions on the basis of geography or product line. Attempting qualitative measures of reputation risk should also be done via monitoring industry headlines and reporting trends to the board as well as hiring external parties to conduct relevant surveys.

Using RAF to Manage Business Lines

LO 40.3: Explain the role of a RAF in managing the risk of individual business lines within a firm.

Generally speaking, the RAF helps to ensure that each business line's strategies are congruent with the firm's desired risk profile. The various business line managers each submit a medium-term business plan to senior management and/or the board to determine if it is consistent with the RAF. Such determinations are often made with stress tests or scenario analyses. Afterward, the RAF will set the risk limits allocated to each business line based on its desired risk profile.

Additionally, the RAF considers the integrated nature of the business lines within the firm. For example, the RAF can help determine how much a given business line's medium-term business plans has to be amended in order to allow another business line's proposal to be approved. In other words, there may be some borrowing of the risk appetite allotment from a business line in order to take advantage of the current opportunity in another business line. Familiarity with the RAF by business line managers would dramatically decrease the number of plans that fall well outside acceptable bounds. A clear RAF assists the firm in preventing risk appetite drift when economic conditions change.

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Effective RAF Metrics

LO 40.4: Describe the classes of risk metrics to be communicated to managers within the firm.

Examples of metrics that can be monitored as part of an effective RAF are as follows:

- Capital targets (economic capital, tangible common equity, total leverage) or capital-at-risk amounts.
- Liquidity ratios, terms, and survival horizons.
- Net interest income volatility or earnings-at-risk calculations.
- Value at risk (VaR) limits.
- Risk sensitivity limits.
- Risk concentrations by internal and/or external credit ratings.
- Expected loss ratios.
- The firm's own credit spreads.
- Asset growth ceilings by business line or exposure type.
- Performance of internal audit ratings.
- Economic value added.
- Post-stress-test targets for capital, liquidity, and earnings.

It is important to ensure that the metrics used to monitor risk are appropriate to the users of the information. Therefore, the risk metrics should be divided into classes, depending on who is receiving the information within the firm. For example:

- Directors should receive high-level metrics (less detail) that reflect the firm's key risks.
- CEO, CFO, CRO should receive more detailed metrics than directors.
- Business line leaders should receive very detailed metrics, especially in relation to their respective business lines.

Risk Data Infrastructure

LO 40.5: Explain the benefits to a firm from having a robust risk data infrastructure, and describe key elements of an effective IT risk management policy at a firm.

A benefit of a robust risk data infrastructure is the ability to aggregate timely and accurate data to report on credit, market, liquidity, and operational risks. This, in turn, allows management to make proper decisions regarding the firm's strategy, risk appetite, and risk management during periods of constant and frequent changes. Another benefit is the ability to sufficiently document and convey the firm's risk reporting requirements. Such requirements include: specific metrics, data accuracy expectations, element definitions, time frames, supervisory expectations, and regulatory reporting requirements.

Key elements of an effective IT risk management policy at a firm are described as follows:

- Clearly defined standards and internal risk reporting requirements to ensure a proper IT infrastructure and internal reporting.
- Sufficient funding is provided to develop IT systems for the purpose of internal risk reporting; they compete equally with proposals that are revenue generating, for example.

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- Assessing IT infrastructure and capacity prior to approving new products.
- Post-implementation reviews of IT systems performed anywhere from 6–18 months afterward as a check that the systems meet the risk personnel's needs.
- The level of governance for outsourced IT activities is the same as if they were done in-house. There are no impediments to implementation or access to data due to outsourcing.
- The existence of effective project management offices (PMOs) to ensure that timelines and deliverables are met. Specifically, one person is in charge of the PMO, which seems to result in stronger coordination and communication between project staff.
- There is a data administrator as well as a data owner, and the data owner must ensure a sufficiently high level of data accuracy, integrity, and availability. This helps to ensure that IT projects are meeting the users' needs.
- The board is able to implement relevant internal audit programs to allow for periodic reviews of data maintenance processes and functions. The monitoring could be continuous or specific to a product or business line. This would allow for the quick correction of any weaknesses detected by internal audit.

Poor or Fragmented IT Infrastructure

LO 40.6: Describe factors which could lead to poor or fragmented IT infrastructure at an organization.

There are five major factors to consider with regard to poor or fragmented IT infrastructures.

1. *No common understanding of long-term business strategy between business lines and IT management.* This factor often results due to internal competition for funding, thereby not permitting important IT infrastructure projects to be completed.

2. *Management only makes decisions based on short-term profits.* As a result of this factor, many IT infrastructure projects are scaled back, delayed, or eliminated.

3. *Significant turnover in important IT roles within the firm.* This factor has resulted in delays in completing IT projects.

4. *Insufficient data governance and insufficient data management plan within the firm.* This factor results in inconsistency across business lines in how to upgrade systems; this is costly if the systems end up being incompatible because of the inconsistencies.

5. *Merger and acquisition activities.* This factor results in multiple systems running simultaneously within the recently merged firm. Data aggregation across products and business lines becomes a significant challenge.

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Data Aggregation Best Practices

LO 40.7: Calculate the financing advantage of a bond trading special when used in a repo transaction.

The existence of several IT systems being operated simultaneously within a firm results in a lack of integrated IT systems. This, in turn, requires a significant amount of manual data entry to allow for proper aggregation of risk data. Best practices related to data aggregation at an organization are explained as follows:

- To increase efficiency and accuracy, minimize the amount of manual intervention and manual data manipulation (i.e., spreadsheets) by automating the risk data aggregation process.
- Aggregated risk data needs to be accurate, timely, and comprehensive in order to have value. Therefore, there must be standards, cutoff times, and timelines regarding the production of internal risk reports.
- Single platform centralized databases with single identifiers and/or consistent naming conventions could allow for the timely retrieval of multiple records of risk data across the firm. They also permit data segmentation when required to produce specific data (i.e., risk concentrations).
- Create data warehouses that will take information from various subsystems and store them in a warehouse. The data is then filtered and reorganized so that customized reports can be created using specific data from the warehouse.
- Automated reconciliation will reduce the risk of manual errors and incomplete information. For example, off-balance sheet data should not be omitted.
- Periodic reconciliation of risk and financial data will ensure the accuracy and proper operation of the IT system.
- For merger and acquisition transactions, ensuring that legacy IT systems are integrated into the chosen IT system as soon as possible.
- When obtaining approvals for new IT purchases, involve the appropriate technical staff to ensure that the existing systems can process and aggregate data from these new items.

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Key Concepts

LO 40.1

A risk appetite framework (RAF) sets in place a clear, future-oriented perspective of the firm's target risk profile in a number of different scenarios and maps out a strategy for achieving that risk profile. An RAF should start with a risk appetite statement that is essentially a mission statement from a risk perspective. Benefits of a well-developed RAF include assisting firms in preparing for the unexpected and greatly improving a firm's strategic planning and tactical decision-making.

LO 40.2

The chief risk officer (CRO) should be easily available to the board of directors (board) and there should be a strong alliance between the CRO and the chief financial officer (CFO).

The chief executive officer (CEO) should strongly support the RAF and give the CRO the final word on risk decisions.

The board should: be willing to challenge management to operate the firm consistent with the RAF, actively work with senior management to continually revise the RAF, have sufficient technical and business understanding of the risks facing the firm, be proactive in stating the nature and frequency of the information they need, and set up a reputational risk committee.

LO 40.3

The RAF helps to ensure that each business line's strategies are congruent with the firm's desired risk profile. It also considers the integrated nature of the business lines within the firm.

LO 40.4

Many metrics can be monitored as part of an effective RAF. Risk metrics should be divided into classes, depending on who is receiving the information within the firm.

LO 40.5

A robust data infrastructure results in management being able to make proper decisions regarding a firm's strategy, risk appetite, and risk management. Additionally, it allows for the ability to sufficiently document and convey the firm's risk reporting requirements.

Key elements of an effective IT risk management policy include: clearly defined standards and internal risk reporting requirements, sufficient funding to develop IT systems, assessing IT infrastructure and capacity prior to approving new products, timely post-implementation reviews of IT systems, and sufficient governance for outsourced IT activities.

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LO 40.6

Poor or fragmented IT infrastructures result from a lack of common understanding of long-term business strategies between business lines and IT management, managers thinking only about short-term profits, significant turnover in IT roles, insufficient data governance, and merger and acquisition activities.

LO 40.7

The lack of integrated IT systems is the major challenge related to data aggregations. Many best practices regarding data aggregations exist including: minimizing the amount of manual data processes, using single platform centralized databases, creating data warehouses, automated and periodic data reconciliations, and timely integration of legacy IT systems.

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Concept Checkers

1. Which of the following statements regarding the risk appetite framework (RAF) is correct?
   A. The RAF represents the firm's core risk strategy.
   B. The RAF should be amended to take advantage of all profitable opportunities.
   C. The RAF focuses on which risks the firm is willing to take and under what conditions.
   D. The RAF begins with the risk appetite statement that contains many elements, including examining the composition of the income statement.

2. As a best practice, which of the following members of senior management should have the final word on significant risk decisions at a firm?
   A. Chief executive officer.
   B. Chief financial officer.
   C. Chief operating officer.
   D. Chief risk officer.

3. Which of the following statements regarding the role of a risk appetite framework (RAF) in managing the risk of individual business lines within a firm is correct?
   A. Individual business lines may collectively cause the firm's RAF to drift when market conditions change.
   B. Sensitivity analysis is a robust tool to assist senior management and/or the board to determine consistency with the RAF.
   C. Each individual business line's risk appetite allotment according to the RAF is independent of the others to ensure objectivity in the process.
   D. The business line managers submit long-term business plans to senior management and/or the board to determine if they are consistent with the RAF.

4. Which of the following statements is incorrect regarding the key elements of an effective IT risk management policy?
   A. Having a single person in charge of the project management office.
   B. Comparable funding for IT projects and revenue-generating projects.
   C. Post-implementation reviews of IT systems at least 24 months after implementation.
   D. Outsourced and in-house IT activities being subjected to the same level of monitoring.

5. Which of the following items is a best practice related to data aggregation at an organization?
   A. Integrating legacy IT systems into the new IT system immediately.
   B. The use of one master spreadsheet to accumulate all of the data in one place.
   C. Periodic manual reconciliations to reduce the risk of errors and incomplete information.
   D. Allowing individual departments as much time as they require to produce internal reports that are accurate, timely, and comprehensive.

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Concept Checker Answers

1. A The RAF represents the firm's core risk strategy. The RAF does not necessarily need to be amended every time there is a profitable opportunity; doing so would cause the RAF to lose its value. The RAF also focuses on which risks the firm is unwilling to take. The risk appetite statement would not likely include an examination of the composition of the income statement; it would more likely be the balance sheet (i.e., debt, equity).

2. D The willingness of the CEO to give the CRO the final word on many risk decisions is a best practice, which has strengthened the importance of the risk management function.

3. A Individual business lines may collectively cause the firm's RAF to drift when market conditions change. Sensitivity analysis only examines one change in a variable at a time. More robust tools would be stress tests and scenario analyses, for example. Each business line's risk appetite allotment according to the RAF may be amended if another business line encounters an opportunity that requires more capital. The business line managers submit medium-term business plans to senior management and/or the board.

4. C Post-implementation reviews should be performed 6–18 months after implementation; 24 months or more would likely be too long. Having one person in charge of the project management office seems to have resulted in stronger coordination and communication between project staff.

5. A For merger and acquisition transactions, it is best that legacy IT systems are integrated into the chosen IT system as soon as possible. Spreadsheets are a form of manual data manipulation and, because they are not automated, they would not be a best practice. Automated reconciliations should be performed, not manual. One of the key points about internal risk reports is that they should be produced on a timely basis, therefore, there must be standards, cutoff times, and timelines regarding their production.

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

OpRisk Data and Governance

Topic 41

Exam Focus

This topic discusses the seven level 1 categories of operational risk (OpRisk) events defined in Basel II and describes level 2 examples of operational risk events for each category. For the exam, understand how the collection and reporting of loss data, the risk control self assessment (RCSA), identification of key risk indicators (KRIs), and scenario analysis are all important elements of a firm's OpRisk process. Also, be familiar with the OpRisk profiles across various financial sectors with emphases on the highest frequency percentages and severity percentages. Finally, be prepared to describe the typical progression through four organizational risk designs for large firms.

Event-Driven Risk Categories

LO 41.1: Describe the seven Basel II event risk categories and identify examples of operational risk events in each category.

Basel II provides seven categories of level 1 **loss events** that most firms have adopted to meet their own operational risk (OpRisk) framework requirements. OpRisk models are concerned with identifying and mitigating operational risks of the firm that are a function of people, systems, and external events. The seven Basel II event risk categories are described in Figure 1 and are intended to capture all potential operational risks. Every loss event should be mapped to the risk event categories outlined in the firm's operational risk management policies and procedures. However, some loss events may fall under more than one category.

It is important to recognize that the severity and frequency of losses can vary dramatically among the categories. For example, loss events are small but occur very frequently in the *Execution, Delivery, and Process Management* category. Whereas, losses are much less frequent but typically have a large dollar amount in the *Clients, Products, and Business Practices* category as these loss events commonly arise from substantial litigation suits.

The modeling of loss event data differs for each category. Thus, it is important to make sure every event is placed in the appropriate group. When assigning loss events, consistency is more important than accuracy. Effective operational risk management requires that similar events are consistently categorized the same way. If mistakes are made classifying risks in past years it will impact the risk management control process and reporting to regulators. In order to properly classify risks, it is important for the firm to perform a comprehensive risk mapping exercise that details every major process of the firm. The process of identifying and classifying risks is commonly referred to as **OpRisk taxonomy**.

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Figure 1: Level 1 Categories of Operational Risk Events

Event Category	*Definition*
Execution, Delivery, and Process Management	Losses from failed transaction processing or process management from relations with trade counterparties and vendors.
Clients, Products, and Business Practices	Losses arising from unintentional or negligent failures to meet a professional obligation to specific clients (including fiduciary and suitability requirements) or from the nature or design of a product.
Business Disruption and System Failures	Losses arising from disruption of business or system failures.
Internal Fraud	Losses due to acts intended to defraud, misappropriate property, or circumvent regulations, the law, or company policy.
External Fraud	Losses due to acts intended to defraud, misappropriate property, or circumvent the law, by a third party.
Employment Practices and Workplace Safety	Losses arising from acts inconsistent with employment, health, or safety laws or agreements, from payment of personal injury claims, or from diversity/discrimination events.
Damage to Physical Assets	Losses arising from loss or damage to physical assets from natural disaster or other events such as vandalism or terrorism.

Source: Basel Committee on Banking Supervision, Annex 9, *Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework, 2006.*

Each of these seven level 1 categories identified in Figure 1 is then further broken down into a level 2 subcategory. As mentioned previously, the first two event types in Figure 1 have a higher frequency and severity of losses. Thus, it should not be surprising that there are more level 2 subcategories for these two event types. The level 2 categories help to further classify the type of loss event. Figure 2 identifies the six level 2 categories for the event type identified in level 1 as *Execution, Delivery, and Process Management (EDPM).*

For financial firms, the EDPM category typically has the highest frequency of occurrence compared to the other categories. Business units in financial firms often deal with large numbers and executions of transactions. Due to the large volume of transactions on a daily basis, miscommunications and data-entry errors are common. For example, in the futures market, FX transactions are typically very large in order to compensate for the low margins of this product line. Errors in finalizing a transaction even for a few days can result in large losses as counterparties will require compensation for the use of funds. Identifying where the errors occur and the number of occurrences is necessary for managing these OpRisks.

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Figure 2: Execution, Delivery, and Process Management (Level 1)

Level 2 Event Category	*Examples*
Transaction Capture, Execution, & Maintenance	Data entry, miscommunication, delivery failure, and accounting errors
Monitoring & Reporting	Mandatory reporting failure, inaccurate external report of loss incurred
Customer Intake & Documentation	Missing client permissions, incomplete documents
Customer/Client Account Management	Unapproved access, incorrect client records with loss incurred, negligent loss
Trade Counterparties	Non-client counterparty misperformance or disputes
Vendors & Suppliers	Outsourcing or vendor disputes

Source: Basel Committee on Banking Supervision, Annex 9, *Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework, 2006.*

The second Basel II category listed in Figure 1 is *Clients, Products, and Business Practices (CPBP).* The most common type of loss events in this category arise from disagreements between clients and counterparties, as well as regulatory fines for negligent business practices and advisory fiduciary duties. Litigation cases are high in the United States and the severity of losses is very high even though the frequency of loss events is typically less than the EDPM category. Figure 3 provides the level 2 subcategories with examples for the CPBP category.

Figure 3: Clients, Products, and Business Practices (Level 1)

Level 2 Event Category	*Examples*
Suitability, Disclosure, & Fiduciary	Fiduciary violations, disclosure issues, privacy violation, account churning
Improper Business or Market Practices	Antitrust, improper trade or market practices, insider trading, market manipulation
Product Flaws	Product defects, model errors
Selection, Sponsorship, & Exposure	Client guidelines failure or excess client limits
Advisory Activities	Advisory performance disputes

Source: Basel Committee on Banking Supervision, Annex 9, *Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework, 2006.*

The *Business Disruption and System Failures (BDSF)* category is far less common than the first two Basel II categories. A system crash will result in substantial losses for a firm, but most of these losses would be categorized under the EDPM category. The following example illustrates a type of BDSF loss. Suppose a bank's funding system crashes early in the day and is not back online until after the money markets are already closed after 4:00 p.m. EST. Due to this system crash, the bank needs to fund an extra $30 billion for the day's activities. To do so, the bank must make special arrangements with counterparties at a much higher cost than the daily average funding cost. Basel II defines failed activity examples leading to loss events in the BDSF category as hardware, software, telecommunications, and utility outage.

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The Basel II level 1 *External Fraud* category has only two subcategories: (1) theft and fraud and (2) systems security. Examples of activities that are classified under the theft and fraud subcategory are theft, forgery, and check kiting. Examples of activities that are classified under the systems security subcategory are hacking damage and theft of information with monetary losses.

The Basel II level 1 *Internal Fraud* category also has only two subcategories: (1) unauthorized activity and (2) theft and fraud. Examples of activities that are classified under unauthorized activity are intentionally not reporting transactions, unauthorized transaction type, and the intentional mismarking of positions. Examples of activities that are classified under the theft and fraud subcategory are fraud, theft, extortion, embezzlement, misappropriation of assets, forgery, tax evasion, and bribes.

The Basel II level 1 *Employment Practices and Workplace Safety* (*EPWS*) category has three subcategories: (1) employee relations, (2) safe environment, and (3) diversity and discrimination. Examples of activities that can lead to losses in the employee relations subcategory are compensation, benefit, termination, and organized labor. Examples of activities in the safe environment category are generally liabilities from accidents, employee health and safety rules, and workers' compensation. The last subcategory, diversity and discrimination, captures all activities related to discrimination issues.

The last Basel II level 1 category for OpRisk loss events is *Damage to Physical Assets* (*DPA*). The only subcategory is disasters and other events. This category and subcategory captures all loss events related to natural disasters and human losses from external sources such as vandalism and terrorism.

Collecting and Reporting Internal Loss Data

LO 41.2: Summarize the process of collecting and reporting internal operational loss data, including the selection of thresholds, the timeframe for recoveries, and reporting expected operational losses.

The foundation of an OpRisk framework is the internally created loss database. Any event that meets a firm's definition of an operational risk event should be recorded in the loss event database and classified based on guidelines in the operational risk event policy. Many firms adopt Basel II categories at the highest level and then customize lower level entries to match their firm's specific needs. A minimum of five years of historical data is required to satisfy Basel II regulatory guidelines. Collecting and analyzing operational risk events provides valuable insights into a firm's operational risk exposures. When loss data is not collected, it could be perceived by regulators that operational risk management issues are not a concern. Usually once a firm begins to collect loss data, the organization gains a new appreciation of its operational risks.

The collection of data is challenging because large amounts of data must be gathered over diverse geographical areas. The process of gathering data must ensure that it accurately reflects all loss information from all locations. The process should have checks and balances to ensure human errors are not present in gathering data and sending it to the central data collection point. Basel II regulations require a high degree of reliability in the loss data flow from all areas of the financial institution.

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Financial institutions often create OpRisk filters to identify potential operational events used in the calculation of operational losses. These OpRisk filters are typically the most expensive cost in the process. However, filters provide important added assurance for regulators regarding the accuracy of the data collection process.

Basel II requirements allow financial institutions to select a **loss threshold** for loss data collection. This threshold amount will have significant implications for the risk profile of business units within the firm. OpRisk managers should not set the threshold for collecting loss data too low (e.g., $0) if there are business units that have a very large number of smaller losses, because it would require a very high amount of reporting. OpRisk managers should also not just think in terms of large OpRisk threshold amounts. The following example illustrates how setting a threshold too high will bias the total losses and therefore the risk profile for a financial institution.

Suppose the OpRisk manager for Bank XYZ sets the threshold at $50,000. Bank XYZ categorized all losses by the amount of the loss into loss brackets or buckets illustrated in Figure 4. The first row of Figure 4 states that there were two losses greater than $4,000,000 in the past year and the total amount of loss from these two events was $18,242,000. These two losses accounted for 25.3% of the total losses for the year. If a loss threshold was set at $50,000, then the last two rows or 28.3% of the total losses for the year would not be reported. Therefore, if the firm did not set a loss threshold for collecting data they would show that they actually had $72,136,148 of total losses instead of $51,724,314 (computed as $72,136,148 – $4,480,627 – $15,931,207).

Figure 4: Bank XYZ Total Annual Losses

Loss Bracket	*Events*	*Loss Amount*	*Percentage*
Over $4,000,000	2	$18,242,000	25.3%
$1,000,000 to $4,000,000	8	$17,524,400	24.3%
$500,000 to $1,000,000	9	$7,850,425	10.9%
$250,000 to $500,000	7	$1,825,763	2.5%
$100,000 to $250,000	10	$1,784,632	2.5%
$75,000 to $100,000	15	$1,948,971	2.7%
$50,000 to $75,000	18	$2,548,123	3.5%
$25,000 to $50,000	50	$4,480,627	6.2%
Less than $25,000	1230	$15,931,207	22.1%
Total		$72,136,148	100.0%

When quantifying capital requirements, Basel II does not allow **recoveries** of losses to be included in the calculation. Regulators require this rule because gross losses are always considered for capital calculations to provide a more realistic view of the potential of large losses that occur once every 1,000 years.

Another important issue to consider in the process of collecting loss data is the **timeframe for recoveries.** The financial crisis of 2007–2009 illustrated that the complexity of some loss events can lead to very long time horizons from the start of the loss event to the final closure. Complex litigation cases from this financial crisis took five to six years for resolutions. Sometimes loss events will take lawyers and OpRisk managers several years to estimate the loss amount.

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While firms could create reserves for these losses, they seldom do to avoid giving the impression that they may owe a certain amount prior to reaching a judgment. The fact that many firms do not have legal expertise within the firm to handle these complex cases adds to the cost, because outsourcing of lawyers is often required. It is important for firms to have a policy in place for the processing of large long timeframe losses.

To help firms know what to report, the International Accounting Standards Board (IASB) prepared IAS37, which establishes guidelines on **loss provisions** or the reporting of expected operational losses after the financial crisis in 2007–2009. Three important requirements for the reporting of expected operational losses are as follows:

1. Loss provisions are not recognized for future operating losses.

2. Loss provisions are recognized for onerous contracts where the costs of fulfilling obligations exceed expected economic benefits.

3. Loss provisions are only recognized for restructuring costs when a firm has a detailed restructuring plan in place.

The IAS37 report states that loss provisions of restructuring costs should not include provisions related to relocation of staff, marketing, equipment investments, or distribution investments. Loss provisions must be recognized on the balance sheet when the firm has a current obligation regarding a past loss event. Balance sheet reporting of loss events is required when the firm is likely to be obligated for a loss and it is possible to establish a reliable estimate of the amount of loss. Gains from the disposal of assets or expected reimbursements linked to the loss should not be used to reduce the total expected loss amount. Reimbursements can only be recognized as a separate asset.

Identifying, Controlling, and Assessing Operational Risk

LO 41.3: Explain the use of a Risk Control Self-Assessment (RCSA) and key risk indicators (KRIs) in identifying, controlling, and assessing operational risk exposures.

The control environment plays an important role in mitigating operational losses. The OpRisk manager should map each business unit's processes, risks, and control mechanisms associated with the processes. For example, Figure 5 illustrates the equity settlement process for an equity trading firm. All major processes for the business unit are identified as the first step in managing risks.

Figure 5: Equity Settlement Process

A **risk control self-assessment** (RCSA) requires the documentation of risks and provides a rating system and control identification process that is used as a foundation in the OpRisk framework. Once the RCSA is created, it is commonly performed every 12–18 months to assess the business unit's operational risks. It is common for financial institutions to seek

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expert opinions to help provide qualitative measures for the effectiveness of the RCSA framework. The experts perform an evaluation and color rate the performance in each process as Red, Amber, or Green (RAG) to indicate the level of risk based on historical process data.

The following four steps are commonly used in designing an RCSA program:

1. *Identify and assess risks* associated with each business unit's activities. The manager first identifies key functions in the firm and performs risk scenarios to assess potential losses, the exposure or potential loss amount, and the correlation risk to other important aspects of the firm such as financial, reputation, or performance.

2. *Controls* are then added to the RCSA program to mitigate risks identified for the firm. The manager also assesses any residual risk which often remains even after controls are in place.

3. *Risk metrics,* such as key risk indicators or internal loss events, are used to measure the success of OpRisk initiatives and are linked to the RCSA program for review. These risk metrics would also include all available external data and risk benchmarks for operational risks.

4. *Control tests* are performed to assess how effective the controls in place mitigate potential operational risks.

A major challenge for OpRisk managers is the ability to properly interpret output data of the aggregated RCSA framework. Outputs could give managers a false sense of security if risks are controlled within tolerances that are set too high. Alternatively, risk managers may weight some risks more heavily and take corrective actions that focus too intensively on specific "key" measures while spending too little focus on other important variables.

Key risk indicators (KRIs) are identified and used to quantify the quality of the control environment with respect to specific business unit processes. KRIs are used as indicators for the OpRisk framework in the same way that other quantitative measures are used in market and credit risk models. The collection of reliable data used as KRIs is an important aspect of the self-assessment process. The data collection process may be automated to improve the accuracy of the data, but there will be costs associated with implementation. Even though KRIs may be costly to measure, they provide the best means for measuring and controlling OpRisk for the firm.

Regulators prefer the use of accurate quantitative KRIs in a control environment over more qualitative measures that only indicate whether the firm is getting better or worse based on historical losses. The more qualitative measures used in the example of the equity trading process in Figure 5 can be expanded to incorporate quantitative KRIs. Figure 6 includes examples of KRIs for the equity settlement process to help the firm self-assess the quality of the risk control environment.

The first step in creating an OpRisk model is identifying key factors that may be driving the success or failure of a business process. For example, the daily trade volume may be an important measure used to quantify how well the firm is executing the trade capture process. During the exercise of identifying KRIs, assumptions are made to determine proxies or inputs that drive the process. For example, execution errors are assumed to be greater

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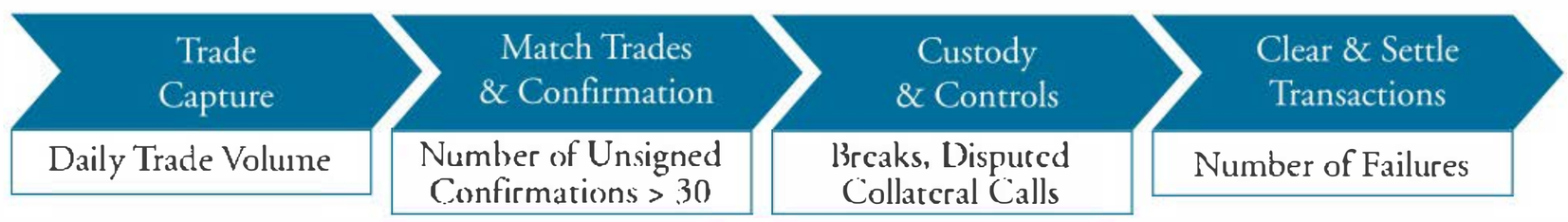
on high volume days. Other examples of KRIs that are used to predict execution errors are the number of securities that were not delivered, trading desk head count, and system downtime.

An important KRI for the process of matching trades and confirmation is the number of unsigned confirmations. KRIs are used as warning lights or red flags that highlight possible concerns for the firm. For example, when the number of unsigned confirmations older than 30 days as a percentage of total confirmations exceeds target percentages it indicates a problem area in the confirmation process. Similarly, the number of disputed collateral calls may be a good KRI for the custody and control step. Finally, the number of transactions that failed to clear or settle may be a good KRI for the settlement process.

Figure 6: Key Risk Indicators for an Equity Trading Firm



Collecting data at the lowest level or the cost center level allows information to be aggregated for all locations. This is very advantageous for the RCSA program because the OpRisk manager is then able to drill down or disaggregate the total data for the firm to help pinpoint where potential concerns may be originating.

Some additional examples of common internal control factors that are used to explain specific business environments are summarized in Figure 7.

Figure 7: Examples of Business Environment and Internal Control Factors (BEICFs)

Business Environment	*Factor Description*
Systems	Minutes system is down or slow
Information Security	Number of malware or hacking attacks
People	Headcount of employees, experience
Execution/Processing	Number of transactions or transaction breaks

External data such as stock market indices and market interest rate levels are also used in RCSA frameworks. For example, increased volatility in the equity market can lead to higher volume and higher operational losses for the firm. The insurance industry often relies on external databases to gather information on accidents or losses for areas or geographical regions they are less familiar with. Banks may also use external databases to gather information regarding losses for risks they have not been exposed to and therefore lack any relevant internal data.

Three common methods of gathering external data are: internal development, consortia, and vendors. Under the internal development method, the firm gathers and collates information from media such as news or magazines. This may be the least expensive method, but it may not be as accurate and has the potential to overlook large amounts of relevant data. The most popular consortium for banks is the **Operational Riskdata eXchange Association** (ORX), which contains large banks in the financial industry. While

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this consortium has a relatively low loss reporting threshold, there are often no details on the losses and therefore this data can only be used for measurement. There are a number of vendors who provide detailed analysis on losses that can be used for scenario analysis. However, the loss threshold for vendor data is often much higher and the information may not always be accurate.

Scenario Analysis

LO 41.4: Describe and assess the use of scenario analysis in managing operational risk, and identify biases and challenges which can arise when using scenario analysis.

Scenario analysis is defined as the process of evaluating a portfolio, project, or asset by changing a number of economic, market, industry, or company specific factors. Scenario analysis models are especially useful tools for estimating losses when loss experiences related to emerging risks are not available to the financial institution. Inputs to scenario analysis models are collected from external data, expert opinions, internal loss trends, or key risk indicators (KRIs). Expert opinions are typically drawn from structured workshops for large financial institutions. However, surveys and individual meetings can also be used to gather expert advice. Studies suggest that most financial firms analyze between 50 and 100 scenarios on an annual basis.

One of the challenges in scenario analysis is taking expert advice and quantifying this advice to reflect possible internal losses for the firm. The following example illustrates how a firm may create a frequency distribution of loss events that can be used in scenario analysis.

Figure 8 illustrates data constructed for a financial institution based on expert inputs. Information is gathered on loss frequencies for pre-determined loss brackets. Thus, a frequency distribution is created to model the probability of losses based on the amount of loss on an annual basis. This frequency distribution is then used in the OpRisk framework for the firm.

Figure 8: Scenario Analysis Model for Loss Frequencies

Loss Bracket	*Number of Losses*	*Frequency*
Over $5,000,000	3	1.8%
$1,000,000 to $5,000,000	9	5.4%
$500,000 to $1,000,000	18	10.7%
$250,000 to $500,000	25	14.9%
$100,000 to $250,000	41	24.4%
$50,000 to $100,000	72	42.9%
Total	168	100.0%

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Biases and Challenges of Scenario Analysis

One of the biggest challenges of scenario analysis is the fact that expert opinions are always subject to numerous possible biases. There is often disparity of opinions and knowledge regarding the amount and frequency of losses. Expert biases are difficult to avoid when conducting scenario analysis. Examples of possible biases are related to presentation, context, availability, anchoring, confidence, huddle, gaming, and inexpert opinion.

Presentation bias occurs when the order that information is presented impacts the expert's opinion or advice. Another similar type of bias is **context bias.** Context bias occurs when questions are framed in a way that influences the responses of those being questioned. In the case of scenario analysis, the context or framing of questions may influence the response of the experts.

Another set of biases are related to the lack of available information regarding loss data for a particular expert or for all experts. **Availability bias** is related to the expert's experience in dealing with a specific event or loss risk. For example, some experts may have a long career in a particular field and never actually experience a loss over $1 billion. The availability bias can result in over or under estimating the frequency and amount of loss events. A similar bias is referred to as anchoring bias. **Anchoring bias** can occur if an expert limits the range of a loss estimate based on personal experiences or knowledge of prior loss events. The availability an expert has to information can also result in a **confidence bias.** The expert may over or under estimate the amount of risk for a particular loss event if there is limited information or knowledge available for the risk or the probability of occurrence.

Expert opinions are often obtained in structured workshops that have a group setting. This group setting environment can lead to a number of biases. **Huddle bias** (also known as **anxiety bias**) refers to a situation described by behavioral scientists where individuals in a group setting tend to avoid conflicts and not express information that is unique because it results from different viewpoints or opinions. An example of a huddle bias would be a situation where junior experts do not voice their opinions in a structured workshop because they do not want to disagree in public with senior experts. Another concern for group environments is the possibility of **gaming.** Some experts may have ulterior motives for not participating or providing useful information in workshops. Another problem with workshop settings is the fact that top experts in the field may not be willing to join the workshop and prefer to work independently. The lack of top experts then attracts less experienced or junior experts who may have an **inexpert opinion.** These inexpert opinions can then lead to inaccurate estimates and poor scenario analysis models.

One technique that can help in scenario analysis is the **Delphi technique.** This technique originated from the U.S. Air Force in the 1950s and was designed to obtain the most reliable consensus of opinions from a group of experts. This technique is useful for many applications for analyzing cases where there is limited historical data available. More specifically, the Delphi technique is often applied in situations that exhibit some of the following issues:

- Precise mathematical models are not available but subjective opinions can be gathered from experts.
- Experts have a diverse background of experience and expertise, but little experience in communicating within expert groups.

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- Group meetings are too costly due to time and travel expenses.
- A large number of opinions is required and a single face-to-face meeting is not feasible.

Under the Delphi technique, information is gathered from a large number of participants across various business units, areas of expertise, or geographical regions. The information is then presented in a workshop with representatives from each area. Recommendations are determined by this workshop group and quantified based on a pre-determined confidence level. A basic Delphi technique commonly goes through the following four steps:

1. Discussion and feedback is gathered from a large number of participants who may have diverse exposure and experience with particular risks.

2. Information gathered in step 1 is summarized and presented to a workshop group with representatives from various locations or business units surveyed.

3. Differences in feedback are evaluated from step 2.

4. Final evaluation and recommendations are made based on analysis of data and feedback from participants and/or respondents.

Operational Risk Profiles

LO 41.5: Compare the typical operational risk profiles of firms in different financial sectors.

Various business units within a financial institution are identified separately in an OpRisk profile. This allows the OpRisk manager to gather data for specific risks of each business unit. For example, an asset management unit typically has greater legal liability problems whereas an investment bank unit has more losses associated with transaction processing operational errors.

Basel II defines level 1 business units into the following categories: Trading and Sales, Corporate Finance, Retail Banking, Commercial Banking, Payment and Settlement, Agency Services, Asset Management, and Retail Brokerage. Large financial institutions typically define business units within their firm based on these Basel II definitions.

Figures 9 and 10 contrast the OpRisk profiles for five of these financial business units with respect to frequency and severity, respectively. The first columns of Figure 9 and Figure 10 summarize the type of event risk for each business unit. The frequency percentages based on the number of loss events are presented for each business unit in Figure 9. The severity percentages based on total dollar amount losses are presented for each business unit in Figure 10.

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Figure 9: OpRisk Profiles Showing Frequency (%)

Event Type	*Trading & Sales*	*Corporate Finance*	*Retail Banking*	*Asset Management*	*Retail Brokerage*
Internal Fraud	1.0%	1.6%	5.4%	1.5%	5.8%
External Fraud	1.0%	5.4%	40.3%	2.7%	2.3%
Employment Practices	3.1%	10.1%	17.6%	4.3%	4.4%
Clients, Products, & Business Practices	12.7%	47.1%	13.1%	13.7%	**66.9%**
Physical Asset Damage	0.4%	1.1%	1.4%	0.3%	0.1%
System Failures & Business Disruptions	5.0%	2.2%	1.6%	3.3%	0.5%
Execution, Delivery, & Process Mgt	76.7%	32.5%	20.6%	74.2%	**20.0%**

Source: 2008 Loss Data collection exercise for Operational Risk BCBS (2009)

Figure 10: OpRisk Profile Showing Severity (%)

Event Type	*Trading & Sales*	*Corporate Finance*	*Retail Banking*	*Asset Management*	*Retail Brokerage*
Internal Fraud	11.0%	0.2%	6.3%	11.1%	18.1%
External Fraud	0.3%	0.1%	19.4%	0.9%	1.4%
Employment Practices	2.3%	0.6%	9.8%	2.5%	6.3%
Clients, Products, & Business Practices	**29.0%**	**93.7%**	40.4%	**30.8%**	59.5%
Physical Asset Damage	0.2%	0.0%	1.1%	0.2%	0.1%
System Failures & Business Disruptions	1.8%	0.0%	1.5%	1.5%	0.2%
Execution, Delivery, & Process Mgt	55.3%	5.4%	21.4%	52.8%	14.4%

Source: 2008 Loss Data collection exercise for Operational Risk BCBS (2009)

The two categories with the largest percentage of losses are emphasized in bold across different business units. The *Clients, Products, and Business Practices (CPBP)* unit and the *Execution, Delivery, and Process Management (EDPM)* unit have the largest losses across business units in terms of both frequency and severity of losses.

The number of losses related to the EDPM unit represented the highest frequency percentage and severity percentage for the *Trading and Sales* business unit in a 2008 survey of financial institutions. This is expected based on the number of trades executed daily by this business unit. Within this business unit, traders are required to execute trades for their firm or clients and then later settle the transactions. The complexity and wide range of products processed increases the possibility that errors may occur in the process. There is also a high frequency percentage and severity percentage related to the CPBP unit. Losses within this category arise from client or counterparty disputes, regulatory fines, and improper advisory activities.

The *Corporate Finance* business unit primarily provides consulting regarding initial public offerings, mergers and acquisitions, and other strategic planning. Figure 10 suggests that

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over 93% of losses fall under the CPBP category. The majority of losses are from litigation from clients arguing IPOs were mispriced or some other improper advice.

The *Retail Banking* unit has the highest frequency of losses associated with external frauds at 40%. However, external fraud accounts for only about 20% of the total severity percentage. The largest severity percentage for the retail banking sector is the *Clients, Products, and Business Practices* category with *Execution, Delivery, and Process Management* as the next highest category.

Prior to the financial crisis of 2007–2009, *Asset Management* firms had steady increases in assets under management (AUM) as profits were realized across most financial markets in the bull market. Thus, most asset managers did not focus on operational costs. Conversely, after the crisis all costs became extremely important as AUM were reduced by as much as 40%. The lack of proper controls increased the losses beyond market related losses.

In addition to the financial crisis, one litigation case reached an unprecedented level and brought an added demand for increased controls. Bernie Madoff's Ponzi scheme caused many individuals to lose all of their investments and pension savings. These events have led to dramatic increases in OpRisk controls for the asset management industry. The asset management industry reduced operational costs by consolidating administration and distribution departments for large geographical regions. In addition, more focus is now concentrated toward reducing operational costs and risk management. Productivity has also seen changes as illustrated by select financial firms significantly reducing the number of products offered to focus on fewer products on a global scale.

OpRisk, market risk, and credit risk are all concerns for asset management firms. However, economic losses are largely due to OpRisk losses, because credit and market risks do not have an immediate impact on manager fee income. The OpRisk profile for asset management firms reveals the largest frequency and severity percentage in the *Execution, Delivery, and Process Management* area.

The OpRisk profile for firms in the *Retail Brokerage* industry can vary to some extent due to the wide range of business strategies ranging from online to brick-and-mortar broker-dealers. Changes in technologies have significantly increased the speed of trading and clients of broker-dealers now have direct market access through trading tools. Clients such as hedge funds, mutual funds, insurance companies, or wealthy individuals are able to directly access markets using the broker-dealer's market participant identifier (MPID). This greatly increases the operational risk for broker-dealers who are responsible for all trades made with their MPID. If trades are not filtered by the broker-dealer, then the risks are even greater.

For example, due to the high speed of trades driven by algorithms and large blocks of trades, a two-minute delay in detecting a mistake could lead to losses approaching three-quarters of a billion dollars. Thus, it is important to integrate pre-trade controls into the system to mitigate the risk of mistakes or entry errors. The OpRisk profile of the retail brokerage industry has the largest frequency and severity percentage in the *Clients, Products, and Business Practices* area.

There was no loss frequency or severity data provided for the *Insurance* sector. Perhaps this is due to the fact that firms in the insurance industry are still in the early stages of developing accurate OpRisk frameworks and there is no data available. The insurance sector

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is divided into three major insurance types: life, health, and property and casualty. The insurance industry collects premiums for insuring individual losses and the insurer pays for losses incurred by policyholders, thus reducing the possibility of a large loss for any one individual.

In order to properly price the premiums, the insurer must have accurate actuarial calculations. In fact, OpRisk capital requirement models determined by regulators are designed after actuarial calculation models in the property and casualty insurance industry. Some major OpRisks for insurers include misselling products to clients, fraudulent sales techniques, customer frauds, discrimination litigation, and incomplete policy litigation following the 9/11 attacks.

Organizational Designs for Risk Management

LO 41.6: Compare different organizational designs for a risk management framework.

A key factor in creating a successful OpRisk framework is the organizational design of the risk management framework. Developing an understanding of reporting lines is just as important as developing good measurement tools and key risk indicators. All stakeholders for the organization should be informed of the OpRisk framework to help ensure that data is collected accurately and reflects the systems in place. The way in which risk is managed in an organization and the internal governance is an important aspect of OpRisk management.

There are four main organizational designs for integrating the OpRisk framework within the organization. Most large firms start at design 1 and progress to design 4 over time. The four organizational designs are illustrated in Figure 11 and summarized below.

Design 1: Central Risk Function Coordinator

In the first risk organizational design, the risk manager is viewed more as a coordinator or facilitator of risk management. This risk management design typically involves only a small Central Risk group who is responsible for OpRisk management. The risk manager gathers all risk data and then reports directly to the Chief Executive Officer (CEO) or Board of Directors. Regulators believe there exists a conflict of interest for reporting risk data directly to management or stakeholders that are primarily concerned with maximizing profits. Thus, this design can only be successful if business units are responsive to the Central Risk function without being influenced by upper management who controls their compensation and evaluates their performance.

Design 2: Dotted Line or Matrix Reporting

Creating a link or dotted line from the business risk managers to the Central Risk function of the organization is the next natural progression in risk organizational design. The dotted line implies that business unit managers are still directly under the influence of the CEO who controls their compensation and evaluates their performance. Thus, this type of framework is only successful if there is a strong risk culture for each business unit that

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encourages collaboration with the Central Risk function. Furthermore, this dotted line structure is preferred when there is a culture of distrust of the Central Risk function based on some historical events.

Design 3: Solid Line Reporting

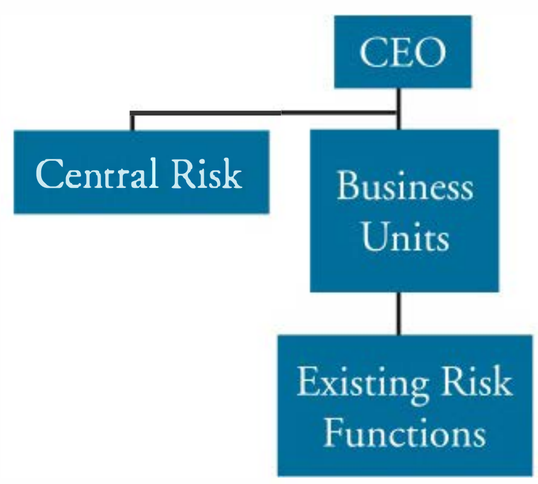
For larger firms that have centralized management, the solid line reporting is more popular. The solid line indicates that each business unit has a risk manager that reports directly to the Central Risk function. This design enables the Central Risk function to more effectively prioritize risk management objectives and goals for the entire firm. The solid line reporting also creates a more homogeneous risk culture for the entire organization.

Design 4: Strong Central Risk Management

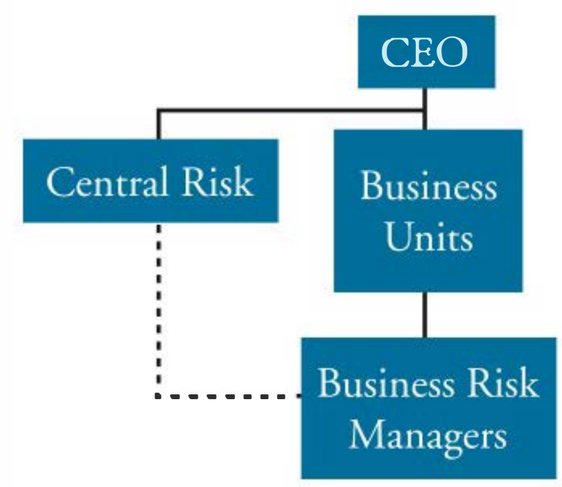
Many large firms have evolved into a strong central risk management design either voluntarily or from regulatory pressure. Under this design, there is a Corporate Chief Risk Officer who is responsible for OpRisk management throughout the entire firm. The Central Risk Manager monitors OpRisk in all business units and reports directly to the CEO or Board of Directors. Regulators prefer this structure as it centralizes risk data which makes regulatory supervision easier for one direct line of risk management as opposed to numerous risk managers dispersed throughout various business units of the firm.

Figure 11: Risk Department Organizational Designs

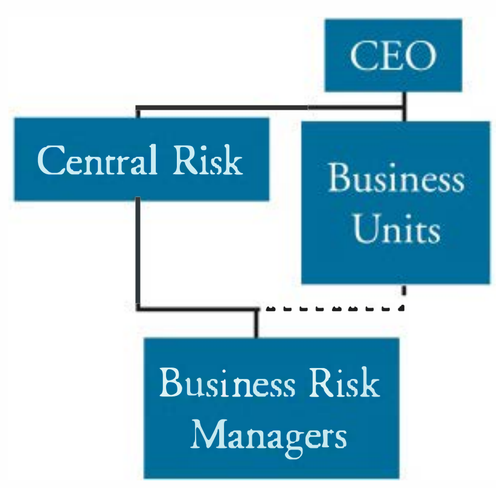
1. Central Risk Function Coordinator



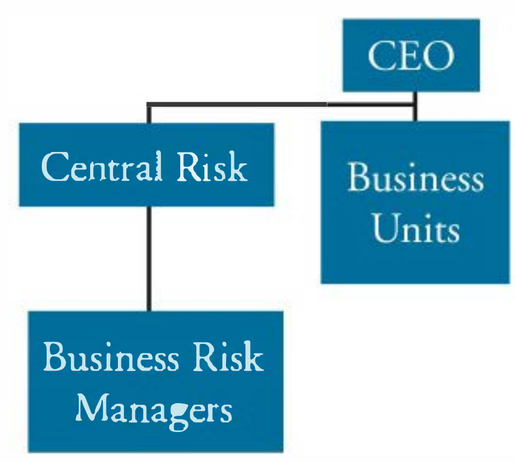
2. Matrix Reporting (Dotted Line)



3. Central Risk Management (Solid Line)



4. Strong Central Risk Management



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Key Concepts

LO 41.1

Basel II classifies loss events into seven categories. Loss events in the Execution, Delivery, and Process Management category have a small dollar amount but a very large frequency of occurrence. Losses are more infrequent but very large in the Clients, Products, and Business Practices category.

LO 41.2

Thresholds for collecting loss data should not be set too low if there are business units that have a very large number of smaller losses. Another important issue to consider in the process of collecting loss data is the timeframe for recoveries. Time horizons for complex loss events can stretch out for as much as five years or longer.

The International Accounting Standards Board (IASB) prepared IAS37, which states that loss provisions: (1) are not recognized for future operating losses, (2) are recognized for onerous contracts where the costs of fulfilling obligations exceed expected economic benefits, and (3) are only recognized for restructuring costs when a firm has a detailed restructuring plan in place.

LO 41.3

Risk control self-assessment (RCSA) requires the assessment of risks that provides a rating system and control identification process for the OpRisk framework. Key risk indicators (KRIs) are used to quantify the quality of the control environment with respect to specific business unit processes.

LO 41.4

Expert opinions are drawn from structured workshops and used as inputs in scenario analysis models. A challenge for scenario analysis is that these expert opinions may contain the following biases: presentation, context, availability, anchoring, huddle, gaming, confidence, and inexpert opinion.

LO 41.5

In general, the Clients, Products, and Business Practices unit and the Execution, Delivery, and Process Management unit have the largest losses based on OpRisk profiles across financial sectors in terms of severity and frequency of losses.

LO 41.6

There are four main organizational designs for integrating an OpRisk framework. Most large firms evolve from design 1 to design 4 over time. The primary difference in the designs is how risk is reported and the link between separate business unit risk managers and the Central Risk function.

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Concept Checkers

1. Suppose a broker-dealer has a loss that occurs from a failure in properly processing and settling a transaction. According to Basel II operational risk categories, this type of event loss would be categorized as:
   A. Business Disruption and System Failures.
   B. Clients, Products, and Business Practices.
   C. Execution, Delivery, and Process Management.
   D. Employment Practices and Workplace Safety.

2. There are typically four steps used in designing the risk control self-assessment (RCSA) program for a large firm. Which of the following statements is least likely to be a step in the design of that program?
   A. Identify and assess risks associated with each business unit's activities.
   B. Controls are added to the RCSA program to mitigate risks identified for the firm.
   C. Risk metrics and all other OpRisk initiatives are linked to the RCSA program.
   D. Reports to regulators are prepared that summarize the degree of OpRisk.

3. Scenario analysis is often used by financial institutions in determining the amount and frequency of losses. Because historical data is often limited for all possible losses, the opinions of experts are often obtained from workshops. These expert opinions are often subject to biases. Which of the following biases refers to the problem that can arise in this group setting where an expert may not be willing to share a conflicting opinion?
   A. Huddle bias.
   B. Context bias.
   C. Availability bias.
   D. Anchoring bias.

4. Based on OpRisk profiles across financial sectors, which of the following loss event type categories have the highest frequency and severity of losses?
   A. Business Disruption and System Failures.
   B. Clients, Products, and Business Practices.
   C. External Fraud.
   D. Internal Fraud.

5. Which of the following risk organizational design frameworks is preferred by regulators?
   A. Central risk function coordinator.
   B. Matrix reporting using dotted lines.
   C. Solid line reporting to central risk management.
   D. Strong central risk management.

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Concept Checker Answers

1. C Basel II classifies losses from failed transaction processing or process management from relations with trade counterparties and vendors under the Execution, Delivery, and Process Management category.

2. D The last step in the design of a risk control self-assessment (RCSA) program involves control tests to assess how well the controls in place mitigate potential risks.

3. A Huddle bias suggests that groups of individuals tend to avoid conflicts that can result from different viewpoints or opinions. Availability bias is related to the expert's experience in dealing with a specific event or loss risk. Anchoring bias occurs when an expert limits the range of a loss estimate based on personal knowledge. Context bias occurs when questions are framed in a way that influences the responses of those being questioned.

4. B From the choices listed the Clients, Products, and Business Practices unit has the highest frequency percentages and severity of loss percentages across business units. The Execution, Delivery, and Process Management unit also has large losses across business units in terms of frequency and severity of losses, however, this category was not listed as a possible choice.

5. D Regulators prefer the strong central risk management design because they can streamline their supervision over one direct line of risk management as opposed to numerous risk managers throughout the firm.

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

External Loss Data

Topic 42

Exam Focus

This topic examines the motivations for using external operational loss data and compares characteristics of loss data from different sources. For the exam, understand why firms are motivated to use external data in their internal operational risk framework development and the types of data that are available. Also, understand the differences in construction methodologies between the ORX and FIRST databases and be able to cite examples of how these differences manifest themselves in the data. Finally, be able to describe the Société Générale operational loss event.

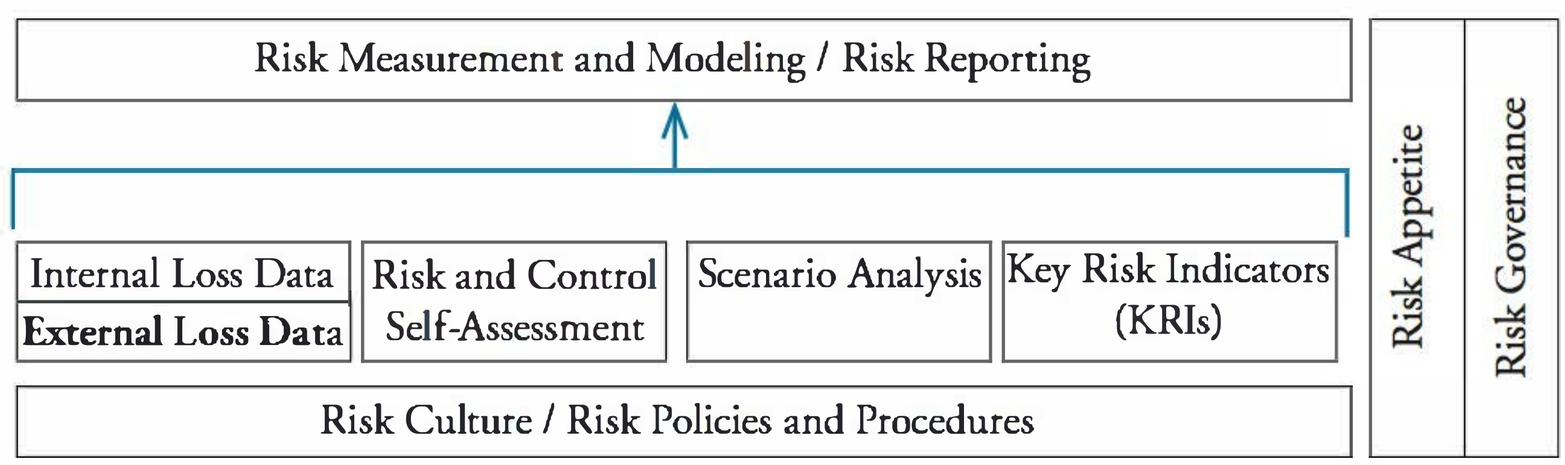
Collecting External Loss Data

LO 42.1: Explain the motivations for using external operational loss data and common sources of external data.

One reason operational risk departments look at events outside the firm is to gain valuable insights and inputs into operational risk capital calculations. Furthermore, external data is a required element in the advanced measurement approach (AMA) capital calculation under Basel II.

External events can be useful in many areas of the firm's operational risk framework, as these events provide information for risk self-assessment activities. They are key inputs in scenario analysis and can help in developing key risk indicators for monitoring the business environment.

Figure 1: External Loss Data in the Operational Risk Framework



Senior management should take an interest in external events because news headlines can provide useful information on operational risk. Examining events among industry peers and competitors helps management understand the importance of effective operational risk management and mitigation procedures. This is why external data is the key to developing a strong culture of operational risk awareness.

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An example of a huge risk event that impacted industry discipline is the €4.9 billion trading scandal at Société Générale in 2006. This internal loss for Société Générale demonstrated to the financial services industry how operational risk can lead to large losses. In spite of the lessons learned from this experience, the financial industry saw another huge trading loss event at UBS in 2011, which led firms to reassess how they respond to external events and to ensure any lessons learned do not go unheeded.

Sources of External Loss Data

There are many sources of operational risk event data in the form of news articles, journals, and email services. Operational risk system vendors offer access to their database of events, and there are consortiums of operational risk losses as well. External events are a valuable source of information on individual events and also serve as a benchmarking tool for comparing internal loss patterns to external loss patterns. This process provides insight into whether firm losses are reflective of the industry.

Subscription Databases

Subscription databases include descriptions and analyses of operational risk events derived from legal and regulatory sources and news articles. This information allows firms to map events to the appropriate business lines, risk categories, and causes. The primary goal of external databases is to collect information on tail losses and examples of large risk events. An excerpt showing the total operational risk loss percentages to date by risk category in the IBM Algo FIRST database is shown in Figure 2.

Figure 2: Operational Risk Losses Recorded in IBM Algo FIRST (Q4 2012)

Event Type	*% of Losses*	*% of Events*
Business Disruption and System Failures	0.41%	1.54%
Clients, Products, and Business Practices	48.25%	46.11%
Damage to Physical Assets	19.22%	3.18%
Employment Practices and Workplace Safety	0.88%	5.97%
Execution, Delivery, and Process Management	6.68%	7.28%
External Fraud	3.94%	9.71%
Internal Fraud	20.63%	26.20%
Total	100%	100%

Through these statistics, we can see some patterns in operational risk events. For example, 46% of all records fall into the category of Clients, Products, and Business Practices, accounting for 48% of dollar value losses. Internal Fraud is another large area of risk events, with 26% of records and 21% of losses. Damage to Physical Assets is the next most expensive category with 19% of losses but only 3% of events.

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Figure 2 shows us that within an internal database such IBM Algo FIRST (FIRST), operational risk losses from Internal Fraud, Damage to Physical Assets, and Client, Products, and Business Practices are more significant than those from other categories. However, keep in mind that the FIRST database includes business lines that are not part of the Basel-specified business lines. This results in relatively high Damage to Physical Assets losses, as insurance company losses are included in that category.

In Figure 3, we see subsets of losses from the FIRST database. (Note that any losses not attributed to one of the Basel business lines have been removed.)

Figure 3: FIRST Losses by Business Line (Q4 2012)

Business Line	*% of Losses*	*% of Events*
Agency Services	0.35%	2.22%
Asset Management	14.40%	16.37%
Commercial Banking	23.42%	17.70%
Corporate Finance	17.56%	9.00%
Payment and Settlement	2.72%	5.90%
Retail Banking	23.67%	20.79%
Retail Brokerage	1.30%	10.33%
Trading and Sales	16.58%	17.70%
Total	**100%**	**100%**

Figure 3 shows about 10% of events occur in the Retail Brokerage business line, but these retail brokerage events account for only 1% of losses because average losses in this business line are relatively small. Conversely, we see that Corporate Finance generated 9% of events but accounted for 18% of losses. Clearly, average losses in Corporate Finance tend to be more expensive.

We should keep in mind that this analysis is based on publicly available data for operational risk events, which is subject to reporting bias. The FIRST database is useful for financial services firms to compare their risk profiles to the industry by category and business line. FIRST provides insights into events that may not have occurred at a particular firm in the risk modeling process.

Consortium Data

Besides the FIRST approach to collecting data, there are also consortium-based risk event services that provide a central data repository. **Operational Riskdata eXchange Association** (ORX) is a provider of this data, which is gathered from members to provide benchmarking. ORX applies quality assurance standards to keep all receipt and delivery of data anonymous and to provide consistency in definitions of events.

Unlike subscription services, ORX data does not suffer from the availability bias that skews the FIRST data (which relies on public sources of information). With ORX, all events are entered anonymously into the database; however, the data relates only to a small subset of firms that are members of the consortium. ORX also uses different business lines than FIRST. For example, it splits retail banking into two groups: Retail Banking and Private

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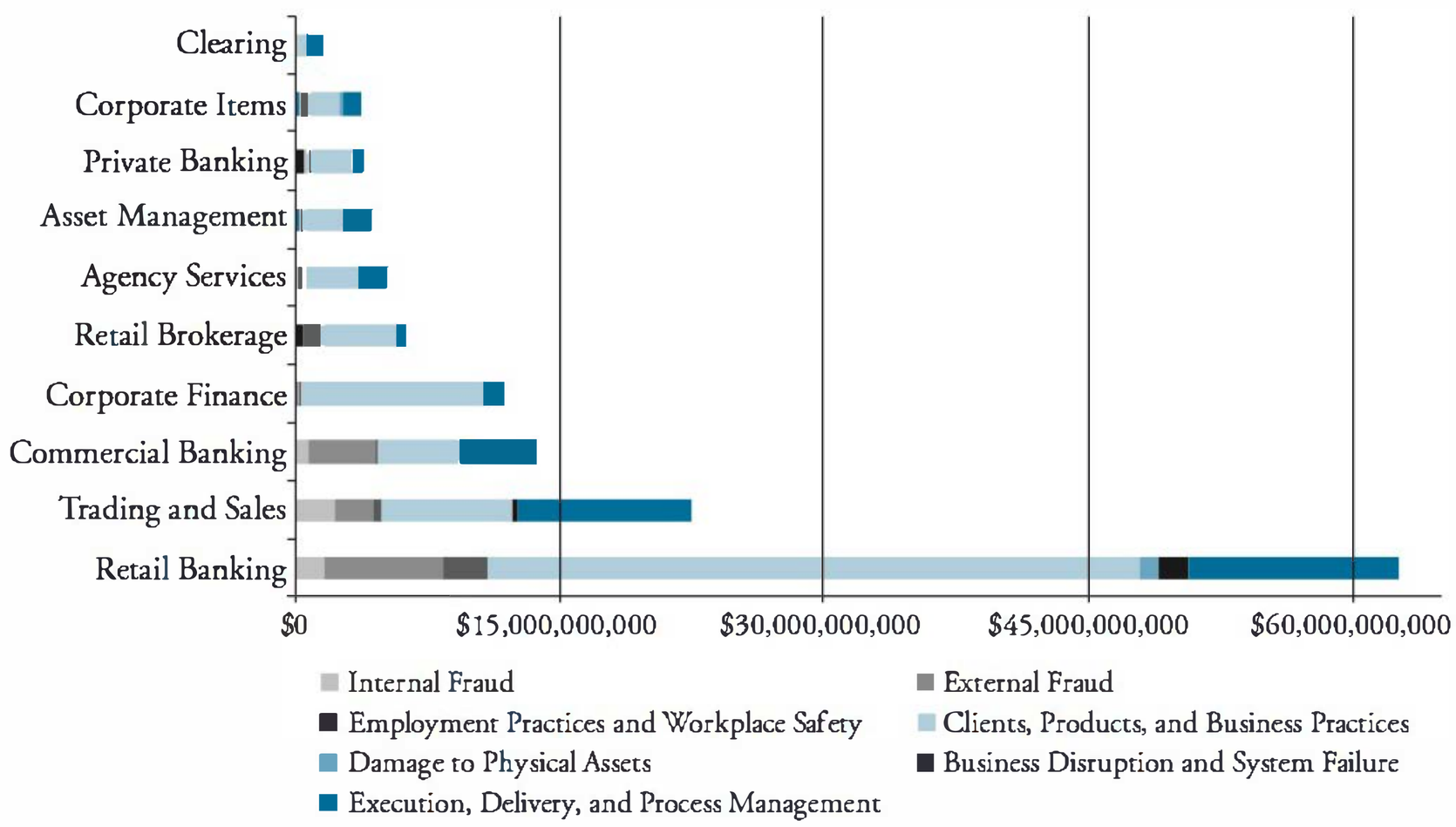
Banking. It also renames Payment and Settlement to "Clearing." The ORX database has gathered nearly 30,000 events costing its members over €100 billion, which helps highlight the potential costs of operational risk.

ORX publishes reports that summarize the number and amount of losses for each business line and risk category. Regarding the reported contributions, the Retail Banking business area generates 58% of events; most of them in the External Fraud category. Trading and Sales and Commercial Banking follow with about 10% of total events each. Retail Banking has the biggest share of total costs at 46% of total losses. Execution, Delivery, and Process Management produce the largest number of events (36%), with 25% of total costs. Also, Clients, Products, and Business Practices accounts for about 17% of events but more than 50% of losses, which demonstrates that for members of ORX, these events tend to be large. Many firms use information from this category to conduct scenario analysis for potential "fat tail" events. Data representing dollar value losses of operational risk for each business line is shown in Figure 4.

Figure 4: Dollar Value Losses by Risk Category and Business Line



Subscription vs. Consortium Databases

LO 42.2: Explain ways in which data from different external sources may differ.

Differences in the collection methods between the ORX and the FIRST databases have an interesting impact on the relative distribution of the loss data.

Size and Frequency of Losses by Risk Category

When comparing the size of losses by risk category in the ORX and FIRST databases, we see that the FIRST database has a significantly higher percentage of losses for Internal Fraud than ORX does. In contrast, ORX has a significantly higher percent of Execution, Delivery,

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and Process Management losses than does FIRST. This could be because not all Execution, Delivery, and Process Management losses are reported by the press, implying that the FIRST database is missing many events and has an unavoidable collection bias.

The primary difference between these two databases with respect to Execution, Delivery, and Process Management events is that ORX data is supplied directly from member banks, which does not include all banks, implying that ORX also suffers from collection bias. This is in contrast to the FIRST database that collects data on all firms, including a significant number of firms outside of Basel II compliance.

Regarding the frequency of losses by risk category, Execution, Delivery, and Process Management events are missing from FIRST data, presumably because they rarely get press coverage. ORX has a larger frequency of External Fraud than FIRST, which suggests that such events are often kept from the press. ORX data also shows a large amount of External Fraud due to the participation of retail banks in the consortium. This is because Retail Banking includes credit card services, which causes this category to be driven by numerous small instances of fraud in retail banking and credit cards. The threshold for reporting loss data to ORX is €20,000.

Size and Frequency of Losses by Business Line

When comparing the size of losses by business lines in the ORX and FIRST databases, ORX losses are heavily weighted toward Retail Banking. Also, Commercial Banking accounts for a smaller percentage of losses for ORX than for FIRST, which may be due to recent commercial banking events making it into the press and, therefore, into the FIRST database (but not the ORX database).

Regarding the frequency of losses by business line, ORX data is driven by Retail Banking events, whereas FIRST events are more evenly distributed among the various business lines. Also, the majority of events for ORX and FIRST occur in Retail Banking but by a slimmer margin for the FIRST database.

Challenges with Using External Data

LO 42.3: Describe the challenges which can arise through the use of external data.

Many firms' operational risk systems not only include ORX and FIRST data but are also supplemented with information from the firm's own research and relevant industry news and journals. However, as we noted previously about the various differences between ORX and FIRST, the databases must be viewed with caution, as there are several challenges with using external data.

For example, external data derived from the media is subject to reporting bias. This is because it is up to the press to decide which events to cover, and the preference is for illegal and dramatic acts. For instance, consider that a large internal trading fraud might get press coverage, while a systems outage might get none. We should also consider that a major gain is less likely to be reported by the media than a major loss. Another barrier to determining whether an event is relevant is that some external events may be ignored because they are

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perceived as types of events that "could not happen here." Finally, the use of benchmark data may be a concern because there is a chance that comparisons may not be accurate due to different interpretations of the underlying database definitions.

One of the best ways to use external data is not to spot exact events to be avoided but rather to determine the types of errors and control failings that could cause similar losses. External data may have direct relevance despite differences in the details. For example, the Société Générale event led many firms to overhaul their fraud controls.

External data can serve a valuable role in operational risk management if its limitations are acknowledged. Databases can provide valuable lessons about risk management and highlight trends in the industry. While internal and external databases only tell us about what has already gone wrong, the data can be used to implement controls to mitigate the chances of similar events repeating, and they provide valuable inputs into the operational risk framework. Loss data is also useful for self-assessment, scenario analysis, and key risk indicators (KRIs) that indicate loss trends and weaknesses in controls.

Société Générale Operational Loss Event

LO 42.4: Describe the Société Générale operational loss event and explain the lessons learned from the event.

In January 2008, it was discovered that one of Société Générale's junior traders, Jérôme Kerviel, was involved in rogue trading activities, which ultimately resulted in losses of €4.9 billion. The multinational bank was fined €4 million, and Mr. Kerviel was sentenced to three years in prison. The incident damaged the reputation of Société Générale and required the bank to raise additional funds to meet capital needs.

Between July 2005 and January 2008, Kerviel established large, unauthorized positions in futures contracts and equity securities. To hide the size and riskiness of these unauthorized positions, he created fake transactions that offset the price movements of the actual positions. Kerviel created fake transactions with forward start dates and then used his knowledge of control personnel confirmation timing to cancel these trades right before any confirmations took place. Given the need to continuously replace fake trades with new ones, Kerviel created close to 1,000 fictitious trades before the fraud was finally discovered.

The operational risk world was galvanized by this event as it demonstrated the dangers of unmitigated operational risk. In 2008, many firms were developing operational risk frameworks and often focused on the delivery of new reporting, loss data tools, and adaptions to their scenario analysis programs. However, even though firms were developing internal risk systems, the amount of new regulatory requirements rapidly overcame their ability to keep up in practice. With the news of Mr. Kerviel's activities, many heads of operational risk found themselves asking the question "Could that happen here?"

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IBM Algo FIRST provided an analysis based on press reviews. The highlights of alleged contributing factors to this operational loss event are summarized as follows:

1. Mr. Kerviel was involved in extensive unauthorized trading activities.

2. Mr. Kerviel was not sufficiently supervised.

3. Mr. Kerviel used his knowledge of middle and back office controls to ensure his fraud went undetected.

4. Mr. Kerviel achieved password access to systems allowing him to manipulate trade data.

A number of reasons were cited that explained how Kerviel's unauthorized trading activity went undetected, including the incorrect handling of trade cancellations, the lack of proper supervision, and the inability of the bank's trading system to consider gross positions.

Regarding trade cancellations, the bank's system was not equipped to review trading information that was entered and later canceled. In addition, the system was not set up to flag any unusual levels of trade cancellations. Regarding the lack of supervision, oversight of Kerviel's trading activity was weak, especially after his manager resigned in early 2007. Under the new manager, Kerviel's unauthorized trading activity increased significantly. Regarding the size of Kerviel's positions, the bank's system was only set up to evaluate net positions instead of both net and gross positions. Thus, the abnormally large size of his trading positions went undetected. Had the system properly monitored gross positions, it is likely that the large positions would have issued a warning sign given the level of riskiness associated with those notional amounts. Also, the large amount of trading commissions should have raised a red flag to management.

Additional reasons that contributed to the unauthorized positions going undetected included the inaction of Kerviel's trading assistant to report fraudulent activity, the violation of the bank's vacation policy, the weak reporting system for collateral and cash accounts, and the lack of investigation into unexpected reported trading gains.

Kerviel's trading assistant had immediate access to Kerviel's trading activities. Because the fictitious trades and the manipulation of the bank's trading system went unreported, it was believed that the trading assistant was acting in collusion with Kerviel. Regarding the bank's vacation policy, the rule that forced traders to take two weeks of vacation in a row was ignored. Had this policy been enforced, another trader would have been responsible for Kerviel's positions and likely would have uncovered the fraudulent activity of rolling fake transactions forward. Regarding collateral and cash reports, the fake transactions did not warrant any collateral or cash movements, so nothing balanced the collateral and cash needs of the actual trades that were being offset. If Société Générale's collateral and cash reports had been more robust, it would have detected unauthorized movements in the levels of these accounts for each individual trader. Regarding reported trading gains, Kerviel inflated trading gains above levels that could be reasonably accounted for given his actual authorized trades. This action should have prompted management to investigate the source of the reported trading gains.

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Ultimately, the unauthorized trading positions were discovered by chance after one of Kerviel's fake trades was detected by control personnel during a routine monitoring of positions. Kerviel's inability to explain the fictitious transaction led to a rigorous investigation, revealing the depth of his fraudulent activities.

Lessons to be learned specific to this operational loss event include the following:

- Traders who perform a large amount of trade cancellations should be flagged and, as a result, have a sample of their cancellations reviewed by validating details with trading counterparties to ensure cancellations are associated with real trades.
- Tighter controls should be applied to situations that involve a new or temporary manager.
- Banks must check for abnormally high gross-to-net-position ratios. High ratios suggest a greater probability of unauthorized trading activities and/or basis risk measurement issues.
- Control personnel should not assume the independence of a trading assistant's actions. Trading assistants often work under extreme pressure and, thus, are susceptible to bullying tactics given that job performance depends on them following direction from traders.
- Mandatory vacation rules should be enforced.
- Requirements for collateral and cash reports must be monitored for individual traders.
- Profit and loss activity that is outside reasonable expectations must be investigated by control personnel and management. Reported losses or gains can be compared to previous periods, forecasted values, or peer performance.

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KEY CONCEPTS

LO 42.1

Operational risk departments look at events outside the firm to gain valuable insights and inputs into operational risk capital calculations. External events can also be useful in many areas of a firm's operational risk framework, as they provide information useful for risk self-assessment activities. These events are key inputs in scenario analysis and can help in developing key risk indicators for monitoring the business environment. Additionally, external data is a required element in the advanced measurement approach (AMA) capital calculation.

Subscription databases include descriptions and analyses of operational risk events, which are derived from legal and regulatory sources and news articles. In addition to database systems, there are also consortium-based risk event services that provide a central data repository to member firms and can offer benchmarking services as well. ORX is a provider of this type of data.

LO 42.2

When comparing data in the FIRST and ORX databases, we see significant differences between them. The FIRST database has a significantly higher percentage of losses for Internal Fraud than does ORX. In contrast, ORX has a significantly higher percent of Execution, Delivery, and Process Management losses. This could be because not all Execution, Delivery, and Process Management events are reported by the press, implying the FIRST database is missing many events and has an unavoidable collection bias.

Another difference between the two databases with respect to Execution, Delivery, and Process Management events is that ORX data is supplied directly from member banks. However, not all banks are ORX members, implying that ORX likely also suffers from collection bias. This is in contrast to the FIRST database that collects data on all firms, including a significant number of firms outside of Basel II compliance.

LO 42.3

ORX and FIRST databases must be viewed with caution, as there are several challenges with using external data. For example, external data derived from the media is subject to reporting bias because the press is far more likely to cover illegal and dramatic events. The use of benchmark data is also a concern, as there is a chance that comparisons are not accurate because of different interpretations of the underlying database definitions.

One of the best ways to use external data is not to spot exact events to be avoided but rather to determine the types of errors and control failings necessary to avoid similar losses. External data can still have a valuable role in operational risk management if staff acknowledges any limitations. Databases can provide valuable lessons about risk management and highlight trends in the industry.

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LO 42.4

Jérôme Kerviel, a junior trader at Société Générale, participated in unauthorized trading activity and concealed this activity with fictitious offsetting transactions. The fraud resulted in €4.9 billion in losses and severely damaged the reputation of Société Générale.

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Concept Checkers

1. Which of the following reasons is least likely to be a motivation for firms to use external data?
   A. To provide inputs into operational risk calculations.
   B. To engage in risk self-assessment activities.
   C. To ignore any operational loss events outside of external loss databases.
   D. To use in the advanced measurement approach (AMA) capital calculation.

2. In the IBM Algo FIRST database, which event type accounts for the most risk events?
   A. Business Disruptions and Systems Failures.
   B. Execution, Delivery, and Process Management.
   C. Clients, Products, and Business Practices.
   D. Internal Fraud.

3. Which database is likely to suffer from selection bias for Execution, Delivery, and Process Management losses because not all events are reported in the press?
   I. IBM Algo FIRST
   II. Operational Riskdata eXchange Association (ORX)
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

4. Which of the following statements is least likely to be a limitation of using external databases? External databases:
   A. must be viewed with caution.
   B. suffer from collection biases.
   C. do not report all events.
   D. cannot be used in internal calculations.

5. Which of the following statements was not a contributing factor to Jérôme Kerviel's activities at Société Générale? Mr. Kerviel:
   A. engaged in extensive unauthorized activities.
   B. engaged in rogue trading despite being sufficiently supervised.
   C. had knowledge of controls to ensure his activities were not detected.
   D. gained password access to back office systems to manipulate data.

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Concept Checker Answers

1. C Operational risk departments look at events outside the firm to gain valuable insights and inputs into operational risk capital calculations. Firms should understand that external loss databases only include a sample of potential operational loss events.

2. C Forty six percent of all records in the FIRST database fall into the category of Clients, Products, and Business Practices, more than any other category.

3. A Because not all Execution, Delivery, and Process Management events are reported by the press, it is likely that the FIRST database is missing many events and, thus, has an unavoidable collection bias.

4. D The use of external databases is critical to firms' operational risk management calculations, an example of which is observing fat tail events at other firms.

5. B Mr. Kerviel was insufficiently supervised according to IBM Algo FIRST.

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

Capital Modeling

Topic 43

Exam Focus

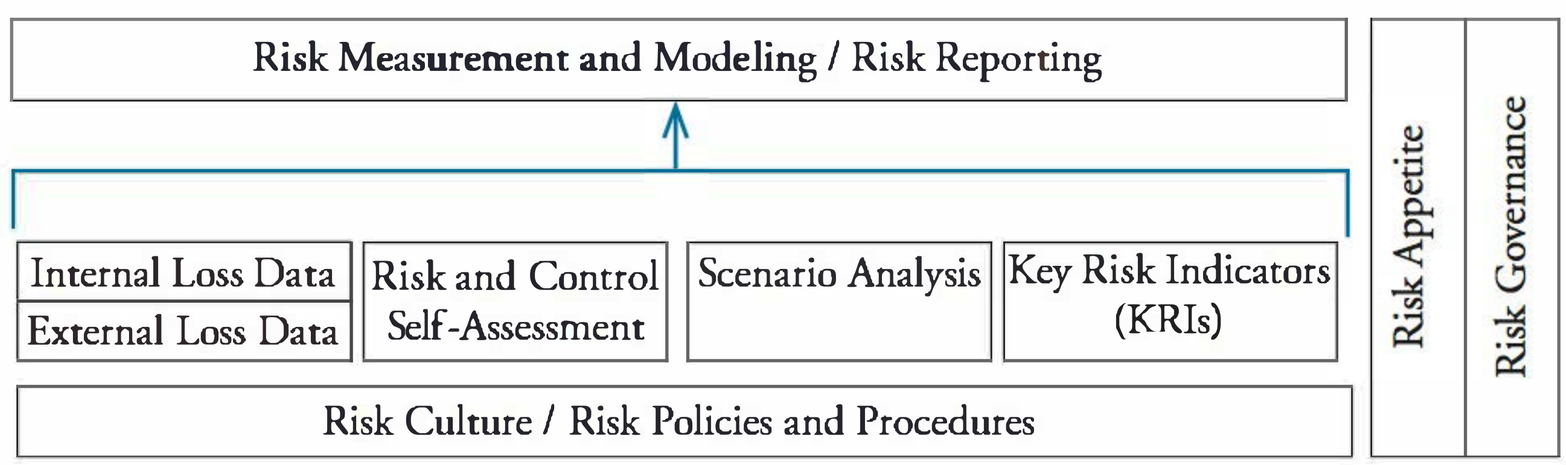
This topic discusses approaches for modeling operational risk capital requirements. Collecting data for loss frequency and loss severity distributions is an important component of allocating operational risk capital among various bank business lines. The loss distribution approach (LDA) models losses with respect to both frequency and severity with the goal of determining the appropriate level of capital. For the exam, be able to compare the approaches for calculating operational risk capital charges and be able to describe the LDA for modeling capital. The LDA, as well as common frequency and severity distributions, are also addressed in the next topic (Topic 44). In addition, approaches for calculating operational risk capital requirements will be covered again in Topic 55 later in this book.

Operational Risk Capital Requirements

LO 43.1: Compare the basic indicator approach, the standardized approach, and the alternative standardized approach for calculating the operational risk capital charge and calculate the Basel operational risk charge using each approach.

Basel II proposed three approaches for determining the operational risk capital requirement (i.e., the amount of capital needed to protect against the possibility of operational risk losses). The **basic indicator approach** (BIA) and the **standardized approach** (TSA) determine capital requirements as a multiple of gross income at either the business line or institutional level. The **advanced measurement approach** (AMA) offers institutions the possibility to lower capital requirements in exchange for investing in risk assessment and management technologies. If a firm chooses to use the AMA, calculations will draw on the underlying elements illustrated in Figure 1.

Figure 1: Role of Capital Modeling in the Operational Risk Framework



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Basel II encourages banks to develop more sophisticated operational risk management tools and expects international banks to use either the standardized approach or advanced measurement approach. In fact, many nations require large financial institutions to calculate operational risk with the AMA in order to be approved for Basel II.

Basic Indicator Approach

With the BIA, operational risk capital is based on 15% of the bank's annual gross income (GI) over a three-year period. Gross income in this case includes both net interest income and noninterest income. The capital requirement, K_{BIA}, under this approach is computed as follows:

$$K_{BIA} = \frac{\left(\sum_{i=1}^{n} GI_i \times \alpha\right)}{n}$$

where:
GI = annual (positive) gross income over the previous three years
n = number of years in which gross income was positive
α = 15% (set by Basel Committee)

Firms using this approach are still encouraged to adopt the risk management elements outlined in the Basel Committee on Banking Supervision, Risk Management Group, "Sound Practices for the Management and Supervision of Operational Risk." When a firm uses the BIA, it does not need loss data, risk and control self-assessment, scenario analysis, and business environment internal control factors (BEICF) for capital calculations. However, these data elements are needed as part of an operational risk framework to ensure risks are adequately identified, assessed, monitored, and mitigated.

Example 1: Calculating BIA capital charge

Assume Omega Bank has the following revenue results from the past three years:

	Year 1	*Year 2*	*Year 3*
Annual Gross Revenue (in $100 millions)	25	30	35

Calculate the operational risk capital requirement under the BIA.

Answer:

$$K_{BIA} = \frac{[(25+30+35)\times 0.15]}{3} = 4.5$$

Thus, Omega Bank must hold $450 million in operational risk capital under Basel II using the basic indicator approach.

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Example 2: Calculating BIA capital charge

Assume Theta Bank has the following revenue results from the past three years:

	Year 1	*Year 2*	*Year 3*
Annual Gross Revenue (in $100 millions)	10	–5	15

Calculate the operational risk capital requirement under the BIA.

Answer:

Because Year 2 is negative, it will not count toward the sum of gross income over the past three years. This will also reduce the value of *n* to two.

$$K_{BIA} = \frac{[(10+15)\times 0.15]}{2} = 1.875$$

Thus, Theta Bank must hold $187.5 million in operational risk capital under Basel II using the basic indicator approach.

The BIA for risk capital is simple to adopt, but it is an unreliable indication of the true capital needs of a firm because it uses only revenue as a driver. For example, if two firms had the same annual revenue over the last three years, but widely different risk controls, their capital requirements would be the same. Note also that operational risk capital requirements can be greatly affected by a single year's extraordinary revenue when risk at the firm has not materially changed.

The Standardized Approach

For the standardized approach (TSA), the bank uses eight business lines with different **beta factors** to calculate the capital charge. With this approach, the beta factor of each business line is multiplied by the annual gross income amount over a three-year period. The results are then summed to arrive at the total operational risk capital charge under the standardized approach. The beta factors used in this approach are shown as follows:

- Investment banking (corporate finance): 18%.
- Investment banking (trading and sales): 18%.
- Retail banking: 12%.
- Commercial banking: 15%.
- Settlement and payment services: 18%.
- Agency and custody services: 15%.
- Asset management: 12%.
- Retail brokerage: 12%.

The standardized approach attempts to capture operational risk factors not covered by the BIA by assuming that different business activities carry different levels of operational risk.

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Any negative capital charges from business lines can be offset up to a maximum of zero capital. The capital requirement, K_{TSA}, under this approach is computed as follows:

$$K_{TSA} = \frac{\left\{\sum_{3\ \text{Years}} \max\left[\sum(GI_{1-8} \times \beta_{1-8}), 0\right]\right\}}{3}$$

where:
GI_{1-8} = annual gross income in a given year for each of the eight business lines
β_{1-8} = beta factors (fixed percentages for each business line)

In the following examples, Gamma Bank has only three lines of business and uses the standardized approach for its operational risk capital calculation.

Example 1: Calculating TSA capital charge

Assume Gamma Bank has the following revenue (in $100 millions) for the past three years for its three lines of business: trading and sales, commercial banking, and asset management.

Business Line	*Year 1*	*Year 2*	*Year 3*
Trading and Sales	10	15	20
Commercial Banking	5	10	15
Asset Management	10	10	10

Calculate the operational risk capital requirement under TSA.

Answer:

To calculate TSA capital charge, we first incorporate the relevant beta factors as follows:

Business Line	*Year 1*	*Year 2*	*Year 3*
Trading and Sales	10 × 18% = 1.8	15 × 18% = 2.7	20 × 18% = 3.6
Commercial Banking	5 × 15% = 0.75	10 × 15% = 1.5	15 × 15% = 2.25
Asset Management	10 × 12% = 1.2	10 × 12% = 1.2	10 × 12% = 1.2
Total	3.75	5.4	7.05

Next, enter these totals into the capital charge calculation as follows:

$$K_{TSA} = \frac{(3.75 + 5.4 + 7.05)}{3} = 5.4$$

Thus, Gamma Bank must hold $540 million in operational risk capital under Basel II using the standardized approach.

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Example 2: Calculating TSA capital charge

If Delta Bank has negative revenue in any business line, it can offset capital charges that year up to a maximum benefit of zero capital. Beta Bank has had the following revenue (in $100 millions) for the past three years for its two lines of business: corporate finance and retail banking.

Business Line	*Year 1*	*Year 2*	*Year 3*
Corporate Finance	5	10	15
Retail Banking	5	–25	5

Calculate the operational risk capital requirement under TSA.

Answer:

Business Line	*Year 1*	*Year 2*	*Year 3*
Corporate Finance	5 × 18% = 0.90	10 × 18% = 1.80	15 × 18% = 2.7
Retail Banking	5 × 12% = 0.60	–25 × 12% = –3.0	5 × 12% = 0.60
Total	1.5	–1.2	3.3

Because a negative number cannot be used in the numerator, we replace –1.2 in Year 2 with zero. However, unlike the BIA, the number of years remains at three. Entering these totals into the capital charge calculation yields:

$$K_{TSA} = \frac{(1.5 + 0 + 3.3)}{3} = 1.6$$

Thus, Delta Bank would hold $160 million operational risk capital under Basel II using the standardized approach.

Alternative Standardized Approach

Under Basel II, a bank can be permitted to use the alternative standardized approach (ASA) provided it can demonstrate an ability to minimize double counting of certain risks. The ASA is identical to the standardized approach except for the calculation methodologies in the retail and commercial banking business lines. For these business lines, gross income is replaced with loans and advances times a multiplier, which is set equal to 0.035. Under the ASA, the beta factor for both retail and commercial banking is set to 15%. The capital requirement for the retail banking business line, K_{RB}, (which is the same for commercial banking) is computed as follows:

$$K_{RB} = \beta_{RB} \times LA_{RB} \times m$$

where:
β_{RB} = beta factor for retail banking business line (15%)
LA_{RB} = average total outstanding retail loans and advances over the past three years
m = multiplier (0.035)

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Unanticipated Results from Negative Gross Income

The BIA and TSA capital charge methodologies can produce inappropriate results when accounting for negative gross income. For example, consider the following gross income amounts multiplied by the corresponding beta factors (in $100 millions):

Business Line	*Year 1*	*Year 2*	*Year 3*
Corporate Finance	5 × 18% = 0.9	10 × 18% = 1.8	−15 × 18% = −2.7
Retail Banking	5 × 12% = 0.6	−25 × 12% = −3	5 × 12% = 0.6
Total	1.5	−1.2	−2.1

Under this scenario, the standardized approach will compute a capital charge of $50 million as follows:

$$K_{TSA} = \frac{(1.5+0+0)}{3} = 0.5$$

However, recall that the BIA applies a fixed 15% of gross income and reduces the value of n when negative gross income is present. Thus, under the same scenario, the BIA will compute a capital charge of $150 million as follows:

$$K_{BIA} = \frac{[(5+5)\times 0.15]}{1} = 1.5$$

Therefore, this bank would hold only $50 million in operational risk capital using TSA but $150 million under the BIA. The Basel Committee has recognized that capital under Pillar 1 (minimum capital requirements) may be distorted and, therefore, recommends that additional capital should be added under Pillar 2 (supervisory review) if negative gross income leads to unanticipated results.

Advanced Measurement Approach

LO 43.2: Describe the modeling requirements for a bank to use the Advanced Measurement Approach (AMA).

The advanced measurement approach (AMA) allows banks to construct their own models for calculating operational risk capital. Although the Basel Committee allows significant flexibility in the use of the AMA, there are three main requirements. A bank must:

- Demonstrate an ability to capture potentially severe "fat-tail" losses (banks must use 99.9th percentile events with a one-year time horizon).
- Include internal loss data, external loss data, scenario analysis, and business environment internal control factors (i.e., the four data elements).
- Allocate capital in a way that incentivizes good behavior (i.e., create incentives to improve business line operational risk management).

Under the AMA, capital requirements should be made for all seven risk categories specified by Basel II. Some firms calculate operational risk capital at the firm level and then allocate down to the business lines, while others calculate capital at the business line level. Capital

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calculations are typically performed by constructing a business line/event type matrix, where capital is allocated based on loss data for each matrix cell.

Additional quantitative requirements under the AMA include:

- The approach must capture all expected and unexpected losses and may only exclude expected losses under certain criteria as stated in Basel II.
- The approach must provide sufficient detail to ensure that fat-tail events are captured.
- The bank must sum all calculated cells in the business line/event type matrix and be able to defend any correlation assumptions made in its AMA model.
- All four data elements must be included in the model, including the use of internal and external data, scenario analysis, and business environment factors.
- The bank must use appropriate weights for the four data elements when determining operational risk capital.

While the four data elements must be considered in the capital calculations, many banks use some of these elements only to allocate capital or perform stress tests, and then adjust their models, rather than using them as direct inputs into capital calculations. Regulators have accepted many different types of AMA models, such as the loss distribution approach, given the rapid development of modeling operational risk capital.

Loss Distribution Approach

LO 43.3: Describe the loss distribution approach to modeling operational risk capital.

The **loss distribution approach** (LDA) relies on internal losses as the basis of its design. A simple LDA model uses internal losses as direct inputs with the remaining three data elements being used for stressing or allocation purposes. However, according to Basel II, a bank must have at least five years of internal loss data regardless of its model design but can use three years of data when it first moves to the AMA.

The advantage of the LDA is that it is based on historical data relevant to the firm. The disadvantage is that the data collection period is likely to be relatively short and may not capture fat-tail events. For example, no firm can produce 1,000 years of data, but the model is supposed to provide a 99.9% confidence level. Also, some firms find that they have insufficient loss data to build a model, even if they have more than five years of data. Additionally, banks need to keep in mind that historical data is not necessarily reflective of the future because firms change products, processes, and controls over time.

LO 43.4: Explain how frequency and severity distributions of operational losses are obtained, including commonly used distributions and suitability guidelines for probability distributions.

Modeling Frequency

When developing a model of expected operational risk losses, the first step is to determine the likely frequency of events on an annual basis. The most common distribution for

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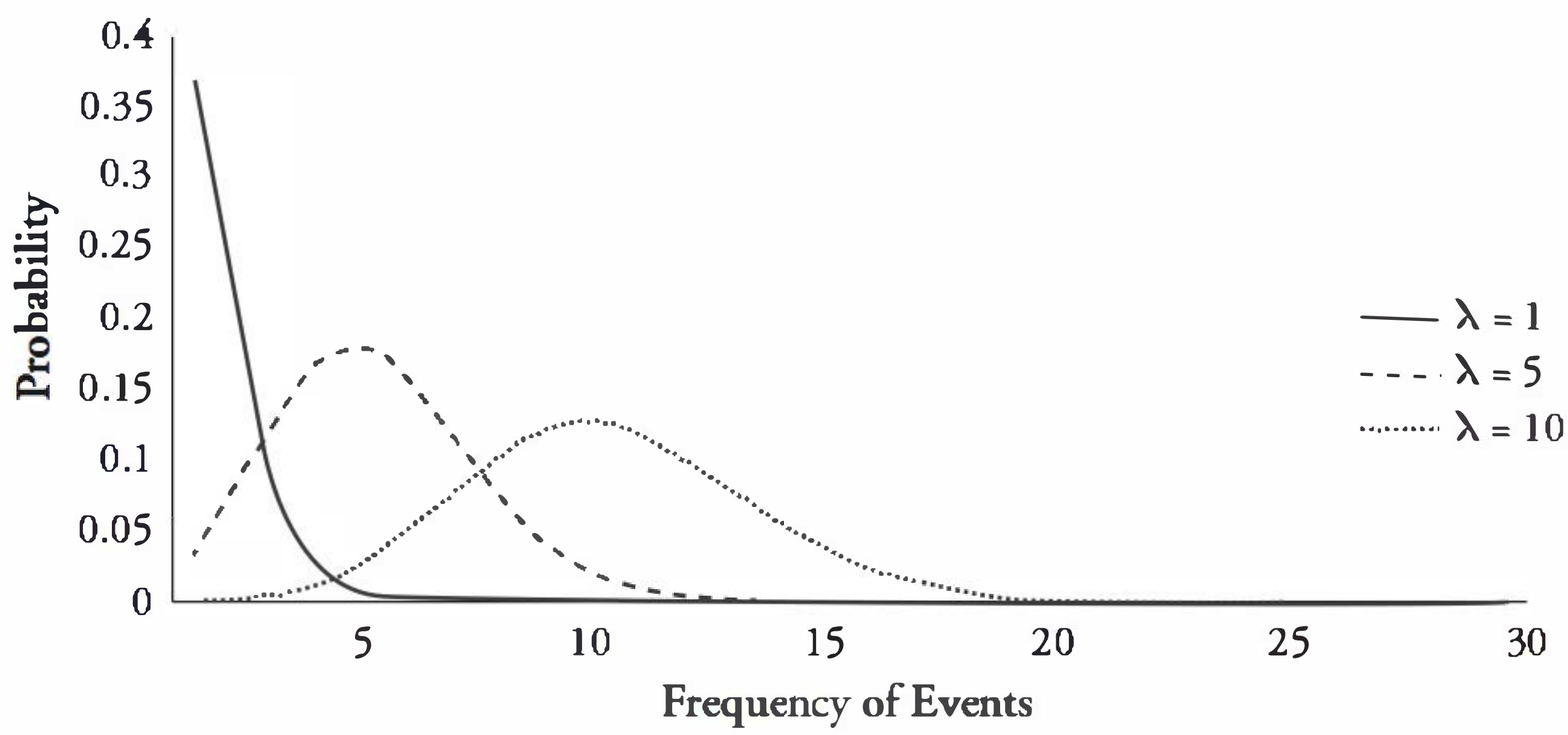
modeling frequency is the **Poisson distribution**. This distribution uses only one parameter, λ, which represents the average number of events in a given year, as well as the distribution's mean and variance. In an LDA model, λ can be obtained by observing the historical number of internal loss events per year and then calculating the average.

The Poisson distribution represents the probability of a certain number of events occurring in a single year. As shown in Figure 2, lower values of λ produce more skewed and leptokurtic annual loss distributions than higher values of λ.

Figure 2: Comparing Poisson Distributions



Modeling Severity

The next step in modeling expected operational risk losses is to determine the likely size (i.e., severity) of an event. The most common and least complex approach is to use a **lognormal distribution**. However, low frequency losses may be a better fit to distributions such as Generalized Gamma, Transformed Beta, Generalized Pareto, or Weibull. Regulators are interested in the selected distribution's "goodness of fit."

Regardless of the distribution selected, the probability density function must exhibit fat tails. Events that are more than three standard deviations from the mean are more likely to occur than in a normal distribution; thus, the distribution will be skewed as seen in Figure 3.

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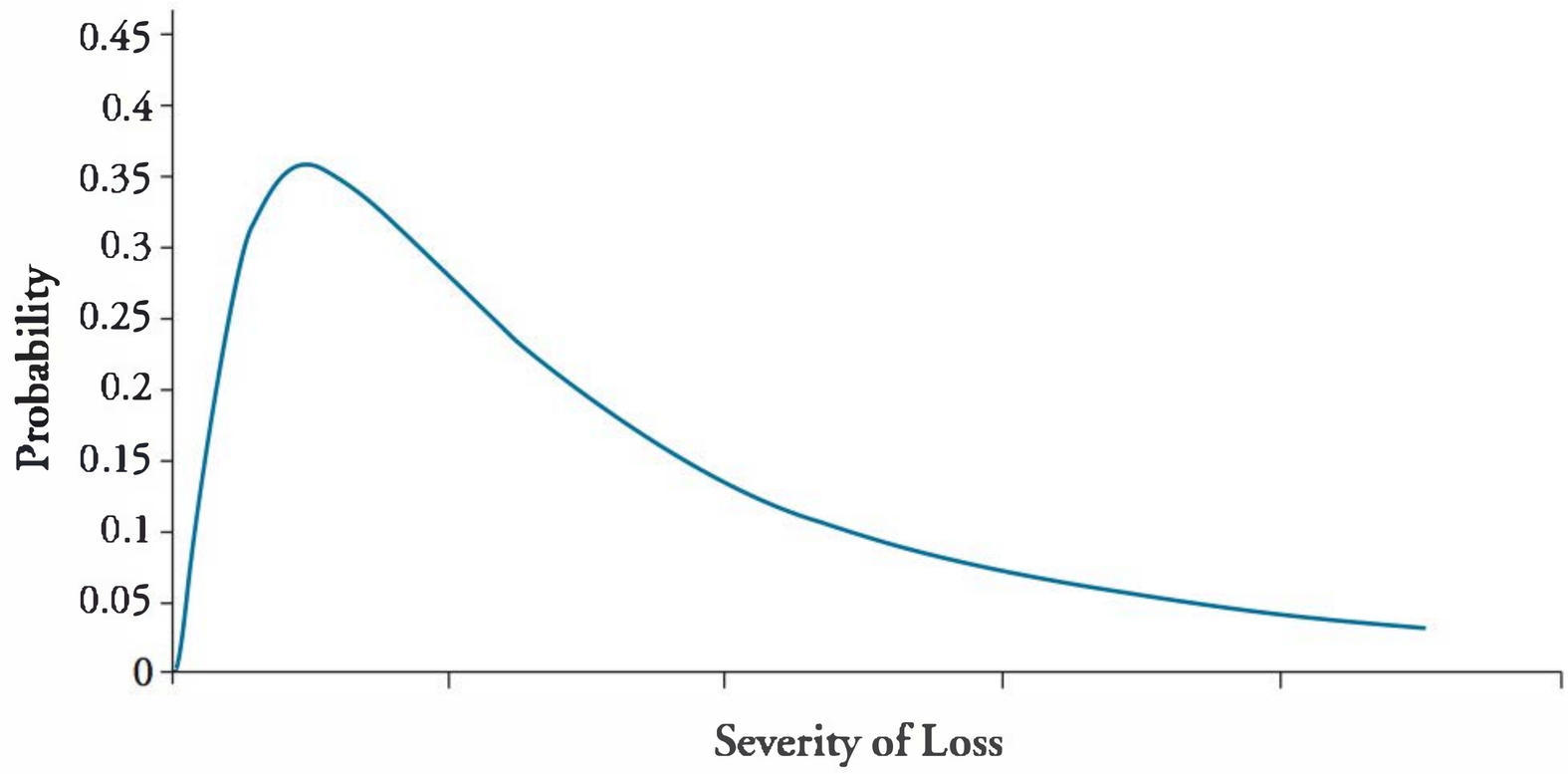
Figure 3: Example Severity Probability Distribution



Monte Carlo Simulation

LO 43.5: Explain how Monte Carlo simulation can be used to generate additional data points to estimate the 99.9th percentile of an operational loss distribution.

Once the frequency and severity distributions have been established, the next step is to combine them to generate data points that better estimate the capital required. This is done to ensure that likely losses for the next year will be covered at the 99.9% confidence level. **Monte Carlo simulation** can be used to combine frequency and severity distributions (a process known as **convolution**) in order to produce additional data points with the same characteristics as the observed data points.

With this process, we make random draws from the loss frequency data and then draw those events from the loss severity data. Each combination of frequency and severity becomes a potential loss event in our loss distribution. This process is continued several thousand times to create the potential loss distribution. To find the 99.9% confidence level, with a million observations for example, we would select the 1,000th item in an ordered list (from largest to smallest loss) to represent the maximum loss that will be experienced in a single year with 99.9% certainty.

Scenario Analysis

LO 43.6: Explain the use of scenario analysis and the hybrid approach in modeling operational risk capital.

Scenario analysis data is designed to identify fat-tail events, which is useful when calculating the appropriate amount of operational risk capital. The advantage of using scenario analysis is that data reflects the future through a process designed to consider "what if" scenarios, in contrast to the LDA which only considers the past. The major disadvantage of scenario analysis is that the data is highly subjective, and it only produces a few data points. As a result, complex techniques must be applied to model the full loss distribution,

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as the lack of data output in scenario analysis can make the fitting of distributions difficult. In addition, small changes in assumptions can lead to widely different results.

There are many different approaches to scenario analysis, but whichever method is used, a scarcity of data points is likely. This makes pure scenario analysis a difficult approach to defend in estimating risk capital. Also, the more reliance there is on scenario analysis, the more robust the program must be because sometimes there is little or no loss data available and a model may need to rely purely on scenario analysis for a particular risk category. Consequently, it is acceptable to have different modeling techniques for various risk categories as long as the differences are justified. While some scenario-based models have been approved in Europe, U.S. regulators generally do not accept them.

In the **hybrid approach**, loss data and scenario analysis output are both used to calculate operational risk capital. Some firms combine the LDA and scenario analysis by stitching together two distributions. For example, the LDA may be used to model expected losses, and scenario analysis may be used to model unexpected losses. Another approach combines scenario analysis data points with actual loss data when developing frequency and severity distributions.

Insurance

LO 43.7: Describe the AMA guidelines for the use of insurance in reducing a bank's operational risk capital charge.

Banks have the option to insure against the occurrence of operational risks. The important considerations are how much insurance to buy and which operational risks to insure. Insurance companies offer polices on everything from losses related to fire to losses related to a rogue trader. A bank using the AMA for calculating operational risk capital requirements can use insurance to reduce its capital charge. However, the recognition of insurance mitigation is limited to 20% of the total operational risk capital required.

The LDA allows for a risk profiling of an institution, which can include the risk reducing effect of insurance, which then alters the aggregate loss distribution. Typically this is done by reducing the severity of the losses that exceed a given deductible in the insurance policy. In other words, insurance typically lowers the severity but not the frequency.

Operational risk capital may need to be billions of dollars, so it can be worthwhile to pursue insurance as a means to reduce the amount of capital needed. Insurance companies are attempting to accommodate industry needs through new insurance products that meet Basel requirements.

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KEY CONCEPTS

LO 43.1

The three methods for calculating operational risk capital requirements are (1) the basic indicator approach (BIA), (2) the standardized approach (TSA), and (3) the advanced measurement approach (AMA). Large banks are encouraged to move from TSA to the AMA in an effort to reduce capital requirements.

LO 43.2

The first requirement to use the AMA is that the model must hold sufficient capital to cover all operational risk losses for one year with a certainty of 99.9%. The second requirement is that internal loss data, external loss data, scenario analysis, and business environment internal control factors must be included in the model. The third requirement is that there must be a method for allocating capital that incentivizes good behavior.

LO 43.3

The loss distribution approach (LDA) relies on internal losses as the basis of its design. It uses internal losses as direct inputs, with the remaining data elements being used for stressing or allocation purposes. However, regardless of its model design, a bank must have at least three years of loss data. The advantage of the LDA model is that it is based on historical data relevant to the firm. The disadvantage is that the data collection period is likely to be relatively short and may not capture all fat-tail events.

LO 43.4

When developing a model of expected operational risk losses, the first step is to determine the likely frequency of events on an annual basis. The most popular distribution for modeling frequency is the Poisson distribution. In a Poisson distribution, there is only one parameter, λ, which represents the average number of events in a given year. The next step in modeling expected operational risk losses is to determine the severity of an event. The most common and least complex distribution is to use a lognormal distribution.

LO 43.5

Once the frequency and severity distributions have been established, the next step is to use them to generate data points to better estimate the capital required at a 99.9% confidence level. Monte Carlo simulation is a method for combining frequency and severity distributions to produce additional data points that have the same characteristics as observed data points.

LO 43.6

Scenario analysis data is designed to identify fat-tail events and is useful in calculating the appropriate amount of operational risk capital. In the hybrid approach, loss data and scenario analysis output are both used to calculate operational risk capital.

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LO 43.7

Insurance alters the aggregate loss distribution and, when insurance is used, it should be included in LDA models. Insurance typically lowers the severity but not the frequency of losses.

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Concept Checkers

1. Under the basic indicator approach (BIA), what is Alpha Bank's capital charge if it has revenues of $100 million, $150 million, and $200 million in the first three years?
   A. $22.0 million.
   B. $22.5 million.
   C. $23.0 million.
   D. $23.5 million.

2. Which of the following statements is not a requirement to apply the advanced measurement approach (AMA)?
   A. The model must hold capital to cover all operational risk losses for one year with a certainty of 99.9%.
   B. Internal loss data, external loss data, scenario analysis, and business environment internal control factors must be included in the model.
   C. Capital must be allocated to minimize risk.
   D. There must be a method for allocating capital that incentivizes good behavior.

3. Which of the following reasons is not a disadvantage of the loss distribution approach (LDA) to modeling operational risk capital requirements?
   A. The LDA is based on historical data.
   B. Most firms have limited historical data.
   C. Fat-tail events may not be captured by modeling.
   D. Historical data is not reflective of the future.

4. When modeling risk frequency, it is common to:
   A. use a Poisson distribution.
   B. assume that risks are highly correlated.
   C. assume risk frequency and severity are the same.
   D. use a straight-line projection from the most recent loss data.

5. Extreme losses in the tail of the operational risk loss distribution most likely follow which type of process/distribution?
   A. Generalized Pareto distribution.
   B. Historical simulation method.
   C. Poisson distribution.
   D. Extreme value theory.

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Concept Checker Answers

1. B The BIA is based on 15% of the bank's annual gross income over a three-year period and is computed as follows:

$$K_{BIA} = \frac{[(100+150+200)\times 0.15]}{3} = \$22.5 \text{ million}$$

2. C There is no specific requirement under the AMA to minimize risk.

3. A An advantage of the LDA model is that it is based on historical data relevant to the firm.

4. A It is common to use a Poisson distribution to model loss frequency. A Poisson distribution has a single parameter, λ, which can be varied to accurately describe loss data.

5. A The most common and least complex approach for modeling extreme losses is to use a lognormal distribution. However, low frequency losses may be a better fit to distributions such as Generalized Gamma, Transformed Beta, Generalized Pareto, or Weibull.

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

Operational Risk—Supervisory Guidelines for the Advanced Measurement Approaches

Topic 44

Exam Focus

This topic is an extension of Topic 38, providing more specific guidelines from the Basel Committee on Banking Supervision regarding operational risk measurement, specifically the advanced measurement approach (AMA). The AMA allows banks substantial flexibility in developing operational risk measurement and management systems. The Committee would like to see sufficient consistency in the application of this approach. For the exam, understand guidelines for verification and validation of a bank's operational risk management framework (ORMF) and its operational risk management system (ORMS). Also, be familiar with the key guidelines for selecting operational risk categories (ORCs) and how the distribution for individual ORCs is modeled. Finally, understand the application of frequency and severity distributions when modeling operational risk losses.

Advanced Measurement Approach (AMA)

In an effort to further strengthen the soundness and stability of the international banking system, the Basel Committee on Banking Supervision developed the Basel II framework. One of the goals of Basel II is to give guidance to banks regarding operational risk management. Basel II recommends a measurement framework that meets the requirements of the **advanced measurement approach** (AMA). The Basel Committee also formed the Standards Implementation Group, and its Operational Risk Subgroup (SIGOR) focuses on the challenges of identifying and managing operational risk. The SIGOR resolves the practical challenges associated with the development, implementation, and maintenance of the AMA framework.

The AMA allows banks to develop empirical models to quantify the capital required for operational risks. Banks must be approved by regulators (i.e., supervisory authorities) to use the approach and must convince regulators that the board of directors and senior management are actively engaged in the oversight of operational risks. The AMA is flexible and modeling reflects individual bank risk profiles. However, the committee does not want banks with similar risk profiles to have different levels of required capital. This can happen if banks rely on very different risk assumptions and approaches to modeling operational risks. As such, they offer substantial guidance (presented in this topic) to help banks converge around common risk management practices while still allowing for individual flexibility.

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Operational Risk Measurement and Management

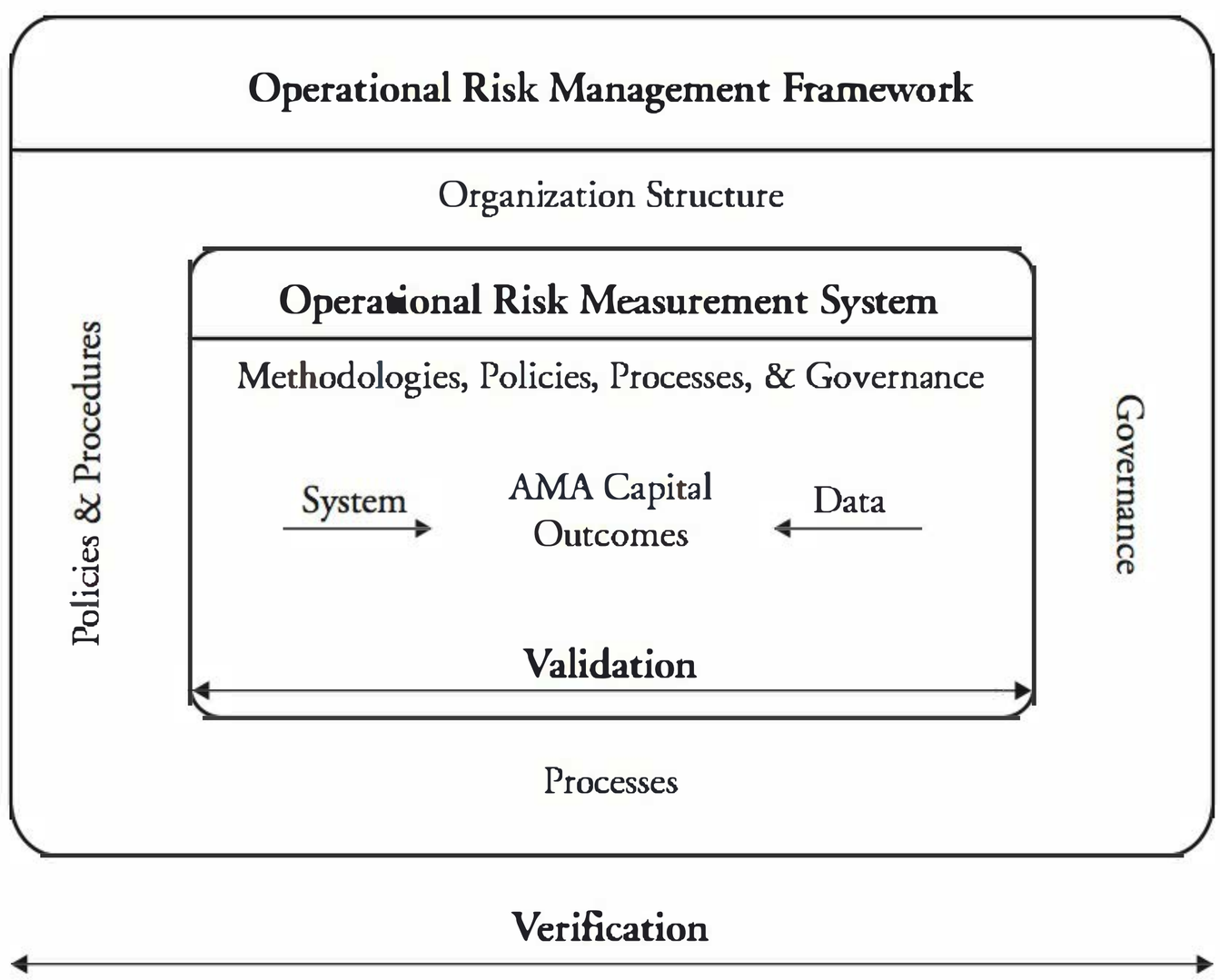
LO 44.1: Summarize key guidelines for verification and validation of a bank's operational risk management framework (ORMF) and its operational risk management system (ORMS), including the use test and experience.

The **operational risk management framework** (ORMF) is the umbrella under which all operational risk management operations fall. Recall that the ORMF was called the "Framework" in Topic 38. According to the Basel Committee, sound internal governance forms the foundation of an effective ORMF. Topic 38 indicated that business line management, an independent corporate operational risk function (CORF), and independent review (i.e., the three lines of defense) are also necessary for an effective ORMF.

The **operational risk measurement system** (ORMS) includes all the factors that are components of risk measurement and modeling systems used to estimate operational risk capital charges. That is:

- Statistical methodologies.
- Bank policies regarding risk identification, measurement, and management.
- Bank processes regarding risk identification, measurement, and management.
- Internal governance.
- Bank systems, data, and AMA capital allocation outcomes.
- Validation to ensure that the ORMS is robust.
- Verification to test the effectiveness of the overall ORMF.

Figure 1: Relationship Between ORMF and ORMS



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Validation and Verification

Validation and verification are fundamental components of the AMA. They are effective challenge functions that assess the reliability of the ORMF and identify areas for improvement. These activities are concerned with both the quantitative and qualitative processes of the bank. Senior managers and the board of directors should use validation and verification activities to better understand and manage operational risks and the ORMF. Validation and verification processes should provide independent assessments (i.e., should not be improperly influenced by divisions that are being reviewed and should be willing to challenge management's views).

There are, according to the committee, subtle differences between validation and verification. They are described as:

- **Validation** provides assurance of the integrity of the inputs in AMA operational risk capital models, the assumptions used in the models, bank processes, and model outputs. Validation allows the bank a degree of certainty that AMA measurement methodologies result in credible estimates of operational risk capital. The capital charge must be commensurate with the risk exposure of the bank. Validation activities test the robustness and effectiveness of the ORMS but are not limited to quantitative aspects. For example, the use of outputs in operational risk models must also be validated.
- **Verification** is conducted by internal and/or external audits and may be conducted by qualified third parties. It is done on a periodic basis. Verification is concerned with the overall effectiveness of the ORMF. ORMS validation processes must be verified as well (e.g., is validation of inputs and models independent?).

There are challenges with respect to validation and verification. They include:

1. The board of directors and senior managers must identify independent (i.e., cannot influence the operation of the AMA framework), qualified personnel who are skilled, competent, and appropriately trained.

2. Conventional validation procedures may be inadequate for the validation of AMA models (e.g., a lack of independence, overlapping responsibilities, and fragmented responsibilities for the development and implementation of AMA models).

3. Operational loss data continues to be scarce. Also, AMA models are still in the development phase as banks adopt this new system of estimating operational risk capital.

The bank must verify that the ORMF has been implemented effectively, is performing as intended, and is still appropriate for the bank's operational risk management. Guidelines for verification of the ORMF state that verification activities should ensure that:

- Operational risk management policies and procedures are transparent, sound, and documented.
- The CORF, business unit functions, and operational risk management governance committees and processes are appropriate for risk management.
- Model inputs and outputs are accurate, complete, relevant, credible, authorized by appropriate personnel, and accessible.
- Monitoring of risk management processes is effective.
- Remediation and improvements are made if identified and/or necessary.

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- Outcome analysis is effective, includes proper comparisons (e.g., between loss data and scenario analysis results), and is incorporated into bank processes.
- Validation of AMA models is completed in accordance with bank validation policies.
- Tests of operational risk management controls are designed properly and prevent, detect, and correct deviations from bank policies and procedures.
- All aspects (divisions, activities, and subsidiaries) of the bank are included.
- The AMA framework is subject to periodic, independent review.

In general, validation processes should (1) be broad in scope, (2) evaluate the bank's escalation processes when concerns are identified (e.g., all ORMS concerns are acted upon by senior management or the board and concerns are escalated to the appropriate governance committees), (3) evaluate the conceptual soundness of model outputs, (4) be consistent with board of directors and senior managers' expectations, (5) assess whether independent review, defined responsibilities, model validation and documentation, frequency of validation procedures, and audit oversight is in place, and (6) verify that model inputs and outputs are stable and that methods underlying models are intuitive and transparent.

Guidelines for validation of the ORMS state that validation activities should be broad in scope and evaluate all relevant matter of the ORMS, including:

- Assumptions regarding correlations and distributions.
- Documentation of assumptions regarding correlations, distributions, and other inputs.
- The four AMA data elements (discussed in LO 44.7).
- Qualitative factors such as internal controls, reporting, and the role of senior management in the risk management process.
- Technological infrastructure relating to computational processes.
- Required procedures for approval of new or modified estimation models or methodologies (in the approval process, the explicit opinion of the validation function should be sought).

With respect to validation and verification, the committee recommends:

- A work plan or strategic plan that governs the verification and validation processes including detailed annual plans.
- Documentation and reporting. Validation and verification reports should be distributed to managers and appropriate committees. Responsible personnel should have access to the reports and should understand the reports. Reports should identify weaknesses and include processes needed to resolve problem areas and audits should evaluate management's response to important reported deficiencies. The reports should be summarized for the bank's board of directors.

As a bank gains more experience with measuring and managing operational risk, its ORMF should evolve and be updated regularly. Banks also need to ensure that the degree of ORMF implementation (or embeddedness) across the organization is not influenced by changes within the bank. When a bank's operational risk discipline changes, it is important to increase embeddedness by clearly communicating the bank's operational risk profile and the bank's operational risk appetite and tolerance. It is also important to ensure that the ORMF is properly used during overall risk management decision-making processes. Regarding the

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use and embeddedness of the OMRF, the ORMS, and the AMA framework, a bank should incorporate the following guidelines:

- The AMA should be used throughout the organization and not be solely reserved for compliance purposes.
- Changing risk management practices should be reflected in the AMA as a bank gains experience.
- The AMA should be used to support operational risk management practices and policies.
- The AMA should be used to benefit a bank's management of operational risk.

Data Elements in an AMA Framework

LO 44.7: Describe the four required data elements in an AMA model and the guidelines for combining data from each element in modeling the capital charge.

The Basel Committee requires four data elements that a bank must use to calculate the operational risk capital charge based on the AMA framework. The elements must be used in different "combinations" and the bank must prove that the combinations are sufficient for successful model estimations. The four data elements are:

1. **Internal loss data.** Loss data used in the AMA model should reflect both the bank's risk profile and risk management systems. Data is used in the operational risk measurement system (ORMS) to estimate the frequency of losses and severity distributions and as an input in scenario analysis.

2. **External loss data.** External data contains valuable information regarding the tail of the loss distribution(s). External data helps the bank estimate the severity of losses. Public databases can provide external data where members submit loss information or they can collect pertinent external data themselves.

3. **Scenario analysis.** Reliable scenario outputs form part of the input into the AMA model. Scenario analysis is an important tool in the operational risk management framework (ORMF). Scenario analysis is, however, qualitative and likely contains considerable uncertainties. The uncertainty (along with other non-scenario analysis-related uncertainties) should be reflected in the output of the model estimating the operational risk capital charge although quantifying these uncertainties is a major challenge. The committee indicates that this is an area requiring further research.

4. **Business environment and internal control factors (BEICFs).** BEICFs are subjective and are often used as indirect inputs in models or are used ex post to adjust a model's output.

The goal of operational risk models (and the data used in the models) is to ensure the bank's operational risk capital is commensurate with the bank's operational risk exposure. Banks must be able to justify assumptions and modeling choices. Also, banks must conduct research and analysis that supports their modeling decisions.

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Internal Loss Data Threshold

Bank supervisors require an internal loss data threshold. The threshold influences both the measurement and management of operational risk. The bank should be able to (ideally) establish, using statistical evidence, that losses below the threshold level have an immaterial effect on capital calculations. Banks should be aware that thresholds affect capital.

Internal loss data thresholds should:

- Be defined and justified for each operational risk category (for data collection and modeling).
- Be reasonable and include material operational loss event data that is relevant for measuring and managing operational risk (i.e., does not omit relevant loss data).
- Support the credibility and accuracy of operational risk measures (i.e., should not adversely impact the integrity and accuracy of risk measures).

Losses should be grouped for quantification purposes only if they are caused by a common operational loss event. If a bank combines small losses that are not related, they should generally be excluded from the calculation dataset or at least show that the grouped losses do not distort the calculation of capital.

De minimis "modeling thresholds" may be established for operational risk categories (ORCs). This is established so frequency and severity distributions in each ORC are fitted to data above the de minimis threshold. If a bank sets de minimis levels higher than data collection thresholds, the bank must justify the levels using sensitivity analysis and other tools. Losses above the de minimis threshold should be included in the calculation dataset.

Selecting Internal Loss Reference Dates

There are several relevant dates related to loss (i.e., dates that have relevant information regarding the operational loss), including the date of the event's occurrence, the date of discovery, the date of contingent liability, the date of the first financial impact, and the date of the settlement. A bank may choose one reference date for risk management and another for quantification purposes. The quantification date is critical because in the Basel II framework it is used to fulfill the minimum observation period.

A concern is that AMA banks might choose a reference date for quantification that will result in the omission of large internal losses. This affects the bank's operational risk capital charge. The Basel Committee recommends a convergence of practice in how losses are recorded so there will not be differences in capital requirements for similar risk events.

The Basel guidelines are meant to encourage consistency across banks' AMA models. The Committee would also like to see more harmony to AMA implementation for building a calculation dataset. Three reference dates are typically most important. They are as follows: (1) date of occurrence, (2) date of discovery, and (3) accounting date.

The accounting date and discovery dates are the best dates for building the operational risk dataset that is used to calculate operational risk capital related to the event. The date of occurrence can be used but may result in some material losses being excluded if the date of

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occurrence falls outside the time series used to estimate the capital charge. The bottom line is that a bank should choose an observation period that does not exclude material loss data.

The bank should also be conservative when considering inputs into the AMA model related to the recognition of legal losses. The date should be no later than the date for the establishment of a legal reserve. Scenario analysis can also be used to estimate legal exposures because legal exposure can change over time.

Loss Distribution Approach

LO 44.3: Describe commonly used distributions used to model the frequency and severity of a bank's operational loss events.

One of the approved alternatives under the Basel II AMA framework to quantifying operational risk is called the **loss distribution approach** (LDA). Under the LDA, capital requirements are determined based on the historical losses suffered by the institution. The Basel Committee defines LDA as an estimate of the loss distribution resulting from each business line and event type of operational risk. The distribution is constructed based on assumptions of loss frequency and loss severity, which primarily come from the historical loss experience of the institution.

The loss distribution approach has several steps as follows:

Step 1: Organize and group loss data into a business line/event type matrix that corresponds to the LDA model. The evaluation of loss data allows a bank to understand its exposure to operational risk. Note that loss data is "backward-looking."

Professor's Note: Recall the discussion of business lines and event types in Topics 41 and 42. Examples of business lines include corporate finance, retail banking, commercial banking, and asset management. Examples of event types are operational risks, such as internal and external fraud, and clients, products, and business practices.

Step 2: Assign every data point in the matrix an equal weight (except for split losses, old losses, and external losses and scenarios).

Step 3: Model an operational risk loss distribution in each cell of the business line/event type matrix using an actuarial approach. This involves deriving one distribution for event frequency and one distribution for severity from loss data and then combining them using Monte Carlo simulation.

Step 4: Determine the operating risk capital requirements for each business line by combining empirical distributions and parametric tail distributions.

The overall operational risk capital requirement for the firm would combine the results in each of the cells from the business line/event type matrix in such a way that takes into account that losses would not be perfectly correlated (i.e., diversification).

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Frequency Distributions

As mentioned, LDA models have two dimensions, frequency of loss and severity of loss. Each is modeled separately. With respect to frequency, LDA models most often use the **Poisson distribution**, the **negative binomial distribution**, or the **binomial distribution**. Some practitioners suggest only using internal data because it is most relevant, and it is difficult to ensure the completeness of external data. Also, modeling the frequency distribution requires less data when compared to modeling the severity. When using external loss data in the frequency calibration, the external frequency data has to be scaled.

The calibration process for the frequency distributions uses a time series of internal frequency data in each cell and separates frequency data into monthly buckets in order to ensure that the number of data points is sufficient for a statistical analysis. The goal is to choose the appropriate distribution (e.g., Poisson distribution). This is done by comparing the mean and variance and applying a goodness-of-fit test such as a chi-squared test. The chosen distribution should be the one that most closely fits the hypothetical distribution.

Another way to determine the proper distribution analyzes the interarrival time of losses. Assuming the loss events follow a Poisson distribution, the interarrival times between the events follow an exponential distribution, and the data is fit to that distribution. A chi-squared test then assesses the quality of the fit. Firms have generally used the Poisson distribution over the binomial distribution to fit frequency distributions.

Severity Distributions

Loss severity is often modeled with a **lognormal distribution**. This distribution is asymmetrical (i.e., the frequency of high-impact, low-frequency losses is not equal to the frequency of low-impact, high-frequency losses) and fat-tailed (i.e., rare events occur more often than would be indicated by a normal distribution). The mean and standard deviation are derived from the logarithm of losses.

The severity distributions are generally considered more important than the frequency distributions. There are some practical considerations that make modeling severity more difficult. One problem is that recent internal loss data (five to seven years) may not be sufficient for calibrating tails of severity distributions. Using external data usually requires scaling the data and combining data from several sources.

Furthermore, for a more complete model of possible losses, the analyst should extrapolate the observed losses to estimate values beyond those observed. The common approach is to fit the losses to a parametric distribution that allows for values beyond those observed and use that distribution to extrapolate the additional values. The goal is to get values "in the tail" of the distribution. Choosing the distribution is a non-trivial task, which can have a significant impact on the model's results. Analysts have found that it may be best to separate the distribution and model the body and the tail separately (i.e., extreme value theory), which obviously adds complexity.

Another practical consideration is to recognize that the analyst's ultimate goal is to determine the operational risk capital reserve (or charge), and extrapolations could lead to the inclusion of extremely severe hypothetical losses and an overestimation of the needed

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capital reserve. Finally, in developing the process, the analyst must consider how she will communicate it to colleagues and managers in other departments.

Dependencies in LDA Models

To this point, we have assumed that losses in cells are independent and that the estimated frequency and severity distributions, modeled separately, are independent. There are several types of dependencies that can affect the true probability of loss and the economic capital of the bank. There can be *within-cell* dependencies, which include the dependence between the following:

- The occurrence of loss events.
- The frequency distribution and the severity distribution.
- Severity samples in a cell.

It may also be possible to have *between-cell* dependencies. The statistical evidence supports the assumption that the frequency and severity distributions in a cell are independent and the severity samples are independent. Furthermore, the regulatory focus is on modeling dependencies between cells, that is, between different business lines/event types. The choices in modeling these dependencies are (1) the level of the dependencies (i.e., frequencies, severities, or loss distributions) and (2) the appropriate mathematical models.

In practice, for various reasons, the focus is further narrowed to the dependencies of frequency distributions. Copula functions can model the dependency of frequency distributions and, for simplicity, Gaussian copulas are often used. To take into account the uncertainty regarding the correct copula family, the correlation estimates are chosen conservatively. It has been found that the correlations between the frequencies are significant only between specific subsets of cells, but are still rather low.

Aggregate Loss Distribution

LO 44.5: Describe techniques used to get an aggregated loss distribution from frequency and severity distributions.

Through a process called **convolution**, the frequency and severity distributions can be combined into a single operational loss distribution. Constructing the loss distribution for the entire institution is accomplished through Monte Carlo simulation across the loss frequency and severity data, beginning with each loss type in each business line, and then aggregating across all business lines/event types. With this single operational loss distribution, a bank can then identify the mean annual loss and the loss at any given confidence level, and determine the amount of capital required to support the potential operational risk. Note that while it is unlikely that losses are perfectly correlated, it may be unreasonable to assume no correlation. Therefore, analysis of the correlations between business line/event type data may be required.

Once the loss distribution (that combines severity and frequency) is constructed, we can examine the difference between the operational value at risk (OpVaR) measure and expected loss to determine the amount of capital needed to cover potential operational risk losses (i.e., unexpected losses).

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Selecting Operational Risk Categories

LO 44.2: Describe key guidelines for the selection of a bank's Operational Risk Categories (ORCs).

Operational risks are quite diverse, ranging from losses that result from natural disasters to fraud committed by employees. As a result, banks categorize operational risks based on similar characteristics (i.e., event types). The capital charge is significantly influenced by the number of **operational risk categories** (ORCs) the bank chooses. There is sizeable variation between banks regarding the number of ORCs. The Basel Committee guides banks toward comparable standards when selecting ORCs for operational risk modeling. The committee also requires that an AMA bank's risk measurement system must be granular enough to capture the drivers of operational risk that impact the shape of the tail in the loss distribution.

Supervisory guidelines regarding ORCs include:

- Banks should consider both the complexities and the idiosyncrasies (e.g., risk profile, history of operational losses, business profile, business environment, and so on) of the bank's operations when modeling operational risks. Banks should characterize operational risks (i.e., choose ORCs) along these factors. Risks that share common factors should be grouped together.
- Granularity must remain valid in the face of significant changes to the bank or the bank's risk profile.
- Very low and very high numbers of ORCs are both problematic, especially when used in conjunction with a loss distribution approach (LDA). When a bank uses only one or a few categories, granularity is lost. However, when a bank uses a very high number of ORCs, the number of losses in each category is likely to fall below the model's data threshold. The importance of the bank's business lines may be one factor used to determine the level of granularity (i.e., the number of ORCs).
- The bank should provide evidence to supervisory authorities that the choice of ORCs is reasonable and does not adversely impact other risk model factors such as correlations, diversification assumptions, and capital allocation.
- The bank should support the reasonableness of the number of ORCs, particularly with respect to the impact on operational risk capital charges. Both quantitative and qualitative methods should be used to support the choice of granularity. For example, for the event type External Fraud, there are the "business as usual" type frauds that are small and somewhat frequent (e.g., petty theft and robbery) and large, unusual fraudulent activities (e.g., Ponzi schemes). The External Fraud category should be split into subcategories to reflect the two very different types of fraud.
- A high number of ORCs may lead to an unrealistically high capital charge if no correlations are modeled and capital charges for all ORCs are summed. On the other hand, it may be difficult for a bank to validate correlation assumptions due to minimal loss data for a large number of ORCs. Banks must mitigate these issues by choosing the appropriate number of ORCs.
- When choosing ORCs, the bank should consider the capital allocation to internal business lines. Changes in the ORCs do not necessarily have to correspond to changes in the capital allocation method. Changes in business units that do not affect the risk profile of the bank do not have to result in changes to the ORCs. However, these changes will have to be incorporated in the capital allocation process.

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Modeling ORC Distributions

LO 44.4: Explain key guidelines for modeling the distribution of losses within individual ORCs, including the selection of thresholds, necessary adjustments, and selection of statistical tools and probability distributions.

According to the committee, the basis of all operational risk models is a distribution of risk losses. Most banks model the severity and frequency distributions separately. The distributions are fitted to the calculation dataset that fulfills the requirements to serve as inputs in the AMA operational risk model. The bank must demonstrate that the distributional assumptions capture potentially severe "tail" loss events.

As mentioned earlier, the most common frequency distribution used by banks is the Poisson distribution. Banks may assume that losses follow similar or different paths. For example, high frequency low impact events (HFLI) (i.e., the body of the distribution) may follow a different path than low frequency high impact events (LFHI) (i.e., the tail of the distribution). In fact, 50% of AMA banks apply two separate distributions for the body and the tail data. Banks also differ in their choices of modeling thresholds and the methods they use to estimate the distribution parameters. Ultimately these differences result in the variations across banks in the calculations of operational risk capital requirements.

Supervisory guidelines regarding the building of the calculation dataset include:

- There should be a policy that identifies when a loss that is recorded in the internal or external loss event database is also included in the calculation dataset.
- The observation period, reference date, de minimis modeling thresholds, data treatment, and so on must be addressed as the bank builds a proper calculation dataset.
- Low frequency events (e.g., Ponzi scheme) may require five years or more of data collection to generate reliable operational risk measures and ensure that all material losses are included in the calculation dataset.
- The bank should not use losses net of insurance recoveries in AMA models.

Supervisory guidelines regarding probability distributions include:

- The choice of distributions related to severity is critical to AMA models. Medium/heavy-tailed distributions are frequently used. The choice of the frequency distribution is less important to the final outcome than the choice of the severity distribution.
- Probability distributions must be consistent with all of the elements of the AMA model, realistic (i.e., realistic capital requirement estimates result), well specified (characteristics of the fitted data are similar to the loss data), flexible (accommodates a wide variety of empirical data), and simple (easy to implement and generate random numbers for loss simulations).
- The bank should document and be able to verify the choice of a distribution. The bank should undertake exploratory data analysis (EDA) for each ORC in order to understand the statistical profile of the data. This allows (or at least assists) the bank to choose an appropriate distribution. The bank should also use appropriate techniques and diagnostic tools to evaluate distributions. *Preference should be given to distributions that are most sensitive to the tail.*

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- Banks should use statistical tools that examine the statistical properties of each ORC (i.e., homogeneity, independence, and stationarity). Tools may include scatter plots, time series autocorrelation plots, regression analysis, histograms, and empirical distribution plots. Mean excess plots, p-p plots, and q-q plots provide evidence of the type and shape of the probability distributions.
- Data from a severity perspective (as opposed to a frequency perspective) illustrate positive skewness and medium/heavy tailedness (i.e., exhibits leptokurtosis). Due to the dispersion of the data, the higher moments of the distribution (standard deviation, skewness, and kurtosis) are calculable but likely very large. The bank should not use empirical curves to estimate the tail region because it is impossible to extrapolate information beyond the last observable data point. The use of **sub-exponential distributions** (e.g., lognormal, lognormal-gamma, log-gamma, generalized Pareto, Burr, Weibull with shape parameter < 1) is highly recommended by the committee.
- When two distributions are used (i.e., for the body and tail), the bank should carefully choose the body-tail modeling threshold that distinguishes the two areas.
- Data is scarce and estimates of kurtosis-related parameters (which describe the tail region of the losses) can be highly unstable. The bank should use methodologies that reduce estimate variability and should provide measures of errors around the estimates such as confidence intervals and *p*-values.
- Robust estimation methods should be used, making certain that methodologies do not underestimate tail risk.
- The bank should use tools such as goodness-of-fit tests and graphical methods to assess the quality of the fit between the distribution selected by the bank and the bank's operational risk loss data. Goodness-of-fit tests that are more sensitive to the tail should be used (e.g., the Anderson-Darling upper tail test).
- **Goodness-of-fit tests** are sensitive to sample size and the number of parameters estimated. Thus, the tests do not always indicate the best fitting distribution. Alternative methods that use relative performance of the distributions at different confidence intervals such as the Likelihood Ratio, the Schwarz Bayesian Criterion, and the Violation Ratio may be preferable.

Within an ORC, losses should be independent of each other. There is a tradeoff between rigor and conservatism. Banks should be more conservative when using dependence assumptions that are less rigorous. However, supervisory authorities will not accept conservatism in place of sound assumptions.

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Modeling Dependence

LO 44.6: Explain supervisory guidelines for modeling dependence and correlation effects between operational risk factors across different operational risk categories.

Multiple business lines within a bank have exposure to shared policies, structural factors (e.g., IT systems), and environmental factors (e.g., legal risk). These factors give rise to operational risk dependence, and will likely impacted loss frequency and loss severity throughout the bank. There are several approaches for modeling dependence and correlation effects; however, the choice of approach will play a major role in a bank's operational risk capital requirements. Thus, it is important to ensure that the analysis of dependence is not impacted by any spurious exposure differences.

Supervisory guidelines regarding dependence and correlation effects include:

- Historical data and expert opinion should be combined to support dependence assumptions. Data limitations may arise from subjective choices of internal and external loss data, as well as the number of ORCs.
- Due to unknowns regarding dependence modeling, the assumptions surrounding dependence should be conservative. For example, it is recommended to use a t-distribution instead of a normal distribution when estimating dependence between tail events because the normal distribution will likely underestimate the tails of a loss distribution.
- As dependence model complexity increases and reliability of capital estimates decreases, the level of conservatism should increase.
- If the losses within each ORC are not independent, within-ORC dependence should be modeled or data inputs for the model should be modified to reflect independence.
- The choice of granularity should not impact dependence modeling inappropriately. In other words, banks need to ensure that dependence assumptions are not being influenced by the choice of too few or too many ORCs.
- Sensitivity analysis and stress testing should be conducted considering different dependence assumptions (e.g., different correlation models). Results from this analysis may encourage a bank to revise its estimate of operational risk capital requirements.
- Some consistency in dependence assumptions across multiple banks is acceptable given the evolving nature of dependence models for operational risk.

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Key Concepts

LO 44.1

The operational risk management framework (ORMF) is the umbrella under which all operational risk management operations fall. According to the Basel Committee, sound internal governance forms the foundation of an effective ORMF.

The operational risk measurement system (ORMS) includes all factors that are components of risk measurement and modeling systems used to estimate operational risk capital charges.

All components of the ORMF and the ORMS must be verified and validated.

Validation provides assurance of the integrity of the inputs in AMA operational risk capital models, the assumptions used in the models, bank processes, and model outputs. Validation allows the bank a degree of certainty that the AMA measurement methodologies result in credible estimates of operational risk capital.

Verification is conducted by internal and/or external audits and may be conducted by qualified third parties. It is done on a periodic basis. Verification is concerned with the overall effectiveness of the ORMF.

LO 44.2

Banks categorize operational risks, which are quite diverse, based on similar characteristics (i.e., event types). The capital charge is significantly influenced by the number of operational risk categories (ORCs).

The Basel Committee requires that an AMA bank's risk measurement system sufficiently capture operational risk factors that influence estimates of extreme losses.

LO 44.3

The loss distribution approach (LDA) has several steps, which largely involve organizing the data to model the losses with frequency and severity distributions and ultimately determining the capital requirements.

LDA models frequency of loss and severity of loss separately. For the frequency, LDA models use the Poisson distribution, the negative binomial distribution, or the binomial distribution.

Assumptions concerning the severity distributions are generally considered more important than the frequency distributions, and using external data is usually necessary. Also, an analyst may wish to extrapolate the observed losses to estimate values beyond those observed.

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LO 44.4

According to the committee, the basis of all operational risk models is a distribution of risk losses. Most banks model the severity and frequency distributions separately.

Loss distributions are fitted to the calculation dataset (i.e., the dataset that includes the operational risk losses of the bank) that fulfills the requirements to serve as inputs in the AMA operational risk model. The bank must demonstrate that the distributional assumptions capture potentially severe "tail" loss events.

LO 44.5

Through a process called convolution, the frequency and severity distributions can be combined into a single operational loss distribution. Once the loss distribution (that combines severity and frequency) is constructed, we can examine the difference between the operational value at risk (OpVaR) measure and expected loss to determine the amount of economic capital needed to cover potential operational risk losses (i.e., unexpected losses).

LO 44.6

Common exposures to polices, structural factors, and environmental factors give rise to operational risk dependence across multiple areas within a bank. This dependence will likely impact a bank's frequency and severity of losses. The chosen approach for modeling dependence will influence a bank's operational risk capital requirements.

LO 44.7

The Basel Committee suggests that there are four data elements that a bank must use in various combinations to calculate the operational risk capital charge based on the AMA framework. The four data elements are (1) internal loss data, (2) external loss data, (3) scenario analysis, and (4) business environment and internal control factors (BEICFs).

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Concept Checkers

1. The loss distribution approach (LDA) typically models:
   A. frequency of loss and severity of loss separately.
   B. frequency of loss and severity of loss in a single bivariate distribution.
   C. frequency of loss but not severity of loss.
   D. severity of loss but not frequency of loss.

2. The Basel Committee requires that four data elements be used to calculate a bank's operational risk capital charge. Which of the following is not one of the four elements?
   A. External loss data.
   B. Scenario analysis.
   C. Internal loss data.
   D. Regression analysis and other statistical tools.

3. All of the factors that are components of risk measurement and modeling systems used to estimate operational risk capital charges are included in the:
   A. operational risk measurement system (ORMS).
   B. corporate operational risk function (CORF).
   C. business environment and internal control factors (BEICFs).
   D. Standards Implementation Group Operational Risk Subgroup (SIGOR).

4. Which of the following risk management activities is generally conducted by internal and external audits or third parties?
   A. Validation.
   B. Verification.
   C. Certification.
   D. Authentication.

5. Great North Bank and Trust utilizes the advanced measurement approach (AMA). The risk managers in the bank have been very careful to meet all the requirements of the Basel Committee's guidelines. They have chosen a very large number of operational risk categories (ORCs) for risk management. Which of the following problems is most likely to result from choosing too many operational risk categories?
   A. Too many losses that fall below the bank's data threshold.
   B. A loss of granularity.
   C. An inability to capture the complexities and idiosyncrasies of the bank's operations when modeling operational risks.
   D. Loss data that is too high for each category.

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Concept Checker Answers

1. A The LDA models frequency of loss and severity of loss separately. For loss frequency, LDA models use the Poisson distribution, the negative binomial distribution, or the binomial distribution. Loss severity is often modeled with a lognormal distribution.

2. D The Basel Committee requires four data elements that a bank must use in various combinations to calculate the operational risk capital charge based on the AMA framework. The four data elements are (1) internal loss data, (2) external loss data, (3) scenario analysis, and (4) business environment and internal control factors (BEICFs).

3. A The operational risk measurement system (ORMS) includes all factors that are components of risk measurement and modeling systems used to estimate operational risk capital charges. Business environment and internal control factors (BEICFs) are subjective and are often used as indirect inputs in models or are used ex post to adjust a model's output.

4. B There are subtle differences between verification and validation of the operational risk management systems. Verification is conducted by internal and/or external audits and may be conducted by qualified third parties. It is done on a periodic basis. Verification is concerned with the overall effectiveness of the ORMF. ORMS validation processes must be verified as well. Validation provides assurance of the integrity of the inputs in AMA operational risk capital models, the assumptions used in the models, bank processes, and model outputs. Validation allows the bank a degree of certainty that AMA measurement methodologies result in credible estimates of operational risk capital.

5. A Very low and very high numbers of ORCs are both problematic, especially when used in conjunction with the LDA. When a bank uses only one or a few categories, granularity is lost. However, when a bank uses a very high number of ORCs, the number of losses in each category is likely to fall below the model's data threshold. The importance of the bank's business lines may be one factor used to determine the level of granularity (i.e., the number of ORCs).

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

Model Risk

Topic 45

Exam Focus

Models are indispensible in modern finance in quantifying and managing asset-liability risk management, credit risk, market risk, and many other risks. Models rely on a range of data input based on a combination of historical data and risk assumptions, and are critical in managing risk exposures and financial positions. However, models rely on the accuracy of inputs, and errors give rise to model risk. Model risk can range from errors in inputs and assumptions to errors in implementing or incorrectly interpreting a model, and can result in significant losses to market participants. For the exam, be able to identify and explain common model errors, model implementation and valuation issues, and model error mitigation techniques. Also, be familiar with the two case studies discussed related to model risk: Long-Term Capital Management and the London Whale incident.

Sources of Model Risk

LO 45.1: Identify and explain errors in modeling assumptions that can introduce model risk.

Modeling is a critical component in the risk management of an organization. Models help quantify risk and other exposures as well as potential losses. However, models can be complex and are subject to **model risk**, which includes input errors, errors in assumptions, and errors in interpretation.

Model Complexity

When quantifying the risk of simple financial instruments such as stocks and bonds, model risk is less of a concern. These simple instruments exhibit less volatility in price and sensitivities relative to complex financial instruments so, therefore, their market values tend to be good indicators of asset values. However, model risk is a significantly more important consideration when quantifying the risk exposures of complex financial instruments, including instruments with embedded options, exotic over-the-counter (OTC) derivatives, synthetic credit derivatives, and many structured products. For these complex instruments, markets are often illiquid and do not provide sufficient price discovery mechanisms, which puts greater emphasis on models to value instruments, typically through a mark-to-model valuation approach. These models are important not only for valuing instruments and assessing risk exposure, but also to determine the proper hedging strategy.

As financial instruments increase in complexity, so do the models used to value them. More complex models, such as the Black-Scholes-Merton option pricing model, increased the

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threat of model risk, especially for the more complex derivatives such as interest rate caps and floors, swaptions, and credit and exotic derivatives. As technology advanced, so did the complexity of the models created and used. The growth in complexity of the models also increased the reliance on these models. In addition, managers often do not have a solid understanding of the more complex models. When models are difficult to understand, the risk of model errors and the risk of incorrect vetting, interpretation, and oversight increases.

The dangers of relying too heavily on complex models became especially apparent during the 2007–2009 financial crisis. When markets endure a prolonged period of turmoil, models tend to underestimate the volatilities, correlations, and risks of financial instruments, and can overstate values, all of which may lead to sustained losses by market participants. Since models are often used for valuing instruments, a model may show that a strategy is profitable when in fact it is experiencing losses. Following the global credit crisis, model risk became more regulated as the Basel Committee mandated that financial institutions more rigorously assess model risk.

Common Model Errors

Model risk has been apparent over the last several decades through various international crises. A model may be incorrect if it contains incorrect assumptions about a financial instrument's price or risk. One example of model error was the remarkable collapse in 1997 of a hedge fund run by Victor Niederhoffer, a well-known Wall Street trader. The fund's strategy was to write (sell) deep out-of-money put options on the S&P 500, based on the assumption that the index volatility would not exceed 5% daily, and therefore, the option would expire worthless. In October 1997, the Asian financial crisis created a contagion effect that impacted North American markets. As a result, market volatilities increased significantly above historical levels. This level of volatility was not priced into the advanced mathematical models used by the fund which instead assumed a normal distribution of risk and historical correlations. The fund ultimately experienced substantial losses as its equity was completely wiped out.

Losses from model errors can be due to errors in assumptions, carelessness, fraud, or intentional mistakes that undervalue risk or overvalue profit. The six common model errors are as follows:

1. *Assuming constant volatility.* One of the most common errors in modeling is the assumption that the distribution of asset price and risk is constant. The 2007–2009 financial crisis showed just how incorrect this assumption can be, when market volatilities not predicted by models increased significantly over a short period of time.

2. *Assuming a normal distribution of returns.* Market participants frequently make the simplifying assumption in their models that asset returns are normally distributed. Practice has shown, however, that returns typically do not follow a normal distribution, because distributions in fact have fat tails (i.e., unexpected large outliers).

3. *Underestimating the number of risk factors.* Many models assume a single risk factor. A single risk factor may produce accurate prices and hedge ratios for simple products such as a callable bond. For more complex products, including many exotic derivatives (e.g., Bermuda options), models need to incorporate multiple risk factors.

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4. *Assuming perfect capital markets.* Models are generally derived with the assumption that capital markets behave perfectly. Consider a delta hedge strategy that requires active rebalancing based on the assumption that the underlying asset position is continuously adjusted in response to changes in the derivatives price. This strategy will not be effective if capital markets include imperfections, including limitations on short selling, various costs (e.g., fees and taxes), and a lack of continuous trading in the markets.

5. *Assuming adequate liquidity.* Models often assume liquid markets for long or short trading of financial products at current prices. During periods of volatility, especially extreme volatility, as seen during the recent financial crisis, liquidity could decline or dry up completely.

6. *Misapplying a model.* Historically, model assumptions have worked well in most world markets, but tend to break down during periods of greater uncertainty or volatility. For example, traditional models assuming normality did not work well in many countries, including the United States, Europe, and Japan in the post financial crisis period, which has been characterized by low or negative interest rates and unconventional monetary policies including quantitative easing. In these markets, models that include other statistical tools work better.

   Similarly, models that work well for traditional assets could yield incorrect results when complex factors including embedded options are factored in. Another example of misapplying a model is to use one that was created to value bonds with no embedded options (e.g., a non-callable, non-convertible bond) to now value bonds with embedded options (e.g., a callable, convertible bond).

LO 45.2: Explain how model risk can arise in the implementation of a model.

In the previous section, we looked at the most common model errors. However, even correct models can be incorrectly implemented. This section looks at the most common implementation issues. Models may be affected by programming bugs or approximation errors, and models that seemed to work under normal conditions may have errors when tested under stressed market conditions.

Common Model Implementation Errors

Implementation error could occur, for example, when models that require Monte Carlo simulations are not allowed to run a sufficient number of simulations. In such a case, even if all the model inputs and assumptions are correct, the results may still be incorrect if insufficient time is given for the computations.

For the implementation of models, important considerations should include how frequently the model parameters need to be refreshed, including volatilities and correlations. Analysts responsible for maintaining models must consider whether adjustments should occur periodically at scheduled dates, or only when material economic events occur. Similarly, the treatment of outliers should also be considered. For example, should outliers be considered extreme outcomes only (that is, not part of the true distribution), or should they be considered part of the true distribution? Correctly answering these questions became especially important in the post-financial crisis period.

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Correctly estimating parameters like durations, volatilities, and correlations is very difficult, and implementing a model with input errors will result in inaccurate results. For example, in the 1970s the investment banking firm Merrill Lynch used incorrect hedge durations for government bonds, which resulted in a considerable loss to the firm. In another example, during the stressed conditions of the financial crisis, default correlations within structured products moved toward the binary extremes of +1 or −1. In other words, the cumulative default rates of collateralized debt obligations (CDOs) either all remained below a threshold with no defaults in any tranches, or all moved above a threshold, leading to defaults of even the AAA-rated tranches.

Common Valuation and Estimation Errors

Models also rely on the accuracy of inputs and values fed into the model, and are therefore subject to human error. *Human error* is particularly of concern in new or developing markets where adequate controls have not been fully defined and implemented.

Common valuation and estimation errors include:

1. *Inaccurate data.* Models may use both internal and external data sources, where the responsibility for data accuracy is not clearly assigned. This could lead to errors from using inaccurate data.

2. *Incorrect sampling period length.* Increasing the number of observations is expected to improve data accuracy and reduce estimation errors. However, including old (and therefore obsolete) statistics could put too much weight on stale data.

3. *Liquidity and valuation problems.* Accurate pricing and valuation may not be possible in all markets. Prices for a particular asset may not exist in certain markets, or the bid-ask spread may be too high to offer accurate valuation.

Mitigating Model Risk

LO 45.3: Explain methods and procedures risk managers can use to mitigate model risk.

Model risk can be mitigated either through investing in research to improve the model or through an independent vetting process. Investing in research leads to developing better and more accurate statistical tools, both internally and externally. Independent vetting includes the independent oversight of profit and loss calculations as well as the model selection and construction process. Vetting consists of the following six phases:

1. *Documentation.* Documentation should contain the assumptions of the underlying model and include the mathematical formulas used in the model. It should contain a term sheet to describe the transaction, a mathematical statement of the model (all the variables and processes, payoff function and pricing algorithms, calibrations, and hedge ratios and sensitivities), and the implementation features, including inputs, outputs, and any numerical methods.

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2. *Model soundness.* Vetting should ensure that the model used is appropriate for the financial instrument being valued. For example, a model valuing option-free bonds would not be appropriate to value convertible or callable bonds.

3. *Independent access to rates.* To facilitate independent parameter estimation, the model vetter should ensure that the middle office has access to independent financial rates.

4. *Benchmark selection.* The vetting process should include selecting the appropriate benchmark based on assumptions made. Results from the benchmark test should be compared with the results from the model test.

5. *Health check and stress test.* Models should be vetted to ensure they contain all necessary properties and parameters. Models should also be stress tested to determine the range of values for which the model provides accurate pricing.

6. *Incorporate model risk into the risk management framework.* Model risk should be considered in the formal risk management governance and framework of an institution. In addition, models need to be periodically reevaluated for relevance and accuracy. Empirical evidence suggests that simple, robust models work better than more complex and less robust models.

Case Studies Related to Model Risk

LO 45.4: Explain the impact of model risk and poor risk governance in the 2012 London Whale trading loss and the 1998 collapse of Long Term Capital Management.

The impact of model risk has been felt significantly during two specific incidents: the 1997 collapse of Long-Term Capital Management (LTCM) and the 2012 "London Whale" trading loss at JPMorgan Chase (JPM). Both incidents illustrate the necessity to closely examine and vet models, and the importance of considering model risk within an organization's institutional risk governance framework.

Long-Term Capital Management

Background and Trading Strategies

LTCM was a U.S. hedge fund that existed between 1994 and 1998. The fund raised in excess of $1 billion in capital at its inception and grew rapidly over its initial years. LTCM's trading strategy relied on arbitrage positions based on market-neutral and relative-value trading. The fund began primarily as a bond arbitrage hedge fund that sought to make money by exploiting the spread differentials between bonds, including spread differences of European sovereign bonds and spread differences of corporate bonds and government Treasuries in the United States and United Kingdom.

LTCM relied on a combination of extensive empirical research and advanced financial modeling to formulate bets on convergence of prices in bond markets. For example, the fund was long (bought) Spanish and Italian sovereign debt and was short (sold) German

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sovereign debt. The strategy assumed that German sovereign bonds were overpriced relative to the weaker Spanish and Italian bonds, which were expected to increase in value with the imminent membership in the European economic and monetary union.

Another strategy was based on the expected convergence between the spreads of corporate and government bonds in the United States and United Kingdom, where spreads were expected to return to normal levels. This strategy was designed to make a profit regardless of the movement in price levels, assuming, however, that spreads moved in the appropriate direction and that correlations did not change materially.

Leverage, Correlations, and Volatility

LTCM's strategies were designed to generate only modest profits (around 1%). In order for the fund to generate strong performance, it needed to use extensive leverage of up to 25 times. Such leveraged positions relied on large institutional loans that were collateralized by bond investments. Shortly before the fund's collapse in 1998, LTCM had capital of close to $5 billion, assets of over $125 billion, and a notional value of investments in excess of $1.25 trillion. The magnitude of LTCM's leveraged investments was unprecedented in the markets.

LTCM's strategies worked as long as positions converged as anticipated, and as long as correlations did not deviate significantly from historical levels. Volatilities were calculated based on mathematical models to be approximately in line with the risk of investing in the S&P 500. However, at the time of the fund's collapse, its one-day volatility exceeded its model predicted volatility by 2.5 times, and the fund suffered losses of more than 3 times its 10-day predicted maximum loss.

Collapse and Lessons

In 1997, Asian markets experienced considerable economic and financial problems that quickly spread to several economies as contagion increased. These troubles ultimately affected Russia, which was forced to devalue its currency, the ruble, and default on its sovereign debt in August 1998. The Asian and Russian crisis triggered a flight-to-quality in European and North American markets with investors seeking the safe and predictable returns of high-quality sovereign bonds. As a result, the yields of the U.S. and German long-term sovereign bonds declined (their prices increased), while at the same time the yields on the riskier corporate bonds and riskier sovereign bonds (for example, Italy and Spain) increased (their prices fell). Credit spreads widened, volatilities increased beyond historical levels, and correlations in the market moved closer to +1 as the contagion effect of the crisis spread across markets.

With higher volatilities and dramatically widening spreads, the profits on LTCM's short positions were no longer sufficient to offset the losses on its long positions. With losses mounting, lenders demanded additional collateral. In order to meet collateral calls, LTCM had to unwind several unprofitable trades that put further downward pressure on markets given the size of the fund's trading positions. At the same time, liquidity in the markets quickly began to dry up, leaving many of LTCM's market-neutral positions now directionally exposed on the long side. Ultimately, the fund became insolvent in September 1998 and was bailed out by the Federal Reserve Bank of New York in order to curb a potential global financial crisis.

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LTCM's collapse highlighted several flaws in its regulatory value at risk (VaR) calculations:

1. The fund's calculated 10-day VaR period was too short. A time horizon for economic capital should be sufficiently long enough to raise new capital, which is longer than the 10-day assumption.

2. The fund's VaR models did not incorporate liquidity assumptions. The assumption of perfectly liquid markets proved to be incorrect when the fund experienced liquidity droughts.

3. The fund's risk models did not incorporate correlation and volatility risks. This weakness was especially evident when markets moved to a correlation of close to +1 and volatility increased significantly above historical and model predicted levels.

London Whale

Background and Trading Strategy

JPMorgan Chase & Company (JPM), along with its principal banking subsidiary JPMorgan Chase Bank, is a U.S. financial company and one of the largest derivatives traders in the world. JPM garnered international headlines when in the first half of 2012 it sustained losses in excess of $6 billion due to risky synthetic credit derivatives trades executed by a trader, called the "London Whale", in its London office. The London trading desk belonged to JPM's Chief Investment Office (CIO), which was responsible for managing the bank's excess deposits.

The CIO was tasked with keeping the bank's risk level down and prudently managing the bank's $350 billion in excess deposits. Instead, the CIO used the deposits to engage in high-profit potential, high-risk derivatives trading strategies. In 2006, the CIO began a new series of synthetic credit derivatives trading strategies within its Synthetic Credit Portfolio (SCP). Trading focused less on hedging risk and more on earning profits from short positions.

Risk Culture, Model Risk, and Operational Risk

The CIO used various risk metrics for its trading activities, including VaR limits and credit spread widening limits.

In 2011, the CIO was instructed to reduce the bank's risk-weighted assets (RWA) in order to reduce regulatory capital requirements. Instead of the common practice of selling high risk assets, the CIO instead launched a trading strategy to offset its outstanding short positions by taking long positions in synthetic credit derivatives. This resulted not only in an increase in the portfolio's risk and size, but it also put the portfolio in a net long position, which reduced the hedging protection provided by the SCP.

Concurrently, in early 2012, and in response to breaching its own internal VaR limits as well as the bank's VaR limits, the CIO adopted a new VaR model which lowered its calculated VaR by 50%. The revised model allowed the CIO to remain within its VaR limit and at the same time engage in more higher-risk trading activities. However, the bank failed to seek regulatory approval of the new model. In addition, there were manual

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and calculation errors when implementing the model, which led to greater model and operational risk for the bank. Ultimately, the revised VaR model was reversed later in 2012 and the previous model was reinstated.

By 2012, the SCP was losing money on its strategies. In order to minimize its reported losses, the CIO changed its derivatives valuation practices from using midpoint prices (prices at the midpoint of the bid and ask) to using more favorable prices within the bid-ask spread during each day. As the losses in the SCP strategy increased, JPM's counterparties began to dispute the CIO's values, which led to frequent collateral disputes. Ultimately, JPM's positions soured and the bank lost close to $6.2 billion.

The losses from the London Whale trade and the subsequent investigations revealed a poor risk culture at JPM. Risk limits were routinely downplayed or ignored, limit breaches were disregarded, and risk models were altered to favor riskier trading activities.

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Key Concepts

LO 45.1

Model risk becomes important when quantifying the risk exposures of complex financial instruments, including exotic or synthetic derivatives and structured products. Model risk can give rise to losses from model errors, errors in assumptions, carelessness, fraud, or intentional mistakes. These errors can lead to undervaluing risk, overvaluing profit, or both. Six common model errors include:

1. Assuming constant volatility.
2. Assuming a normal distribution of returns.
3. Underestimating the number of risk factors.
4. Assuming perfect capital markets.
5. Assuming adequate liquidity.
6. Misapplying a model.

LO 45.2

Implementation error could occur when models that require complex simulations are not allowed to run a sufficient number of runs. This may result in incorrect output and therefore an incorrect interpretation of results.

For model implementation, considerations include frequency of refreshing model parameters, including volatilities and correlations. Correctly estimating parameters (durations, volatilities, and correlations) is challenging, however, implementing a model with input errors will result in inaccurate results.

Common valuation and estimation errors include:

1. Inaccurate data.
2. Incorrect sampling period length.
3. Liquidity and valuation problems.

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LO 45.3

Model risk can be mitigated either through investing in research to improve the model, or through an independent vetting process. Vetting consists of six phases:

1. Documentation.
2. Vetting the soundness of the model.
3. Ensuring independent access to rates.
4. Benchmark selection.
5. Health check and stress testing of the model.
6. Incorporating model risk into the risk management framework.

LO 45.4

Long-Term Capital Management (LTCM) was a U.S. hedge fund that used arbitrage strategies to exploit spread differentials between bonds, including spread differences of European sovereign bonds and spread differences in corporate bonds and government Treasuries. LTCM's strategy was to make predictable, low returns and then amplify them using extensive leverage.

The collapse of LTCM in 1998 highlights three important lessons:

1. Utilizing a 10-day VaR period as a proxy for the time horizon for economic capital is too short. A time horizon is needed that is sufficiently long enough to model the time to raise new capital.
2. The fund's VaR models ignored the possibility that liquidity may decline or even completely dry up in periods of extreme stress.
3. The fund's risk models ignored correlation and volatility risks. Specifically, the fund did not account for stressed scenarios with material rises in volatility or an increase in positive market correlation as contagion risk spread across international economies.

In 2012, JPMorgan Chase (JPM) and its Chief Investment Office (CIO) sustained severe losses due to risky synthetic credit derivatives trades executed by its London office. The losses from the London Whale trade and the subsequent investigations highlighted a poor risk culture at JPM, giving rise to both model and operational risks across the firm. Risk limits were routinely ignored and limit breaches were disregarded.

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Concept Checkers

1. A risk analyst for a mid-sized bank believes that two common errors in model building include the assumption of constant volatility of returns and the assumption of a non-normal returns distribution. The analyst is correct with regard to the assumption(s) of:
   A. volatility of returns only.
   B. non-normal returns distribution only.
   C. both volatility of returns and non-normal returns distributions.
   D. neither volatility of returns nor non-normal returns distributions.

2. Which of the following scenarios is the best example of a model error?
   A. Assuming a non-normal distribution of returns.
   B. Assuming perfectly liquid markets.
   C. Assuming variable distribution of asset price.
   D. Assuming imperfect capital markets.

3. The chief risk officer (CRO) of a European corporation recommends increasing the length of the sampling period in order to minimize model risk. However, increasing the length of the sampling period will most likely:
   A. increase estimation errors.
   B. diminish the power of the statistical test.
   C. put higher weight on obsolete information.
   D. diminish the relevance of old data.

4. Gamma Investments, LLC (Gamma) uses monthly model vetting to mitigate potential model risk. Gamma's managers recently accepted the use of a model for valuing short-term options on 30-year corporate bonds, but rejected the same model to value short-term options on three-year government bonds. The managers also frequently test proposed analytical models against a simulation approach. These model vetting techniques are examples of which of the following vetting phases?

	Accepting/rejecting a model	Testing models against simulation
A.	Health check of the model	Stress testing
B.	Soundness of a model	Stress testing
C.	Health check of the model	Benchmark modeling
D.	Soundness of a model	Benchmark modeling

5. Which of the following flaws in Long-Term Capital Management's (LTCM) value at risk (VaR) calculations were most evident following its collapse in 1998?
   I. The calculated 10-day VaR period was too short.
   II. The fund's VaR model assumed strong positive correlation.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

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Concept Checker Answers

1. A The analyst is correct with respect to the assumption of volatility of returns only. Another common model error is the assumption of a normal distribution of returns. Market participants frequently make the simplifying assumption in their models that asset returns are normally distributed. However, empirical research shows that returns tend to be non-normally distributed.

2. B Six common model errors include: (1) assuming constant volatility, (2) assuming a normal distribution of returns, (3) underestimating the number of risk factors, (4) assuming perfect capital markets, (5) assuming adequate liquidity, and (6) misapplying a model.

3. C Adding more observations to the model reduces estimation errors and improves the power of statistical tests. However, it gives greater relevance to old and potentially stale data and puts greater weight on obsolete information which may now be irrelevant.

4. D Accepting the model for one use but rejecting it for another (inappropriate) use is an example of vetting the soundness of the model. In other words, the model vetter (in this case the risk managers) should ensure that the mathematical model reasonably represents the asset being valued.

   Testing a proposed analytical model against a simulation approach or a numerical approximation technique is an example of benchmark modeling.

   Health check of the model ensures that the model contains all of the necessary properties. Stress testing a model uses simulations to check the model's reaction to different situations.

5. A LTCM's collapse highlighted several flaws in its regulatory VaR calculations. The fund relied on a VaR model that: (1) used a 10-day horizon, which proved to be too short to sufficiently model the time to raise new capital, (2) did not factor in liquidity risk (in other words, it assumed markets were perfectly liquid), and (3) did not incorporate correlation and volatility risks, where in fact markets exhibited strong positive correlation during periods of stress in 1997 and 1998.

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

Risk Capital Attribution and Risk-Adjusted Performance Measurement

Topic 46

Exam Focus

This topic covers the application of the risk-adjusted return on capital (RAROC) approach to the allocation of economic capital. The application of a hurdle rate for capital budgeting decisions as well as an adjusted version of the traditional RAROC approach is also presented. For the exam, know the differences between economic capital and regulatory capital, and be able to compute RAROC for capital budgeting as well as adjusted RAROC. Also, be familiar with the qualitative concepts discussed, such as reasons for using economic capital to allocate risk capital, the benefits of RAROC, and best practices in implementing the RAROC approach.

Risk Capital

LO 46.1: Define, compare, and contrast risk capital, economic capital, and regulatory capital, and explain the motivations for using economic capital.

Risk capital provides protection against risk (i.e., unexpected losses). In other words, it can be defined as a (financial) buffer to shield a firm from the economic impact of risks taken. Should a disastrous event occur, those impacts could otherwise jeopardize the firm's financial security and its ability to remain a going concern. In short, risk capital provides assurance to the firm's stakeholders that their invested funds are safe. In most cases, risk capital and **economic capital** are treated synonymously, although an alternative definition of economic capital exists (discussed further in LO 46.3):

economic capital = risk capital + strategic risk capital

On the other hand, there are at least three distinct differences between risk capital and **regulatory capital** as follows:

1. Unlike risk capital, regulatory capital is relevant only for regulated industries such as banking and insurance.

2. Regulatory capital is computed using general benchmarks that apply to the industry. The result is a minimum required amount of capital adequacy that is usually far below the firm's risk capital.

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3. Assuming that risk capital and regulatory capital are the same for the overall firm, the amounts may be different within the various divisions of the firm. From a risk capital allocation perspective, one solution is to allocate the greater of risk capital and regulatory capital to a certain division.

Professor's Note: We will examine the regulatory capital charges for credit, market, and operational risk in the Basel readings later in this book.

Given that Basel III requirements are sufficiently robust, it is probable that in certain areas (e.g., securitization), regulatory capital will be substantially higher than risk/economic capital. Although the two amounts may conflict, risk/economic capital must be computed in order to determine the economic viability of an activity or division. Assuming that regulatory capital is substantially higher than risk/economic capital for a given activity, then that activity will potentially move over to shadow banking (i.e., unregulated activities by regulated financial institutions) in order to provide more favorable pricing.

Motivations for Using Economic Capital

From the perspective of financial institutions, the motivations for using economic capital are as follows:

Capital is used extensively to cushion risk. Compared to most other non-financial institutions, financial institutions can become highly leveraged (i.e., riskier) at a relatively low cost simply by accepting customer deposits or issuing debt. All of this may occur without having to issue equity. Additionally, many of the financial institutions will participate in transactions involving derivatives, guarantees, and other commitments that only require a relatively small amount of funding but always involve some risk. As a result, all of the firm's activities must be allocated an economic capital cost.

Financial institutions must be creditworthy. A unique aspect of financial institutions is that their main customers are also their main liability holders. Customers who deposit funds to a financial institution will be concerned about the default risk of the financial institution. With over-the-counter (OTC) derivatives, the concern is counterparty risk. As a result, a sufficient amount of economic capital must be maintained to provide assurance of creditworthiness.

There is difficulty in providing an external assessment of a financial institution's creditworthiness. It is challenging to provide an accurate credit assessment of a financial institution because its risk profile is likely to be constantly evolving. For example, an institution may engage in complicated hedging and derivatives transactions that could rapidly impact its liquidity. Therefore, having a sufficient store of economic capital could mitigate this problem and provide assurance of financial stability.

Profitability is greatly impacted by the cost of capital. Economic capital is similar to equity capital in the sense that the invested funds do not need to be repaid in the same manner as debt capital, for instance. In other words, economic capital serves as a reserve or a financial cushion in case of an economic downturn. As a result, economic capital is more expensive to hold than debt capital, thereby increasing the cost of capital and reducing the financial institution's profits. A proper balance between holding sufficient economic capital and partaking in risky transactions is necessary.

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Risk-Adjusted Return on Capital

LO 46.2: Describe the RAROC (risk-adjusted return on capital) methodology and its benefits.

The **risk-adjusted return on** capital (RAROC) methodology provides users with information pertaining to the risk-adjusted performance of the firm and its business units as opposed to merely the "raw" performance numbers. In measuring economic performance, this methodology involves allocating risk capital to the firm's business units and to specific transactions.

Benefits of RAROC include:

1. Performance measurement using economic profits instead of accounting profits. Accounting profits include historical and arbitrary measures such as depreciation, which may be less relevant.

2. Use in computing increases in shareholder value as part of incentive compensation (e.g., scorecards) within the firm and its divisions. The flexibility of RAROC may also allow for deferred/contingent compensation or clawbacks for subsequent poor performance.

3. Use in portfolio management for buy and sell decisions and use in capital management in estimating the incremental value-added through a new investment or discontinuing an existing investment.

4. Using risk-based pricing, which will allow proper pricing that takes into account the economic risks undertaken by a firm in a given transaction. Each transaction must consider the expected loss and the cost of economic capital allocated. Many firms use the "marginal economic capital requirement" portion of the RAROC equation for the purposes of pricing and determining incremental shareholder value.

LO 46.3: Compute and interpret the RAROC for a project, loan, or loan portfolio, and use RAROC to compare business unit performance.

The necessary amount of economic capital is a function of credit risk, market risk, and operational risk. The RAROC for a project or loan can be defined as risk-adjusted return divided by risk-adjusted capital. The basic RAROC equation is as follows:

$$\text{RAROC} = \frac{\text{after-tax expected risk-adjusted net income}}{\text{economic capital}}$$

There is a tradeoff between risk and return per unit of capital with the numerator acting as return and the denominator acting as risk. For example, a business unit's RAROC needs to be greater than its cost of equity in order to create shareholder value.

Furthermore, measures such as return on equity (ROE) or return on assets (ROA) are based on accounting book values only, and therefore are unable to account for the relevant risks. RAROC has two specific adjustments to these measures. In the numerator, it deducts expected loss (the risk factor) from the return. In the denominator, it replaces accounting capital with economic capital.

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The underlying principles of the RAROC equation are similar to two other common measures of risk/return: (1) the Sharpe ratio, which equals: (expected return – risk-free rate) / standard deviation, and (2) the net present value (NPV), which equals the discounted value of future expected after-tax cash flows. The discount rate for the NPV is a risk-adjusted expected return that uses beta (captures systematic risk only) from the capital asset pricing model (CAPM). In contrast to NPV, RAROC takes into account both systematic and unsystematic risk in its earnings figure.

A more detailed RAROC equation to use for capital budgeting decisions is as follows:

$$\text{RAROC} = \frac{\left(\begin{array}{l}\text{expected revenues} - \text{costs} - \text{expected losses} \\ - \text{taxes} + \text{return on economic capital} \pm \text{transfers}\end{array}\right)}{\text{economic capital}}$$

Where:

- *Expected revenues* assume no losses and *costs* refer to direct costs. *Taxes* are computed using the firm's effective tax rate and *transfers* include head office overhead cost allocations to the business unit as well as transactions between the business unit and the treasury group, such as borrowing and hedging costs.
- *Expected losses* (EL) consist mainly of expected default losses (i.e., loan loss reserve), which are captured in the numerator (i.e., higher funding cost) so there is no adjustment required in the denominator. Expected losses also arise due to market, operational, and counterparty risks.
- *Return on economic capital* refers to the return on risk-free investments based on the amount of allocated risk capital.
- *Economic capital* includes both risk capital and strategic risk capital.

Risk capital serves as a buffer against unexpected losses. It is the amount of funds that the firm must hold in reserve to cover a worst-case loss (an amount over the expected loss) at a specific confidence level that is usually 95% or more. Therefore, it is very similar to the annual value at risk (VaR).

Strategic risk capital pertains to the uncertainty surrounding the success and profitability of certain investments. An unsuccessful investment could result in financial losses and a negative reputational impact on the firm. Strategic risk capital includes goodwill and burned-out capital.

- **Goodwill** is the excess of the purchase price over the fair value (or replacement value) of the net assets recorded on the balance sheet. A premium price may exist because of the existence of valuable but unrecorded intangible assets.
- **Burned-out capital** represents the risk of amounts spent during the start-up phase of a venture that may be lost if the venture is not pursued because of low projected risk-adjusted returns. The venture may refer to a recent acquisition or an internally generated project. Burned-out capital is amortized over time as the strategic failure risk decreases.

Finally, firms may allocate risk capital to any unused risk limits (e.g., undrawn amounts on a line of credit) because risk capacity could be utilized any time. If risk capacity is utilized, the firm would then have to adjust the risk capital amount.

As mentioned, economic capital is designed to provide a cushion against *unexpected losses* at a specified confidence level. The confidence level at which economic capital is set can be viewed as the probability that the firm will be able to absorb unexpected losses over

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a specified period. A simple example can help illustrate the concept of unexpected loss and how it is equal to the risk capital allocation. Assume for a given transaction that the expected loss is 20 basis points (bps) and the worst-case loss is 190 bps at a 95% confidence level over one year. Based on this information, the unexpected loss is 170 bps (excess of worst-case loss over expected loss). There is also still a 5% probability that the actual loss will exceed 190 bps.

Example: RAROC calculation

Assume the following information for a commercial loan portfolio:

- $1.5 billion principal amount
- 7% pre-tax expected return on loan portfolio
- Direct annual operating costs of $10 million
- Loan portfolio is funded by $1.5 billion of retail deposits; interest rate = 5%
- Expected loss on the portfolio is 0.5% of principal per annum
- Unexpected loss of 8% of the principal amount, or $120 million of economic capital required
- Risk-free rate on government securities is 1% (based on the economic capital required)
- 25% effective tax rate
- Assume no transfer pricing issues

Compute the RAROC for this loan portfolio.

Answer:

First, calculate the following RAROC components:

Expected revenue = 0.07 × $1.5 billion = $105 million
Interest expense = 0.05 × $1.5 billion = $75 million
Expected loss = 0.005 × $1.5 billion = $7.5 million
Return on economic capital = 0.01 × $120 million = $1.2 million

Then, apply the RAROC equation:

$$\text{RAROC} = \frac{(105-10-75-7.5+1.2+0)\times(1-0.25)}{120} = 8.56\%$$

Therefore, maintenance of the commercial loan portfolio requires an after-tax expected rate of return on equity of at least 8.56%.

Note that for capital budgeting projects, *expected* revenues and losses should be used in the numerator since the analysis is being performed on an ex ante (or before the fact) basis. In contrast, for performance evaluation purposes on an ex post (or after the fact) basis, *realized* (or actual) revenues and losses should be used.

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Economic Capital Assumptions

LO 46.4: Explain the impact of changing assumptions used in calculating economic capital, including choosing a time horizon, measuring default probability, and choosing a confidence level.

Time Horizon

In computing RAROC, the focus so far has been on one period (i.e., one-year time horizon) since it is convenient from a business planning cycle perspective and it represents the probable amount of time needed for a firm to recover from a significant unexpected loss. At the same time, it is possible to look at multi-period RAROC to obtain a more accurate RAROC measure for longer-term transactions and loans. One issue that arises is how much economic capital to allocate if the risk of a transaction changes dramatically in subsequent periods. For example, using an averaging method would give rise to periods of overcapitalization and periods of undercapitalization.

Risk capital could be thought of as the firm's one-year VaR at a specific confidence level (e.g., 95% or 99%). For both credit risk and operational risk, no adjustments are required from one-year VaR to compute risk capital. For market risk, short time horizons such as one day (risk monitoring) or 10 days (regulatory capital) require adjustments to determine the correct one-year risk capital allocation.

One basic approach is the "square root of time" rule whereby one-year VaR is estimated by multiplying the one-day VaR by the square root of 252 business days in the year. This approach needs to be fine-tuned by considering that even in a worst-case scenario, the firm might only be able to reduce its risk to a core risk level to retain its status as a financially viable business for the rest of the year. Furthermore, the computation must also factor in the time needed to lower the current risk level to the core risk level (i.e., "time to reduce"). That amount of time corresponds to the relative liquidity (during difficult market conditions) of the firm's investment positions taken. As a result, a large amount of time may be required for a reasonable liquidation of the positions.

Example: Risk capital for market risk

Assume the following information where the core risk level is below the current risk level:

- Daily value at risk (VaR) = 80
- Core risk level = 60
- Days needed to reduce current risk level to core risk level = 10 (i.e., risk reduction of 2 VaR per day)
- Number of business days per year = 252

Compute the required risk capital as a percentage of annualized VaR.

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Answer:

$$\text{Risk capital} = \text{square root}\left\{\begin{bmatrix}\text{sum of squares} + \\ \text{core risk level squared} \times (\text{number of business days per year} - \\ \text{days needed to reduce current to core})\end{bmatrix}\right\}$$

$$= \text{square root}\left\{\begin{bmatrix}(80^2 + 78^2 + 76^2 + 74^2 + 72^2 + 70^2 + 68^2 + 66^2 + 64^2 + 62^2) + \\ \left[60^2 \times (252 - 10)\right]\end{bmatrix}\right\}$$

$$= \text{square root}\left[50{,}740 + (3{,}600 \times 242)\right]$$

$$= \sqrt{921{,}940} = 960.18$$

Note that annualized VaR = 80 × square root of 252 = 1,269.96

Therefore, the risk capital required is approximately 75.6% of annualized VaR (960.18 / 1,269.96).

There is a lot of subjectivity in selecting the time horizon for RAROC calculation purposes. A longer time horizon could be selected to account for the full business cycle; it may not always increase the risk capital required since the confidence level required to maintain a firm's solvency will fall as the time horizon is increased. A key consideration with the selection of a time horizon is the fact that risk and return data for periods over one year is likely to be of questionable reliability.

Default Probability

A **point-in-time** (PIT) probability of default could be used to compute short-term expected losses and to price financial instruments with credit risk exposure. A **through-the-cycle** (TTC) probability of default is more commonly used for computations involving economic capital, profitability, and strategic decisions.

A firm's rating is more likely to change when analyzed under the PIT approach versus the TTC approach. As a result, the TTC approach results in a lower volatility of economic capital versus the PIT approach. From time to time, it is advisable to compare the result of PIT versus TTC for RAROC computations at a stable portion of the economic cycle and at the lowest portion of the cycle.

Confidence Level

In computing economic capital, the confidence level chosen must correspond with the firm's desired credit rating. A high rating such as AA or AAA would require a confidence level in excess of 99.95%, for example. Choosing a lower confidence level will reduce the amount of risk capital required/allocated and it will impact the risk-adjusted performance measures. The reduction may be dramatic if the firm is primarily exposed to operational, credit, and settlement risks where large losses are rare.

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Hurdle Rate for Capital Budgeting Decisions

LO 46.5: Calculate the hurdle rate and apply this rate in making business decisions using RAROC.

Similar to internal rate of return (IRR) analysis, the use of a **hurdle rate** (i.e., after-tax weighted average cost of equity capital) is compared to RAROC in making business decisions. In general, the hurdle rate should be revised perhaps once or twice a year or when it has moved by over 10%.

The hurdle rate, $h_{AT,}$ is computed as follows:

$$h_{AT} = \frac{[(CE \times R_{CE}) + (PE \times R_{PE})]}{(CE + PE)}$$

where:
CE = market value of common equity
PE = market value of preferred equity
R_{CE} = cost of common equity [could be derived from the capital asset pricing model (CA M)]
R_{PE} = cost of preferred equity (yield on preferred shares)

Recall, that the CA M formula is as follows:

$$R_{CE} = R_F + \beta_{CE}(R_M - R_F)$$

where:
R_F = risk-free rate
R_M = expected return on market portfolio
β_{CE} = firm's common equity market beta

Once the hurdle rate and the RAROC are calculated, the following rules apply:

- If RAROC > hurdle rate, there is value creation from the project and it should be accepted.
- If RAROC < hurdle rate, there is value destruction from the project and it should be rejected/discontinued.

Obviously, a shortcoming of the above rules is that higher return projects that have a RAROC > hurdle rate (accepted projects) also come with high risk that could ultimately result in losses and reduce the value of the firm. In addition, lower return projects that have a RAROC < hurdle rate (rejected projects) also come with low risk that could provide steady returns and increase the value of the firm. As a result, an adjusted RAROC measure should be computed.

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Adjusted RAROC

LO 46.6: Compute the adjusted RAROC for a project to determine its viability.

RAROC should be adjusted to consider systematic risk and a consistent hurdle rate.

$$\text{Adjusted RAROC} = \text{RAROC} - \beta_E (R_M - R_F)$$

where:
R_F = risk-free rate = hurdle rate
R_M = expected return on market portfolio
β_E = firm's equity beta
$(R_M - R_F)$ = excess return over risk-free rate to account for the nondiversifiable systematic risk of the project

Therefore, the revised business decision rules are as follows:

- If adjusted RAROC > R_F, then accept the project
- If adjusted RAROC < R_F, then reject the project

Example: Adjusted RAROC

Suppose RAROC is 12%, the risk-free rate is 5%, the market return is 11%, and the firm's equity beta is 1.5. Use ARAROC to **determine** whether the project should be accepted or rejected.

Answer:

$$\text{Adjusted RAROC} = \text{RAROC} - \beta_E (R_M - R_F)$$
$$= 0.12 - 1.5(0.11 - 0.05) = 0.12 - 0.09 = 0.03$$

The project should be rejected because the ARAROC of 3% is less than the risk-free rate of 5%.

Risk Capital and Diversification

LO 46.7: Explain challenges in modeling diversification benefits, including aggregating a firm's risk capital and allocating economic capital to different business lines.

The overall risk capital for a firm should be less than the total of the individual risk capitals of the underlying business units. That is because the correlation of returns between the business units is likely to be less than +1. Such risk reduction due to diversification effects over risk types and business activities is very difficult to measure in practice. Instead of using an extremely high overall confidence level for the firm, the various business units may use lower confidence levels to avoid an excessively high aggregate risk capital amount.

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For example, assume a firm is subject to only the following four types of risk (risk capital amounts are provided for each risk):

- Market risk = $400
- Credit risk = $300
- Liquidity risk = $200
- Operational risk = $500

Aggregate risk capital for the firm could be as high as $1,400 assuming a perfect correlation (i.e., sum of the four risk capital amounts). Or it could be as low as $734 assuming zero correlation (square root of the sum of squares of the four risk capital amounts). In taking into account the diversification effects, the firm's overall VaR should be computed as some value between $734 and $1,400, which is a very wide range. In addition, there is a lot of subjectivity involved in allocating the diversification benefits back to the business units in a fair manner especially since the allocation will impact the respective business units' performance measures (i.e., reduction of risk capital required).

It makes sense that a business unit with earnings or cash flows that are highly correlated to the overall firm would need to be allocated more risk capital than a business unit with earnings or cash flows that are negatively correlated (assuming similar volatility). Having business lines that are countercyclical in nature allows the overall firm to have stable earnings and to attain a given desired credit rating using less risk capital. In practice, the easiest allocation method is a pro-rata allocation based on standalone risk capital amounts.

For example, assume the following information pertaining to a business unit that engages in only two activities, A and B:

- Activity A alone requires $50 of risk capital
- Activity B alone requires $60 of risk capital
- Activities A and B together require a total of $90 of risk capital

Stand-alone capital looks at each activity independently and ignores any diversification benefits. Therefore, the stand-alone capital for Activities A and B are $50 and $60, respectively. The stand-alone capital for the business unit is $90.

Fully diversified capital takes into consideration the diversification benefits, which equal $20 ($50 + $60 – $90). For simplicity, the diversification benefit can be done on a pro-rata basis as follows: ($20 × $50) / $110 = $9.1 is allocated to Activity A and ($20 × $60) /$110 = $10.9 is allocated to Activity B. Therefore, Activities A and B have fully diversified capital of $40.9 and $49.1, respectively. Fully diversified capital should be used to determine a firm's solvency and to determine the minimum amount of risk capital required for a given activity.

Marginal capital is the extra capital needed as a result of a new activity added to the business unit. Diversification benefits are fully considered. The marginal risk capital for Activity A is $30 ($90 total – $60 for Activity B) and the marginal risk capital for Activity B is $40 ($90 total – $50 for Activity A). Total marginal risk capital ($70) is below the full risk capital of the business unit ($90). The general method for computing marginal capital of a new activity is to start with the total risk capital required for the business unit minus all of the risk capital required for the other activities. Marginal capital is useful for making active portfolio management and business mix decisions; such decisions need to fully consider diversification benefits.

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In a performance measurement context, stand-alone risk capital is useful to determine incentive pay and fully diversified risk capital is useful to determine the incremental benefit due to diversification. In allocating the diversification benefits, caution must be taken especially since correlations between the risk factors usually change over time. In a more extreme situation such as a market crisis, correlations could move to –1 or +1, thereby reducing diversification benefits.

RAROC Best Practices

LO 46.8: Explain best practices in implementing a RAROC approach.

Recommendations for implementing a RAROC approach are as follows:

Senior Management

The management team (including the CEO) needs to be actively involved with the implementation of a RAROC approach within the firm and promote it as a means of measuring shareholder value creation. The emphasis should be on the level of profits earned by the firm in relation to the level of risks taken as opposed to merely earning as much profit as possible.

Communication and Education

The RAROC process needs to be clearly explained to all levels of management of the firm in order to have sufficient "buy in" from management. Specifically, the process of allocating economic capital to the various business units needs to be fair and transparent in order to minimize the common concerns of excessive economic capital attribution to a given business unit. An open dialogue and debate with the various business unit leaders of issues concerning how economic capital is computed would also be helpful.

Ongoing Consultation

There are key metrics that impact the computation of economic capital. A committee consisting of members from the various business units as well as the risk management group should review these metrics periodically in order to promote fairness in the capital allocation process.

Metrics involving credit risk include: probability of default, credit migration frequencies, loss given default, and credit line usage given default. The metrics will change with time and will need to be updated accordingly. The historical period over which the metrics are adjusted is debatable—a shorter period may result in fluctuating economic capital amounts and a longer period may result in more stable amounts.

Metrics involving market risk focus on volatility and correlation, and should be updated at least monthly. Metrics involving operational risk are not as defined as they are for credit and market risk, so therefore, involve a significant amount of subjectivity and debate. Other key metrics, like core risk level and time to reduce, should be updated annually.

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Data Quality Control

Information systems collect data (e.g., risk exposures and positions) required to perform the RAROC calculations. The data collection process should be centralized with built-in edit and reasonability checks to increase the accuracy of the data. In subdividing the general duties surrounding data, the RAROC team should be responsible for the data collection process, the computations, and the reporting. The business units and the accounting department should be responsible for putting controls in place to ensure the accuracy of the data being used for the RAROC calculations.

Complement RAROC with Qualitative Factors

A qualitative assessment of each business unit could be performed using a four-quadrant analysis. The horizontal axis would represent the expected RAROC return and the vertical axis would represent the quality of the earnings based on the importance of the business unit's activities to the overall firm, growth opportunities, long-run stability and volatility of earnings, and any synergies with other business units. There are four resulting possibilities:

- Low quality of earnings, low quantity of earnings: the firm should try to correct, reduce, or shut down the activities of any of its business units in this category.
- Low quality of earnings, high quantity of earnings (managed growth): the firm should maintain any business units that currently produce high returns but have low strategic importance to the firm.
- High quality of earnings, low quantity of earnings (investment): the firm should maintain any business units that currently produce low returns but have high strategic value and high growth potential.
- High quality of earnings, high quantity of earnings: the firm should allocate the most resources to business units in this category.

Active Capital Management

Business units should submit their limit requests (e.g., economic capital, leverage, liquidity, risk-weighted assets) quarterly to the RAROC team. The RAROC team performs the relevant analysis and sets the limits in a collaborative manner that allows business units to express any objections. Senior management will then make a final decision. The treasury group will ensure the limits make sense in the context of funding limits. The restriction placed on a firm's growth due to leverage limitations helps promote the optimal use of the limited amount of capital available.

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Key Concepts

LO 46.1

Risk capital is a buffer to shield a firm from the economic impacts of the risks that it takes (i.e., protect against unexpected losses). In short, it provides assurance to the firm's stakeholders that their invested funds are safe.

In most cases, risk capital and economic capital are identical; however, strategic risk capital may be added to economic capital as follows:

economic capital = risk capital + strategic risk capital

Regulatory capital is relevant only for regulated industries such as banking and insurance. It is computed using general benchmarks that apply to the industry. Assuming that risk capital and regulatory capital are the same for the overall firm, the amounts may be different within the various divisions of the firm.

For financial institutions, there are four major reasons for using economic capital to allocate risk capital:

- Capital is used extensively to cushion risk.
- Financial institutions must be creditworthy.
- Difficulty in providing an external assessment of a financial institution's creditworthiness.
- Profitability is greatly impacted by the cost of capital.

LO 46.2

Benefits of using the risk-adjusted return on capital (RAROC) approach include:

1. Performance measurement using economic profits instead of accounting profits.

2. Use in computing increases in shareholder value as part of incentive compensation (e.g., scorecards) within the firm and its divisions.

3. Use in portfolio management for buy and sell decisions and use in capital management in estimating the incremental value-added through a new investment or discontinuing an existing investment.

4. Using risk-based pricing, which will allow proper pricing that takes into account the economic risks undertaken by a firm in a given transaction.

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LO 46.3

The basic RAROC equation is as follows:

$$\text{RAROC} = \frac{\text{after-tax expected risk-adjusted net income}}{\text{economic capital}}$$

A more detailed RAROC equation for capital budgeting decisions is as follows:

$$\text{RAROC} = \frac{\left(\begin{array}{l}\text{expected revenues} - \text{costs} - \text{expected losses} \\ - \text{taxes} + \text{return on economic capital} \pm \text{transfers}\end{array}\right)}{\text{economic capital}}$$

LO 46.4

In computing RAROC, the focus is often on a one-year time horizon. However, it is possible to look at multi-period RAROC to obtain a more accurate RAROC measure for longer-term transactions and loans. One issue that arises is how much economic capital to allocate if the risk of a transaction changes dramatically in subsequent periods. There is a lot of subjectivity in selecting the time horizon for RAROC calculation purposes. A longer time horizon could be selected to account for the full business cycle, for example. A key consideration with the selection of a time horizon is the fact that risk and return data for periods over one year is likely to be of questionable reliability.

A point-in-time (PIT) probability of default could be used for short-term expected losses and to price financial instruments with credit risk exposure. A through-the-cycle (TTC) probability of default is more commonly used for computations involving economic capital, profitability, and strategic decisions.

In computing economic capital, the confidence level chosen must correspond with the firm's desired credit rating. Choosing a lower confidence level will reduce the amount of risk capital required/allocated and it will impact risk-adjusted performance measures.

LO 46.5

The hurdle rate is computed as follows:

$$h_{AT} = \frac{\left[(CE \times R_{CE}) + (PE \times R_{PE})\right]}{(CE + PE)}$$

Once the hurdle rate and the RAROC are calculated, the following rules apply:

- If RAROC > hurdle rate, there is value creation from the project and it should be accepted.
- If RAROC < hurdle rate, there is value destruction from the project and it should be rejected/discontinued.

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LO 46.6

RAROC should be adjusted to take into account systematic risk and a consistent hurdle rate as follows:

$$\text{Adjusted RAROC} = \text{RAROC} - \beta_E (R_M - R_F)$$

LO 46.7

The overall risk capital for a firm should be less than the total of the individual risk capitals of the underlying business units. This is because the correlation of returns between business units is likely to be less than +1.

A business unit with earnings or cash flows that are highly correlated to the overall firm should be allocated more risk capital than a business unit with earnings or cash flows that are negatively correlated (assuming similar volatility). Having business lines that are countercyclical in nature allows the overall firm to have stable earnings and to attain a given desired credit rating using less risk capital.

LO 46.8

The management team needs to be actively involved with the implementation of a RAROC approach within the firm and promote it as a means of measuring shareholder value creation.

The RAROC process needs to be clearly explained to all levels of management of the firm in order to have sufficient "buy in" from management.

A committee consisting of members from the various business units as well as the risk management group should periodically review the metrics that impact economic capital calculations in order to promote fairness in the capital allocation process.

The RAROC team should be responsible for the data collection process, the computations, and the reporting. The business units and the accounting department should be responsible for putting controls in place to ensure the accuracy of the data being used for the RAROC calculations.

A qualitative assessment of each business unit could be performed using a four-quadrant analysis. The horizontal axis would represent the expected RAROC return and the vertical axis would represent the quality of the earnings based on the importance of the business unit's activities to the overall firm, growth opportunities, long-run stability and volatility of earnings, and any synergies with other business units.

Business units should submit their limit requests (e.g., economic capital, leverage, liquidity, risk-weighted assets) quarterly to the RAROC team. The RAROC team performs the relevant analysis and sets the limits in a collaborative manner that allows business units to express any objections.

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Concept Checkers

1. Which of the following statements regarding the risk-adjusted return on capital (RAROC) methodology is correct?
   A. In the context of performance measurement, RAROC uses accounting profits.
   B. In the numerator of the RAROC equation, expected loss is added to the return.
   C. If a business unit's cost of equity is greater than its RAROC, then the business unit is not adding value to shareholders.
   D. RAROC is useful for determining incentive compensation but it lacks the flexibility to consider deferred or contingent compensation.

2. Assume the following information for a commercial loan portfolio:
   - $1.2 billion principal amount
   - 6% pre-tax expected return on loan portfolio
   - Direct annual operating costs of $8 million
   - Loan portfolio funded by $1.2 billion of retail deposits; interest rate = 4%
   - Expected loss on the portfolio is 0.4% of principal per annum
   - Unexpected loss of 7% of the principal amount
   - Risk-free rate on government securities is 1%
   - 30% effective tax rate
   - Assume no transfer pricing issues

   Based on the information provided, which of the following amounts is closest to the RAROC?
   A. 9.33%
   B. 10.03%.
   C. 12.33%.
   D. 14.66%.

3. Which of the following statements regarding the computation of economic capital is correct?
   I. Selecting a longer time horizon for RAROC calculations is preferable because risk and return data is more reliable with more time.
   II. Choosing a lower confidence level will not likely reduce the amount of risk capital required if the firm has little exposure to operational, credit, and settlement risks.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

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4 Which of the following statements regarding the choice of default probability approaches in computing economic capital is correct?

A. A through-the-cycle (TTC) approach should be used to price financial instruments with credit risk exposure.
B. A point-in-time (PIT) approach is more commonly used for computations involving profitability and strategic decisions.
C. A TTC approach is more likely to result in a lower volatility of capital compared to the PIT approach.
D. A firm's rating will not change when analyzed under the PIT approach versus the TTC approach.

5. Which of the following statements regarding best practices in implementing a RAROC approach is correct?

A. A successful RAROC approach is focused on maximizing profits earned by the firm.
B. A restriction on the firm's growth due to leverage limitations may result in higher profits.
C. The data collection process throughout the firm should be decentralized to allow the various business units to ensure the utmost accuracy of data.
D. Metrics involving credit risk, market risk, and operational risk to compute economic capital are generally clearly defined and may be computed objectively.

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Concept Checker Answers

1. C The cost of equity represents the minimum rate of return on equity required by shareholders. Therefore, if RAROC is below the cost of equity, then there is no value being added.

   Response A is not correct because RAROC uses economic profits, not accounting profits. Response B is not correct because in the numerator of the RAROC equation, expected loss is deducted from the return. Response D is not correct because RAROC has the flexibility to consider deferred or contingent compensation.

2. B Unexpected loss ($1.2 billion × 7% = $84 million) is equal to the amount of economic capital required. The return on economic capital is then $84 million × 1% = $0.84 million. Also, expected revenues = 0.06 × $1.2 billion = $72 million; interest expense = 0.04 × $1.2 billion = $48 million; expected losses = 0.004 × $1.2 billion = $4.8 million.

$$\text{RAROC} = \frac{\left(\begin{array}{l}\text{expected revenues} - \text{costs} - \text{expected losses} \\ - \text{taxes} + \text{return on economic capital} \pm \text{transfers}\end{array}\right)}{\text{economic capital}}$$

$$\text{RAROC} = \frac{(72 - 8 - 48 - 4.8 + 0.84 + 0) \times (1 - 0.3)}{84} = 10.03\%$$

3. B Choosing a lower confidence level will not likely reduce the amount of risk capital required if the firm has little exposure to operational, credit, and settlement risks. The reduction would be much more dramatic only if the firm has significant exposure to such risks because large losses would be rare.

   In selecting a time horizon for RAROC calculations, risk and return data for periods over one year is likely to be of questionable reliability.

4. C A firm's rating is more likely to change when analyzed under the point-in-time (PIT) approach compared to the through-the-cycle (TTC) approach. As a result, the TTC approach results in a lower volatility of economic capital compared to the PIT approach.

   A PIT approach should be used to price financial instruments with credit risk exposure and to compute short-term expected losses. A TTC approach is more commonly used for computations involving profitability, strategic decisions, and economic capital.

5. B A restriction on the firm's growth due to leverage limitations may result in higher profits because it requires the firm to be "creative" and to optimize a scarce resource (the limited amount of capital available).

   Response A is not correct. A successful RAROC approach is focused on the level of profits earned by the firm in relation to the level of risks taken. Response C is not correct. The data collection process should be the responsibility of the RAROC team; the process should be centralized with built-in edit and reasonability checks to increase the accuracy of the data. Response D is not correct. Metrics involving operational risk are not as defined as credit and market risk, therefore, there is often a significant amount of subjectivity involved in the computations.

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

Range of Practices and Issues in Economic Capital Frameworks

Topic 47

Exam Focus

This topic requires an understanding of many risk management concepts that you have already covered at FRM Part I, as well as in earlier readings in the FRM Part II curriculum. Specifically, this topic expands on the concept of economic capital, which is the capital required to absorb unexpected losses for a given time horizon and confidence interval. For the exam, pay attention to the terminology and attempt to integrate this material to the sections pertaining to market risk and credit risk so as to reinforce your understanding.

Economic Capital Implementation Framework

LO 47.1: Within the economic capital implementation framework describe the challenges that appear in:

- Defining risk measures
- Risk aggregation
- Validation of models
- Dependency modeling in credit risk
- Evaluating counterparty credit risk
- Assessing interest rate risk in the banking book

For this LO, it would be helpful to recall the properties of a **coherent risk measure** from the Part I curriculum. The properties are as follows:

1. **Monotonicity:** A portfolio with greater future returns will likely have less risk.

2. **Subadditivity:** The risk of a portfolio is at most equal to the risk of the assets within the portfolio.

3. **Positive homogeneity:** The size of a portfolio will impact the size of its risk.

4. **Translation invariance:** The risk of a portfolio is dependent on the assets within the portfolio.

Defining Risk Measures

It is not always apparent how risk should be quantified for a given bank, especially when there are many different possible risk measures to consider. Prior to defining specific measures, one should be aware of the general characteristics of ideal risk measures. They

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should be: intuitive, stable, easy to compute, easy to understand, coherent, and interpretable in economic terms. In addition, the risk decomposition process must be simple and meaningful for a given risk measure.

Standard deviation, value at risk (VaR), expected shortfall (ES), as well as spectral (i.e., coherent) and distorted risk measures could be considered, each with their respective pros and cons. Obviously, no one measure would perfectly consider all of the necessary elements in measuring risk. In practice, VaR and ES are the most commonly used measures. The following section is a summary of challenges encountered when considering the appropriateness of each risk measure.

Standard deviation

- Not stable because it depends on assumptions about the loss distribution.
- Not coherent because it violates the monotonicity condition.
- Simple, but not very meaningful in the risk decomposition process.

VaR (the most commonly used measure)

- Not stable because it depends on assumptions about the loss distribution.
- Not coherent because it violates the subadditivity condition (could cause problems in internal capital allocation and limit setting for sub-portfolios).

Expected shortfall

- May or may not be stable, depending on the loss distribution.
- Not easy to interpret, and the link to the bank's desired target rating is not clear.

Spectral and distorted risk measures

- Not intuitive nor easily understood (and rarely used in practice).
- May or may not be stable, depending on the loss distribution.

In defining or using such risk measures, banks often consider several of them and for different purposes. For example, absolute risk and capital allocation within the bank are most commonly measured using VaR, but increasingly, the latter is being measured using ES. The VaR measure of absolute risk tends to be easier to communicate to senior management than ES, but ES is a more stable measure than VaR for allocating total portfolio capital. The challenge for the bank is to determine if and when one or the other, or both, should be used.

Amongst the commonly used measures to calculate economic capital, regulators do not have a clear preference for one over another. If different risk measures are implemented by a bank for external versus internal purposes, then there must be a logical connection between the two risk measures. For regulators, merely comparing a bank's internal and regulatory capital amounts is insufficient when determining the underlying risks in its portfolio. Therefore, such a task presents an analytical challenge to regulators.

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Risk Aggregation

Risk aggregation involves identifying the individual risk types and making certain choices in aggregating those risk types. Classification by risk types (market, credit, operational, and business) may be approximate and prone to error. For example, the definitions of risk types may differ across banks or within a given bank, which complicates the aggregation process.

Even though one or more of the previously mentioned four risk types may be found at the same time within a given bank portfolio, the portfolio will often be represented by one risk type for the bank's classifications purposes. Such a simplistic distinction may result in inaccurate measurements of the risk types and this may bias the aggregation process.

Most banks begin by aggregating risk into silos by risk-type across the entire bank. Other banks prefer using business unit silos, while others combine both approaches. There is no one unanimously accepted method, as each approach has its specific advantages.

Before risk types can be aggregated into a single measure, they must be expressed in comparable units. There are three items to consider: risk metric, confidence level, and time horizon.

1. **Risk metric:** Relies on the metrics used in the quantification of different risk types. Must consider whether the metric satisfies the subadditivity condition.

2. **Confidence level:** Loss distributions for different types of risk are assumed to have different shapes, which implies differences in confidence intervals. The lack of consistency in choosing confidence levels creates additional complexity in the aggregation process.

3. **Time horizon:** Choosing the risk measurement time horizon is one of the most challenging tasks in risk measurement. For example, combining risk measures that have been determined using different time horizons creates problems irrespective of actual measurement methods used. Specifically, there will be inaccurate comparisons between risk types.

A common belief is that combining two portfolios will result in lower risk per investment unit in the combined portfolio versus the weighted average of the two separate portfolios. However, when we consider risk aggregations across different portfolios or business units, such a belief does not hold up with VaR because it does not necessarily satisfy the subadditivity condition. Also, there may be a false assumption that covariance always fully takes into account the dependencies between risks. Specifically, there could be times where the risk interactions are such that the resulting combinations represent higher, not lower, risk. These points highlight an additional challenge in the computation of risk.

There are five commonly used aggregation methodologies. The following is a brief description of them, as well as the challenges associated with using them.

1. Simple summation
   - Adding together individual capital components.

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- Does not differentiate between risk types and therefore assumes equal weighting. Also, does not take into account the underlying interactions between risk types or for differences in the way the risk types may create diversification benefits. In addition, complications arising from using different confidence levels are ignored.

2. Constant diversification
   - Same process as simple summation except that it subtracts a fixed diversification percentage from the overall amount.
   - Similar challenges as simple summation.

3. Variance-covariance matrix
   - Summarizes the interdependencies across risk types and provides a flexible framework for recognizing diversification benefits.
   - Estimates of inter-risk correlations (a bank-specific characteristic) are difficult and costly to obtain, and the matrix does not adequately capture non-linearities and skewed distributions.

4. Copulas
   - Combines marginal probability distributions into a joint probability distribution through copula functions.
   - More demanding input requirements and parameterization is very difficult to validate. In addition, building a joint distribution is very difficult.

5. Full modeling/simulation
   - Simulate the impact of common risk drivers on all risk types and construct the joint distribution of losses.
   - The most demanding method in terms of required inputs. Also, there are high information technology demands, the process is time consuming, and it may provide a false sense of security.

The variance-covariance approach is commonly used by banks. Frequently, however, bank-specific data is not available or is of poor quality. As a result, the items in the variance-covariance matrix are completed on the basis of expert judgment. On a related note, banks often use a "conservative" variance-covariance matrix where the correlations are reported to be approximate and biased upward. In order to reduce the need for expert judgment, banks may end up limiting the dimensionality of the matrix and aggregating risk categories so that there are only a few of them, not recognizing that such aggregations embed correlation assumptions. Clearly, a disadvantage of such a practice is that each category becomes less homogenous and therefore, more challenging to quantify.

One potential disadvantage of the more sophisticated methodologies is that they often lead to greater confidence in the accuracy of the output. It is important to consider robustness checks and estimates of specification and measurement error so as to prevent misleading results.

Validation of Models

Validation is the "proof" that a model works as intended. As an example, while it is a useful tool to test a model's risk sensitivity, it is less useful for testing the accuracy of high quantiles in a loss distribution.

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The validation of economic capital models differs from the valuation of an IRB (internal-ratings based) model because the output of economic capital models is a distribution rather than a single predicted forecast against which actual outcomes may be compared. Also, economic capital models are quite similar to VaR models despite the longer time horizons, higher confidence levels, and greater lack of data.

There are six *qualitative* validation processes to consider. The following is a brief description of them, as well as the challenges associated with using them (where applicable).

1. Use test
   - If a bank uses its measurement systems for internal purposes, then regulators could place more reliance on the outputs for regulatory capital.
   - The challenge is for regulators to obtain a detailed understanding of which model's properties are being used and which are not.

2. Qualitative review
   - Must examine documentation and development work, have discussions with the model's developers, test and derive algorithms, and compare with other practices and known information.
   - The challenge is to ensure that the model works in theory and takes into account the correct risk drivers. Also, confirmation of the accuracy of the mathematics behind the model is necessary.

3. Systems implementation
   - For example, user acceptance testing and checking of code should be done prior to implementation to ensure implementation of the model is done properly.

4. Management oversight
   - It is necessary to have involvement of senior management in examining the output data from the model and knowing how to use the data to make business decisions.
   - The challenge is ensuring that senior management is aware of how the model is used and how the model outputs are interpreted.

5. Data quality checks
   - Processes to ensure completeness, accuracy, and relevance of data used in the model. Examples include: qualitative review, identifying errors, and verification of transaction data.

6. Examination of assumptions—sensitivity testing
   - Assumptions include: correlations, recovery rates, and shape of tail distributions. The process involves reviewing the assumptions and examining the impact on model outputs.

There are also six *quantitative* validation processes to consider. The following is a brief description of them, as well as the challenges associated with using them (where applicable).

1. Validation of inputs and parameters
   - Validating input parameters for economic capital models requires validation of those parameters not included in the IRB approach, such as correlations.

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- The challenge is that checking model inputs is not likely to be fully effective because every model is based on underlying assumptions. Therefore, the more complex the model, the more likely there will be model error. Simply examining input parameters will not prevent the problem.

2. Model replication
   - Attempts to replicate the model results obtained by the bank.
   - The challenge is that the process is rarely enough to validate models and in practice, there is little evidence of it being used by banks. Specifically, replication simply by re-running a set of algorithms to produce the same set of results is not considered enough model validation.

3. Benchmarking and hypothetical portfolio testing
   - The process is commonly used and involves determining whether the model produces results comparable to a standard model or comparing models on a set of reference portfolios.
   - The challenge is that the process can only compare one model against another and may provide little comfort that the model reflects "reality." All that the process is able to do is provide broad comparisons confirming that input parameters or model outputs are broadly comparable.

4. Backtesting
   - Considers how well the model forecasts the distribution of outcomes—comparison of outcomes to forecasts.
   - The challenge is that the process can really only be used for models whose outputs can be characterized by a quantifiable metric with which to compare an outcome. Obviously, there will be risk measurement systems whose outputs cannot be interpreted this way. Also, backtesting is not yet a major part of banks' validation practices for economic purposes.

5. Profit and loss attribution
   - Involves regular analysis of profit and loss—comparison between causes of actual profit and loss versus the model's risk drivers.
   - The challenge is that the process is not widely used except for market risk pricing models.

6. Stress testing
   - Involves stressing the model and comparing model outputs to stress losses.

Overall, although these validation processes may be highly effective in areas such as risk sensitivity, they may not be effective in areas such as overall absolute accuracy.

Additionally, there is difficulty in validating the conceptual soundness of a capital model. The development of a model almost always requires assumptions to be made. However, some of the assumptions may not be testable, so it could be impossible to be absolutely certain of the conceptual soundness of a model. Even though the underlying points may appear reasonable and logical, that may not be the case in practice.

From a regulator's perspective, some industry validation practices are weak, especially for total capital adequacy of the bank and the overall calibration of models. Such a

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validation project is challenging because it usually requires evaluation of high quantiles of loss distributions over long periods of time. In addition, there are data scarcity problems plus technical difficulties, such as tail estimation. Therefore, it is important for senior management and model users to understand the limitations of models and the risks of using models that have not been fully validated.

Dependency Modeling in Credit Risk

Modeling the dependency structure between borrowers is crucial, yet challenging. Both linear and nonlinear dependency relationships between obligors need to be considered.

In general, dependencies can be modeled using: credit risk portfolio models, models using copulas, and models based on the asymptotic single-risk factor (ASRF) model. With the ASRF approach, banks may use their own estimates of correlations or may use multiple systematic risk factors to address concentrations. Such an approach would result in questioning the method used to calibrate the correlations and the ways in which the bank addressed the infinite granularity and single-factor structure of the ASRF model.

There are many issues to consider regarding the challenges in coming up with reliable dependency assumptions used in credit risk portfolio models. Regulators may need to test the accuracy and strength of correlation estimates used by banks given their heavy reliance on model assumptions and the significant impact on economic capital calculations.

In the past, the validity of the following assumptions have been questioned: (1) the ASRF Gaussian copula approach, (2) the normal distribution for the variables driving default, (3) the stability of correlations over time, and (4) the joint assumptions of correctly specified default probabilities and doubly-stochastic processes, which suggest that default correlation is sufficiently captured by common risk factors.

Doubts have been raised about the ability of some models using such assumptions in terms of their ability to explain the time-clustering of defaults that is seen in certain markets. Insufficiently integrating the correlation between probability of default (PD) and loss given default (LGD) in the models, coupled with insufficiently modeling LGD variability, may lead to underestimating the necessary economic capital. Furthermore, it will create challenges in identifying the different sources of correlations and the clustering of defaults and losses.

Rating changes are greatly impacted by the business cycle and are explained by different models during expansionary and recessionary periods. As a result, the sample period and approach used to calibrate the dependency structure could be important in assessing whether correlation estimates are overestimated or underestimated. Furthermore, some models assume that unobservable asset returns may be approximated by changes in equity prices but fail to consider that the relationship between asset returns and equity prices are unobservable and may be non-linear. Also, the use of equity prices to estimate credit default probability is problematic because such prices may include information that is irrelevant for credit risk purposes. As a result, using equity prices may result in some inaccuracy in the correlation estimates.

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In contrast, when banks use a regulatory-type approach, the assumptions of such an approach create other challenges for both banks and regulators:

- Correlation estimates need to be estimated, but there may be limited historical data on which to base the correlation estimates. Also, the assumptions used to generate the correlations may not be consistent with the underlying assumptions of the Basel II credit risk model.
- A bank's use of the Basel II risk weight model requires concentration risk to be accounted for by other measures and/or management methods. It will also require regulators to evaluate such measures/methods.

A key challenge to overcome is the use of misspecified or incorrectly calibrated correlations and the use of a normal distribution (which does not replicate the details of the distribution of asset returns). This may lead to large errors in measuring portfolio credit risk and economic capital.

Evaluating Counterparty Credit Risk

Such a task is a significant challenge because it requires: obtaining data from multiple systems, measuring exposures from an enormous number of transactions (including many that exhibit optionality) spanning a wide range of time periods, monitoring collateral and netting arrangements, and categorizing exposures across many counterparties. As a result, banks need to have well-developed processes and trained staff to deal with these challenges.

Market-risk-related challenges to counterparty exposure at default (EAD) estimation.

- Counterparty credit exposure requires simulation of market risk factors and the revaluation of counterparty positions under simulated risk factor shocks, similar to VaR models. Consider the following two challenges that occur when attempting to use VaR model technology to measure counterparty credit exposure.
  - Market risk VaR models combine all positions in a portfolio into a single simulation. Therefore, gains from one position may fully offset the losses in another position in the same simulation run. However, counterparty credit risk exposure measurement does not allow netting across counterparties. As a result, it is necessary to compute amounts at the netting set level (on each set of transactions that form the basis of a legally enforceable netting agreement), which increases computational complexity.
  - Market risk VaR calculations are usually performed for a single short-term holding period. However, counterparty credit exposure measurement must be performed for multiple holding periods into the future. Therefore, market risk factors need to be simulated over much longer time periods than in VaR calculations, and the revaluation of the potential exposure in the future must be done for the entire portfolio at certain points in the future.

Credit-risk-related challenges to PD and LGD estimation.

- Some material transactions are performed with counterparties with which the bank does not have any other exposures. Therefore, the bank must calculate a probability of default (PD) and loss given default (LGD) for the counterparty and transaction.
- For hedge funds, the measurement challenge occurs when there is little information provided on underlying fund volatility, leverage, or types of investment strategies employed.
- Even for counterparties with which the bank has other credit exposures, the bank still needs to calculate a specific LGD for the transaction.

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Interaction between market risk and credit risk—wrong-way risk.

- Identifying and accounting for wrong-way risk (exposures that are negatively correlated with the counterparty's credit quality) is a significant challenge because it requires an understanding of the market risk factors to which the counterparty is exposed. That would be difficult to do in the case of a hedge fund, for example, which would be less transparent.
- It also requires a comparison of those factor sensitivities to the factor sensitivities of the bank's own exposures to the counterparty.
- The magnitude of wrong-way risk is difficult to quantify in an economic capital model since it requires a long time horizon at a high confidence level.

Operational-risk-related challenges in managing counterparty credit risk.

- The challenge is that managing such risk requires specialized computer systems and people. Complicated transactions, such as daily limit monitoring, marking-to-market, collateral management, and intraday liquidity and credit extensions, increase the risk of measurement errors.
- The quantification of operational risks is a significant challenge, especially when it pertains to new or rapidly growing businesses, new products or processes, intraday extensions of credit, and infrequently occurring but severe events.

Differences in risk profiles between margined and non-margined counterparties.

- The modeling difference between the two types of counterparties is primarily concerned with the future forecasting period. For margined counterparties, the forecasting period is short, and for non-margined counterparties, it is usually much longer.
- As a result of the difference in time periods, the aggregation of risk between these two types of counterparties is a challenge because the usual procedure is to use a single time period for all positions.

Aggregation challenges.

- In general, the challenges are increased significantly when moving from measuring credit risk of one counterparty to measuring credit risk of the firm in general for economic capital purposes.
- When counterparties have both derivatives and securities financing activities, the problem is especially challenging because the systems in place may not be able to handle such aggregation.
- Further aggregation challenges exist when high-level credit risk measures are required to be aggregated with high-level market risk and operational risk measures in order to calculate economic capital.
- Breaking down counterparty credit risk into detailed component parts (as is often done with market risk) is another challenge. The sheer computational complexities and enormous amounts of data required would generally be cost prohibitive to perform on a frequent basis. The challenge still remains for many banks due to outdated or ineffective computer systems.

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Assessing Interest Rate Risk in the Banking Book

The computation challenge arises from the long holding period assumed for a bank's balance sheet and the need to model indeterminate cash flows on both the asset and liability side due to the embedded optionality of many banking book items.

Optionality in the banking book.

- A major measurement challenge is found with non-linear risk from long-term fixed-income obligations with embedded options for the borrower to prepay and from embedded options in non-maturity deposits.
- In considering the asset side of the balance sheet, prepayment risk options (i.e., mortgages, mortgage-backed securities, and consumer loans) are the main form of embedded options. The prepayment option results in uncertain cash flows and makes interest rate risk measurement a difficult task.
- In considering the liability side, there are two embedded options in non-maturity deposits: (1) the bank has an option to determine the interest rate paid to depositors and when to amend the rate, and (2) the depositor has the option to withdraw up to the entire balance with no penalty. The interaction between these two embedded options creates significant valuation and interest rate sensitivity measurement problems.
- Sufficiently modeling optionality exposures requires very complex stochastic-path evaluation techniques.

Banks' pricing behavior.

- This factor contributes to the challenges in measuring the interest rate risk of banking book items. For example, it would require a model to analyze the persistence of the many different non-maturity banking products, as well as a model to determine bank interest rates that consider general market conditions, customer relationships, bank commercial power, and optimal commercial policies.
- Determining bank interest rates would require the pricing of credit risk. The price of credit risk applied to different banking products creates a challenge because it would require a pricing rule that links the credit spread to changes in macroeconomic conditions and interest rate changes. Also, it means that interest rate stress scenarios should consider the dependence between interest rate and credit risk factors.

The choice of stress scenarios.

- The drawbacks of using simple interest rate shocks pose interest rate measurement challenges because the shocks:
  - Are not based on probabilities and, therefore, are difficult to integrate into economic capital models based on VaR.
  - Are not necessarily sensitive to the current rate or economic environment.
  - Do not take into account changes in the slope or curvature of the yield curve.
  - Do not allow for an integrated analysis of interest rate and credit risks on banking book items.

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BIS Recommendations for Supervisors

LO 47.2: Describe the BIS recommendations that supervisors should consider to make effective use of risk measures not designed for regulatory purposes.

There are ten Bank for International Settlements (BIS) recommendations to consider:

1. **Use of economic capital models in assessing capital adequacy.** The bank should show how such models are used in the corporate decision-making process so as to assess the model's impact on which risks the bank chooses to accept. In addition, the board should have a basic understanding of the difference between gross (stand alone) and net (diversified) enterprise-wide risk in assessing the bank's net risk tolerance.

2. **Senior management.** The economic capital processes absolutely require a significant commitment from senior management. They should understand its importance in the corporate planning process and should ensure that there is a strong infrastructure in place to support the processes.

3. **Transparency and integration into decision-making.** Economic capital results need to be easy to trace and understand in order to be useful. Careful attention must be given to obtaining reliable estimates on an absolute basis in addition to developing the flexibility to conduct firm-wide stress testing.

4. **Risk identification.** This is the crucial starting point in risk measurement. The risk measurement process must be very thorough to ensure that the proper risk drivers, positions, and exposures are taken into account in measuring economic capital. That will ensure that there is little variance between inherent (actual) and measured risk. For example, risks that are difficult to quantify should be considered through sensitivity analysis, stress testing, or scenario analysis.

5. **Risk measures.** No given risk measure is perfect, and a bank must understand the strengths and weaknesses of its chosen risk measures. No one risk measure for economic capital is universally preferred.

6. **Risk aggregation.** The reliability of the aggregation process is determined by the quality of the measurement risk components, plus the interrelationships between such risks. The aggregation process usually requires consistency in the risk measurement parameters. The aggregation methodologies used should mirror the bank's business composition and risk profile.

7. **Validation.** The validation process for economic capital models must be thorough and corroborating evidence from various tests must show that the model "works" as intended. In other words, within an agreed upon confidence interval and time period, the capital level determined must be enough to absorb the (unexpected) losses.

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8. **Dependency modeling in credit risk.** Banks must consider the appropriateness of the dependency structures used within their credit portfolio. Specifically, credit models need to be assessed for their limitations, and such limitations need to be dealt with via appropriate supplementary risk management approaches, such as sensitivity or scenario analysis.

9. **Counterparty credit risk.** There are trade-offs to be considered in deciding between the available methods of measuring counterparty credit risk. Additional methods, such as stress testing need to be used to help cover all exposures. Measuring such risk is complicated and challenging. Specifically, the aggregation process needs to be vetted prior to a bank having a big picture perspective of counterparty credit risk.

10. **Interest rate risk in the banking book.** Specifically, financial instruments with embedded options need to be examined closely in order to control risk levels. Certainly, there are trade-offs between using earnings-based versus economic value-based models to measuring interest rate risk. For example, the former has aggregation problems because other risks are measured using economic value. Also, using economic value-based models could be inconsistent with business practices.

Economic Capital Constraints and Opportunities

LO 47.3: Describe the constraints imposed and the opportunities offered by economic capital within the following areas:
- **Credit portfolio management**
- **Risk based pricing**
- **Customer profitability analysis**
- **Management incentives**

Credit Portfolio Management

Constraints imposed:

- Credit quality of each borrower is determined in a portfolio context, not on a stand-alone basis.
- A loan's incremental risk contribution is used to determine the concentration of the loan portfolio.

Opportunities offered:

- The process allows one to determine appropriate hedging strategies to use in reducing portfolio concentration.
- Credit portfolio management becomes a means for protecting against risk deterioration.

Risk-Based Pricing

Constraints imposed:

- Pricing decisions are based on expected risk-adjusted return on capital (RAROC), so deals will be rejected if they are lower than a specific RAROC. The proposed interest rate is determined by the amount of economic capital allocated to the deal.

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- Pricing decisions include: (1) cost of funding, (2) expected loss, (3) allocated economic capital, and (4) additional return required by shareholders. Therefore, a minimum interest rate is determined that will increase shareholder value.

Opportunities offered:

- Can be used to maximize the bank's profitability. For example, some pricing decisions may need to be overridden because certain customer relationships are more profitable (at a lower price/interest rate) or desirable from a reputational point of view. Of course, such overrides are not taken lightly and require upper management approval, as well as rigorous subsequent monitoring.

Customer Profitability Analysis

Constraints imposed:

- The analysis is complicated in that many risks need to be aggregated at the customer level.
- Customers need to be segmented in terms of ranges of (net) return per unit of risk; the underlying information is difficult to measure and allocate.

Opportunities offered:

- Assuming that the measurement obstacles have been overcome, the analysis can be easily used to determine unprofitable or only slightly profitable customers. Such customers could be dropped and economic capital allocated to the more profitable customers.
- Economic capital is used in maximizing the risk-return trade-off (through relative risk-adjusted profitability analysis of customers).

Management Incentives

Constraints imposed:

- Studies show that compensation schemes are a minor consideration in terms of the actual uses of economic capital measures at the business unit level.

Opportunities offered:

- It is suggested that management incentives is the issue that motivates bank managers to participate in the technical aspects of the economic capital allocation process.

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Key Concepts

LO 47.1

A multitude of challenges exist within the economic capital framework that involve: (1) defining risk measures, (2) risk aggregation, (3) validation of models, (4) dependency modeling in credit risk, (5) evaluating counterparty credit risk, and (6) assessing interest rate risk in the banking book.

LO 47.2

There are ten BIS recommendations that supervisors should consider to make effective use of risk measures.

LO 47.3

A number of specific constraints imposed and opportunities offered by economic capital exist within the areas of credit portfolio management, risk based pricing, customer profitability analysis, and management incentives.

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Concept Checkers

1. Which of the following risk measures is the least commonly used measure in the practice of risk management?
   A. Value at risk.
   B. Standard deviation.
   C. Expected shortfall.
   D. Spectral risk measures.

2. Which of the following aggregation methodologies is characterized by great difficulty in validating parameterization and building a joint distribution?
   A. Copulas.
   B. Constant diversification.
   C. Variance-covariance matrix.
   D. Full modeling/simulation.

3. Which of the following model validation processes is specifically characterized by the limitation that it provides little comfort that the model actually reflects reality?
   A. Backtesting.
   B. Benchmarking.
   C. Stress testing.
   D. Qualitative review.

4. Which of the following categories of BIS recommendations specifically refers to the need to consider using additional methods, such as stress testing, to help cover all exposures?
   A. Risk aggregation.
   B. Counterparty credit risk.
   C. Dependency modeling in credit risk.
   D. Interest rate risk in the banking book.

5. The use of which of the following items is meant more for protecting against risk deterioration?
   A. Risk based pricing.
   B. Management incentives.
   C. Credit portfolio management.
   D. Customer profitability analysis.

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Concept Checker Answers

1. **D** Spectral and distorted risk measures are the least used of the four measures and are mainly of academic interest only.

2. **A** Copulas have two notable disadvantages: (1) parameterization is very difficult to validate, and (2) building a joint distribution is very difficult.

3. **B** With benchmarking and hypothetical portfolio testing, the process has its limitations because it can only compare one model against another and may provide little comfort that the model actually reflects "reality." All that the process is able to do is provide broad comparisons confirming that input parameters or model outputs are broadly comparable.

4. **B** There are trade-offs to be considered when deciding between the available methods of measuring counterparty credit risk. Additional methods, such as stress testing, need to be used to help cover all exposures.

5. **C** Credit portfolio management is used as a means to protect against risk deterioration. In contrast, risk based pricing is used to maximize the bank's profitability; customer profitability analysis is used to determine unprofitable or only slightly profitable customers; and management incentives are used to motivate managers to participate in the technical aspects of the economic capital allocation process.

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

Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice

Topic 48

Exam Focus

To protect the smooth functioning of bank holding companies (BHCs), the Federal Reserve's Capital Plan Rule requires BHCs to implement an ongoing internal capital plan for thoroughly assessing and enhancing their capital adequacy under stress scenarios on a firm-wide basis. For the exam, know the fundamental principles and key practices to develop and implement an effective internal control plan, including: risk identifications, model valuation and review, oversight and governance, contingency planning, stress testing and scenario designing, loss estimation and projections methodologies, and evaluating the impact of capital adequacy, including risk-weighted assets and balance sheet projections.

Capital Plan Rule

LO 48.1: Describe the Federal Reserve's Capital Plan Rule and explain the seven principles of an effective capital adequacy process for bank holding companies (BHCs) subject to the Capital Plan Rule.

Bank **holding companies** (BHCs) must have adequate and sufficient capital for their survival and growth. Capital provides a cushion against unexpected losses and allows BHCs to continue to operate. The failure of BHCs (i.e., liabilities exceed assets, resulting in negative capital) would most likely be a burden on taxpayers and deposit insurance funds. An effective and sound capital management policy is critical for the health of BHCs, as well as the smooth functioning and stability of the entire financial system.

The Federal Reserve maintains its interest in survivability and smooth functioning BHCs through its **Capital Plan Rule** and the annual Comprehensive Capital Analysis and Review (CCAR). The CCAR is the Federal Reserve's supervisory program for evaluating capital plans.

The Capital Plan Rule mandates that BHCs develop and put in place a capital plan and a process to evaluate and monitor their capital adequacy. The capital plan covers all U.S. domiciled BHCs with total consolidated assets equal to $50 billion or more.

The Capital Plan Rule lists the principles that the Federal Reserve uses to evaluate the adequacy and appropriateness of a BHC's internal capital planning processes and practices.

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The principles on which the Federal Reserve assesses BHCs for managing and allocating their capital resources is referred to as the **capital adequacy process** (CAP). The seven principles of the CAP are as follows:

1. **Risk management foundation.** A BHC has an effective capital risk management plan to encompass all key risk exposures on a firm-wide basis in terms of identification, evaluation, measurement, and control.

2. **Resource estimation methods.** A BHC has a capital resource estimation plan to clearly define and estimate available capital resources over a stress scenario time horizon.

3. **Loss estimation methods.** A BHC has a process for estimating potential losses and aggregating them on a firm-wide basis over a given stress scenario time horizon.

4. **Impact on capital adequacy.** A BHC has a process to evaluate the combined impact on capital adequacy—given loss estimates and capital resources combined—in light of the stated goals with respect to capital level and composition.

5. **Capital planning policy.** A BHC has a sound capital policy to develop capital goals, determine appropriate capital levels and composition as well as capital distributions (actions) and contingency plans.

6. **Internal controls.** A BHC has a vigorous internal controls policy in place for independent review, model validation, documentation, and internal audit of the capital adequacy process.

7. **Effective oversight.** A BHC has a board and senior management responsible for an effective and thorough oversight of multiple dimensions of the internal capital risk plan, including methods, processes, assessments, validations, reviews, documentation, infrastructure, resources, goals, limitations, and approval of capital decisions.

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Capital Adequacy Process

LO 48.2: Describe practices which can result in a strong and effective capital adequacy process for a BHC in the following areas:

- Risk identification
- Internal controls, including model review and valuation
- Corporate governance
- Capital policy, including setting of goals and targets and contingency planning
- Stress testing and stress scenario design
- Estimating losses, revenues, and expenses, including quantitative and qualitative methodologies
- Assessing the impact of capital adequacy, including RWA and balance sheet projections

For this LO, we detail the seven key practices that can result in a strong and effective capital adequacy process for a BHC.

Risk Identification

BHCs should have a process in place to identify all risk exposures stemming from numerous sources, including stress conditions, changing economic and financial environments, on-and-off balance sheet items, and their impact on capital adequacy. In addition, BHCs should critically scrutinize underlying assumptions regarding risk reduction through risk mitigation or risk transfer techniques. Senior management should regularly update and review the risk identification plan with special consideration for how their risk profiles might change under stress scenarios. Risk identification techniques should be able to detect the changes in the overall risk profile as well as the signs of capital inadequacy in the early stages.

BHCs should integrate the identified risk exposures into their internal capital planning processes. Scenario-based stress testing may not capture all potential risks faced by BHCs, some risks are difficult to quantify or they do not fall into the integrated firm-wide scenarios. However, such risks must be included and accounted for in the capital planning processes. These risks are categorized as "other risks," and their examples include compliance, reputational, and strategic risks. There are a variety of methods which BHCs can employ, including internal capital targets to incorporate such risks.

Internal Controls

An internal audit team should carefully scrutinize the internal control data for accuracy before submitting to senior management and the board. BHCs should have efficiently running management information systems (MIS) for collecting and analyzing pertinent information set quickly and accurately.

In addition, BHCs should put in place a detailed and organized documentation system fully encompassing all dimensions of capital planning processes, including risk identification, loss estimation techniques, capital adequacy, and capital decision processes.

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There must be a thorough, independent, and regular review and validation of all models used for internal capital planning purposes, including assessment of conceptual soundness of models and verification of processes. A validation team should have a required technical skill set as well as complete independence from all business areas of the BHC and model developers. Such independence is crucial for the validation team to offer an unbiased, independent, and valuable verdict.

BHCs should maintain and update a list of all inputs, assumptions, and adjustments for the models used to generate final projections and estimates, such as income, loss expenses, and capital. These models should be validated for their effective use, not only under normal conditions, but also under stress conditions. BHCs should make full disclosure of their validation process and outcome, and should restrict the use of models which are not validated.

Governance

BHCs should have boards with sufficient expertise and involvement to fully understand and evaluate the information provided to them by senior management regarding their capital planning processes. The board should be furnished with comprehensive information with respect to risk exposures, loss estimates, determinants of revenues and losses, underlying models and assumptions, and weaknesses and strengths of capital planning processes. Also, the boards should be informed about the stress scenarios and any corrective measures undertaken as a result of stress testing outcomes.

Under the Capital Plan Rule, the management of BHCs is required to furnish key information to the board for its approval of internal capital adequacy plans. Such information should include underlying assumptions and results of stress testing and the outcome of internal audits, as well as model review and validation checks.

Senior management should evaluate the internal capital plan on an ongoing basis, focusing on key weaknesses, strengths, assumptions, scenarios, estimates, and models. In addition, senior management should make appropriate adjustments and remediation to the capital plan if the review process reveals shortcomings in the plan.

BHCs should maintain detailed minutes of board meetings, describing the issues raised and discussed, as well as the information used and the recommendations made in these meetings.

Capital Policy

A capital policy should clearly define the principles and guidelines for capital goals, issuance, usage, and distributions. The policy should also fully spell out the details of the BHC's capital planning processes, including the decision rules of capital usage and distribution, financing, and other policies. The capital policy should focus on the unique needs and financial situation of BHCs while taking into consideration the supervisory

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expectations. Policies regarding common stock dividends and repurchase agreements should include the following:

- Key metrics influencing the size, timing, and form of capital distributions.
- Materials used in making capital distribution decisions.
- Specific scenarios that would cause a distribution to be reduced or suspended.
- Situations that would cause the BHC to consider replacing common equity with other forms of capital.
- Key roles and responsibilities of individuals or groups for producing reference materials, making distribution recommendations and decisions, and reviewing analysis.

Capital goals developed by BHCs should be compatible with their risk tolerance, risk profile, regulatory requirements, and expectations of various stakeholders (e.g., shareholders, creditors, supervisors, and rating agencies). BHCs should establish specific goals for both the level and composition of capital under normal as well as stress conditions. Capital targets, which need to be set above the capital goals for capital adequacy under stress conditions, should take into consideration future economic outlooks, stress scenarios, and market conditions.

While setting capital distribution levels, BHCs must take into consideration numerous factors, including future growth plans (including acquisitions) and associated risk, current and future general economic conditions, in particular the impact of macroeconomic and global events during stress conditions, on their capital adequacy. Capital distribution decisions must be connected to capital goals or capital adequacy requirements.

BHCs should develop strong contingency planning offering numerous options to deal with contingency situations as well as their effectiveness under stress conditions. Contingency plans should be based on realistic assumptions and contain futuristic outlooks, rather than overly relying on history. Contingency actions should be feasible and realistic in the sense that they should be easy to implement when or if the contingency warrants. Capital triggers flagging the early warning of capital deterioration should be based on the projected results, regulatory requirements, and the expectations of various stakeholders, including creditors, shareholders, regulators, investors, and counterparties.

Stress Testing and Stress Scenario Design

Scenario design and stress testing should focus on unique situations of BHCs, their asset and liability mix, portfolio composition, business lines, geographical territory, and revenue and loss factors, while taking into consideration the impact of macroeconomic and firm-specific vulnerabilities and risks. That is, the stress test designing should go above and beyond the general guidelines established by the supervisory authority. Also, a BHC's scenario designing and testing should not employ optimistic assumptions benefiting the BHC.

BHCs should employ both an internal model and expert judgment, an outside expert's opinion. If only a third-party model is used, it must be tailored to the unique risk profile and business model of a BHC. The designed scenarios should assume a strong strain on the revenue and income of BHCs.

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Stress testing models should be based on multiple variables encompassing all the risk exposures faced by BHCs on a firm-wide basis. For example, BHCs concentrated in a region, business, or industry should include relevant region, business, or industry-related variables. In addition, the scenarios should clearly spell out how they address specific risks faced by BHCs. The description should also provide explanations of how a scenario stresses specific BHC weaknesses and how variables are related to each other.

Estimating Losses, Revenues, and Expenses

Quantitative and Qualitative Basis

BHCs should prefer using internal data to estimate losses, revenues, and expenses. However, in certain situations, it may be more appropriate to use external data. In these instances, it should be ensured that the external data reflects the underlying risk profile of their business lines, and necessary adjustments should be made to data input or output to make the analysis reflect a true picture of the BHC's unique characteristics.

A range of quantitative methods are available to BHCs for estimating losses, revenues, and expenses. Regardless of which method they use, the final outcome should be identification of key risk factors and impact of changing macro and financial conditions under normal and stress conditions on a firm-wide basis.

In addition, BHCs should segment their line of businesses and portfolios utilizing common risk characteristics showing marked differences in past performances. For example, a borrower's risk characteristics can be segmented by criteria such as credit score ranges. However, each risk segment should have sufficient data observations on losses, revenues, and expenses, (and underlying factors impacting losses, revenues, and expenses) in order to generate meaningful model estimates.

Past relationships between losses, revenues, expenses, and underlying driving factors, and their interrelationships may not hold in the future, thus, necessitating employment of sensitivity analysis (to answer "what if" questions) when using models based on historical underlying interactions.

BHCs sometimes use qualitative methodologies, like expert judgment or management overlay, as a substitute or a complement to quantitative methods. Qualitative techniques should be based on sound assumptions, and an external reviewer should find these approaches logical, reasonable, and clearly spelled out. A sensitivity analysis should be used for a qualitative approach as well. From a supervisory standpoint, BHCs are expected to use conservative assumptions, not favorable to BHCs, for estimating losses, revenues, and expenses under normal and stress conditions.

Loss Estimation Methods

BHCs should employ loss estimation methods, which offer theoretical soundness and empirical validity. In addition to using general macroeconomic explanatory variables, the loss estimation models should use specific variables exhibiting a direct link to particular exposures and portfolios.

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BHCs should use uniform, reputable methods to aggregate losses across various lines of business and portfolios for firm-wide scenario analysis. They should also use automated processes, without manual intervention or managerial adjustments showing clear linkage from data sources to loss estimation and aggregation. For estimating retail loan losses, BHCs often use internal data, but for wholesale loss estimation, internal data is supplemented with external data. In the case using external data, BHCs should demonstrate that the data reflects their risk exposures, encompassing geographic, industry, and other key dimensions. Risk segmentation should be supported by the data capturing the unique characteristics of each risk pool.

BHCs can use either an economic loss approach (i.e., expected losses) or an accounting-based loss approach (i.e., charge-off and recovery) to estimate credit losses. For the expected loss approach, BHCs should categorize losses into probability of default (PD), loss given default (LGD), or exposure at default (EAD) and then identify the determinants of each component. Long run averages for PDs, LGDs, and EADs should not be used, as these averages reflect economic downturn and upturn periods not necessarily suitable for scenario testing under stress conditions. LGD should be linked to underlying risk factors, such as a fall in the value of collateralized assets under stress conditions, and it should be estimated at some level of segmentation, such as lending product or type of collateral. EADs should be modeled to exhibit variation depending on changes in macroeconomic conditions.

If BHCs are using rating systems as a key input to estimate expected losses under stress (e.g., on their wholesale portfolios), they should recognize the limitations in rating systems and their data and make necessary adjustments.

BHCs should utilize a robust time series with sufficient granularity while employing role-rate models to estimate the rate at which delinquent and non-delinquent accounts in the current quarter are expected to roll over into default or delinquent status in the next quarter.

If using charge-off models (i.e., accounting models), BHCs should include variables which represent the risk characteristics of an underlying portfolio while estimating the statistical relationship between charge-off rates and macroeconomic variables at the portfolio level.

Operational Risk

In order to determine operational risk, many BHCs estimate correlation between operational risk and macroeconomic factors. If they do not discover a statistically significant relationship between the variables, they employ other methods, including scenario analysis utilizing historical data and management input. BHCs should employ a combination of techniques to develop strong loss estimates under stress conditions, including past loss records, future expected events, macro conditions, and firm-specific risks.

BHCs using regression models to estimate loss frequency and loss severity under stress scenarios should provide statistical support for the period chosen for estimation purposes instead of arbitrary and judgmental selection.

A modified loss distribution approach (LDA) is also used by BHCs to estimate value at risk (VaR) to estimate operational risk losses at a chosen confidence interval (e.g., 90% or 95%).

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To generate a strong and effective process, BHCs should offer a sound justification for their choice and perform a sensitivity analysis around the chosen interval.

Some BHCs use scenario analyses in case they encounter model or data limitations in order to incorporate a wide range of risks (which is not possible otherwise due to data or model limitations). In such events, BHCs should provide a rationale for the chosen scenario in their loss estimation process.

Market Risk and Counterparty Credit Risk

BHCs, which are involved in trading, are subject to counterparty credit risk from changes in the value of risk exposure and creditworthiness of the counterparty due to changing macroeconomic conditions.

In order to estimate the potential loss resulting from market credit interaction, BHCs use probabilistic approaches (which produce a probability distribution of expected portfolio losses) and deterministic approaches (which yield point estimates of an expected portfolio loss).

BHCs using probabilistic approaches should clearly offer evidence that such methods can yield more severe risk scenarios compared to historical scenarios. BHCs should also explain how they utilize tail loss scenarios to detect and address firm-specific risks.

BHCs using deterministic approaches should demonstrate that they have employed a wide range of scenarios, adequately covering their key risk exposures, including mark-to-market positions in the event of firm-specific or market-wide stress conditions. In addition, BHCs should clearly spell out the underlying assumptions employed in stress testing scenarios for risk measurement purposes and corrective measures to fix the identified deficiencies.

Market shock scenarios do not directly incorporate the default of the counterparty. Some BHCs explicitly incorporate the scenario of default of key counterparties (including key customers) while using some sort of probabilistic approach involving some estimates of the PD, LGD, and EAD of counterparties. This method allows BHCs to focus exclusively on the defaults of counterparties to which BHCs have large risk exposure.

BHCs also use assumptions about risk mitigation in the future. Such assumptions, if used, should be conservative in nature. In stress scenarios, the ability of BHCs to take desired actions may be limited.

PPNR Projection Methodologies

PPNR is pre-provision net revenue (i.e., net revenue before adjusting for loss provisions). While estimating revenues and expenses over a planning horizon under stressed conditions (the Capital Plan Rule requires forecasts over the next nine quarters), BHCs should not only take into consideration their current situation, but also the possible future paths of business activities and operational environments related to their on- and off-balance sheet risk exposures, underlying assumptions, and assets and liabilities.

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BHCs should also take into consideration the impact of regulatory changes on their performance and ability to achieve their stated targets and goals. Projections should be based on coherent and clearly defined relationships among numerous, relevant variables, such as revenues, expenses, and balance sheet items within a given scenario. For example, assumptions related to origination should be the same for projections related to loans, fees, costs, and losses.

Underlying assumptions for revenues, expenses, and loss estimates should be theoretically and empirically sound, and the central planning group as well as the corporate planning group should be engaged in aggregating projections on an enterprise-wide basis. In the case of limited data, BHCs should employ external data in conjunction with internal data.

Net interest income projections are not isolated projections; rather, they are entrenched with other items of a capital adequacy plan. Balance sheet assumptions should be consistent while projecting net interest income. For example, balance sheet assumptions for projecting net interest income should be the same when estimating loss. Methods employed for projecting net interest income should incorporate ongoing changes in current and projected balance sheet positions.

BHC projections under various scenarios, based on product characteristics (e.g., a change in deposit mix due to increased demand for time deposits), underlying assumptions, and rationale by product should be carefully explained.

BHCs linking loss projections to net interest income projections should clearly establish this link while using modeling approaches, which incorporate the behavioral characteristics of the loan portfolio.

Net interest income projections should be based on methodologies that incorporate discount or premium amortization adjustments for assets not held at par value that would materialize under different scenarios.

New business pricing projections and underlying assumptions, such as constant add-ons to a designated index value, should be compatible with past data, scenario conditions, and BHCs' balance sheet projections.

BHCs should project non-interest income in light of stated scenarios and business strategies. Projection methods should fully encompass underlying major risk exposures and characteristics of a specific business line. For example, an asset management group should project non-interest income using various methods, including brokerage as well as money management revenues.

Additionally, BHCs with trading portfolios should establish a clear link between trading revenue projections to trading assets and liabilities and the compatibility of all the elements of stress scenario conditions.

BHCs with off-balance sheet business items should demonstrate the linkage between revenue projections and changes in on- and off-balance sheet items.

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BHCs should not assume perfect correlation between revenues (generated from trading or private equity activity) and broad indices. BHCs should estimate the sensitivity coefficients for changes in revenue as a result of changes in broad index movements.

Furthermore, BHCs holding mortgage servicing rights assets (MSRAs) should carefully design assumptions regarding default, prepayment, and delinquency rates, ensuring that these assumptions are robust and scenario specific. In addition, BHCs that hedge MSRA risk exposure should generate scenario specific assumptions.

For BHCs, projecting volume increases in mortgage loans while ignoring market saturation or other key factors would be an ineffective and weak process, whereas consideration of individual business models, client profiles, and capacity constraint (while projecting mortgage loan volume) would be an effective and strong capital adequacy process.

Macroeconomic relationships should be based on sound theoretical construct and supported by empirical evidence. For example, BHCs may experience a steep decline in credit card fee revenues in a strong recessionary period because of a decline in consumer spending. An example of a weaker practice of a capital planning process is if a BHC does not show a sufficient decline in revenue in stressed conditions despite obvious macro relationships.

In addition, BHCs should utilize a wide set of explanatory variables to develop statistical relationships. BHCs should take into consideration the impact of macroeconomic conditions, such as an economic downturn, on their non-interest expense projections. Non-interest expense projections, like all other projections, should be consistent with revenue and balance sheet estimates and should generate the same underlying strategic assumptions. If projections assume that a decline in revenue (e.g., due to an increase in credit collection costs in an economic downturn) can be offset by some mitigating strategies, BHCs should then clearly demonstrate the feasibility of such actions. Mitigation actions should not be supported by past relationships and actions only because future financial, macro, and global environments may not be as favorable to execute such strategies, as was the case in the past.

Estimation methods to project non-interest expense should focus on uncovering determinants (factors) of individual expense items and how sensitive those factors are to changing macro conditions and business strategies.

Assessing the Impact of Capital Adequacy

BHCs should have a well-defined and well-documented process of generating projections with respect to size and composition of on- and off-balance sheet items and risk-weighted assets (RWA) over a stress horizon period.

Projecting balance sheet items, such as changes in assets and funding, directly without consideration of underlying drivers (of such changes), would be a weak practice. BHCs should identify the impact of changes in key factors on changes in asset and liabilities. Projections should take into consideration these vital relationships.

BHCs should incorporate relationships between revenues, expenses, and balance sheet items into their scenario analyses. Projections about losses, revenues, expenses, and on- and

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off-balance sheet items should not be based on favorable underlying assumptions. These assumptions may not stand the trial of uncertain market conditions under stress conditions.

Projections for RWA should be consistent with the projections for risk exposures of on- and off-balance sheet items. All underlying assumptions used for balance sheet and RWA projections should be clearly documented and critically reviewed and validated.

BHCs with a strong process of implementation should form a centralized group responsible for aggregating loss, revenue, expense, on- and off-balance sheets, and RWA projections for enterprise-wide scenario analysis. In addition, BHCs should establish a strong governance structure to critically scrutinize assumptions, methods, and estimates generated in an enterprise-wide scenario analysis and offer needed adjustments. BHCs should carefully evaluate the validity and relevance of underlying assumptions across business lines, portfolios, loss, expense, and revenue estimates if an enterprise-wide scenario analysis produces post-stress results that are more favorable than the baseline conditions. The outcomes of such analyses should also be reconciled for regulatory as well as management reporting purposes.

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Key Concepts

LO 48.1

The Federal Reserve's Capital Plan Rule mandates all top-tier, U.S. domiciled bank holding companies with consolidated assets equal to or greater than $50 billion to develop and maintain an effective and robust internal capital plan for evaluating and assessing their capital adequacy.

There are seven principles on which the Federal Reserve assesses the effectiveness of a BHC's internal capital planning, also known as the capital adequacy process (CAP). These seven principles are related to risk management foundation, resource and loss estimation methods, capital adequacy, capital planning and internal controls policies, and governance oversight.

LO 48.2

BHCs should develop a process to effectively identify all of their risk exposures on a firm-wide basis. BHCs should establish a mechanism for a comprehensive, independent, and regular review and validation of all the models used for capital adequacy planning purposes. BHCs should have boards actively involved in evaluating and approving their internal capital adequacy plans. BHCs should develop a capital policy that clearly defines the principles and guidelines for capital goals, issuance, usage, and distributions.

Stress testing and stress scenario design should be based on a variety of factors encompassing all the risk exposures faced by BHCs on a firm-wide basis. With the option of utilizing various quantitative and qualitative methods, BHCs should carefully identify key risk exposures on a firm-wide scenario basis. BHCs should use loss estimation methodologies, which are based on sound theoretical and empirical foundations. BHCs should use a combination of inputs in order to develop loss estimates arising from operational risk. In order to estimate the counterparty credit risk, BHCs mostly use probabilistic or deterministic approaches. BHCs using a probabilistic approach should offer evidence of generating probable scenarios stronger than past observed events. BHCs using a deterministic approach should generate a wide range of stress scenarios.

While estimating pro-provision net revenue (PPNR) projection methodologies, BHCs should pay particular attention to interrelationships among numerous relevant variables such as revenues, expenses, and on- and off-balance sheet items within a given scenario. Methodologies used for projecting net interest income should incorporate ongoing, current, and projected balance sheet positions. BHCs should project non-interest income in light of stated risk scenarios and business strategies.

BHCs should have a well-defined process in place to develop projections of revenues, expenses, losses, on- and off-balance sheet items, and risk-weighted assets in an enterprise-wide scenario analysis. Projections should be based on sound underlying assumptions, interactions, and factors (main drivers of change), and the estimates should be scrutinized, documented, and reported.

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Concept Checkers

1. The seven principles of an effective capital adequacy process for bank holding companies (BHCs) subject to the Capital Plan Rule include which of the following?
   I. Oversight from peer BHCs
   II. Annual reporting to the stock exchange (where their stock is listed)
   A. I only
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

2. The Federal Reserve's Capital Plan Rule requires BHCs to maintain an effective process for assessing their capital adequacy for:
   A. BHCs, U.S. or non-U.S. domiciled.
   B. BHCs with more than five years of operational history.
   C. BHCs with a net annual income of more than $5 billion.
   D. BHCs with total consolidated assets of $50 billion or greater.

3. How many of the following statements is most likely correct? BHCs should have risk identification processes that evaluate:
   I. On- and off-balance sheet positions.
   II. Risk transfer and/or risk mitigation techniques.
   III. Changes in institutions' risk profile due to portfolio quality.
   IV. Reputational risk.
   A. One statement.
   B. Two statements.
   C. Three statements.
   D. Four statements.

4. Which of the following statements is most likely correct?
   A. The internal controls policy of BHCs requires that senior management should furnish the board of directors with sufficient information to comprehend the BHC risk exposures.
   B. A governance policy offers fundamental guidelines and principles to BHCs for the capital issuance, use, distribution, and planning purposes.
   C. Suspension or reduction in dividends or repurchase programs do not fall under the capital policy of BHCs.
   D. Designing and testing a scenario-related default of a major counterparty is an example of BHC stress testing and a stress scenario design policy.

5. Which of the following statements is most likely correct?
   I. Under the expected losses methodologies, loss estimation involves three elements: probability of default, loss given default, and exposure at default.
   II. Net interest income projections should incorporate changing conditions for balance sheet positions, including embedded options, prepayment rates, loan performance, and re-pricing rates.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

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Concept Checker Answers

1. **D** Oversight from peer BHCs and annual reporting to the stock exchange are not included in the seven principles of an effective capital adequacy process.

2. **D** BHCs with total consolidated assets of $50 billion or greater. The other answers are not part of the requirements under the Capital Plan Rule.

3. **D** All of the statements are correct. BHCs should have risk identification processes effectively identifying all risk exposures for assessing capital needs. Reputational risk, like strategic risk and compliance risk, falls under the category of "other risks" and are more difficult to quantify. Nevertheless, there are a wide range of methods BHCs employ to evaluate other risks.

4. **D** The first statement is the requirement of the governance policy and not the internal control policy. The second statement falls under capital policy and not the governance policy. Regarding the third statement, capital contingency plans (e.g., suspension or reduction in dividends or repurchase programs) are a key part of capital policies of BHCs detailing the actions intended to be taken under deficiencies in capital position. The fourth statement is correct. Many different scenarios, including counterparty default, fall under the BHCs' stress testing and scenario design policy.

5. **C** Both statements are correct. Loss estimation involves probability of default, loss given default, and exposure at default. Net interest income projections should incorporate changing conditions for balance sheet positions, including embedded options, prepayment rates, loan performance, and re-pricing rates.

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

Repurchase Agreements and Financing

Topic 49

Exam Focus

Repurchase agreements, or repos, are short-term financing vehicles to borrow/lend funds on a secured basis. The most common repos are for overnight lending. This topic discusses the mechanics of repos, including settlement calculations, the motivations of market participants for entering into repos, as well as the risks (credit risk and liquidity risk) that arise from their use. It also discusses collateral types used in repos, including general collateral and special collateral. For the exam, focus on the characteristics of repo transactions and the primary motivations for using repos. Understanding these motivations should give you a good indication of how and why repos are used in the market, what risks repos hedge, what risks arise from repo trading, and how changes in the market environment affect repos.

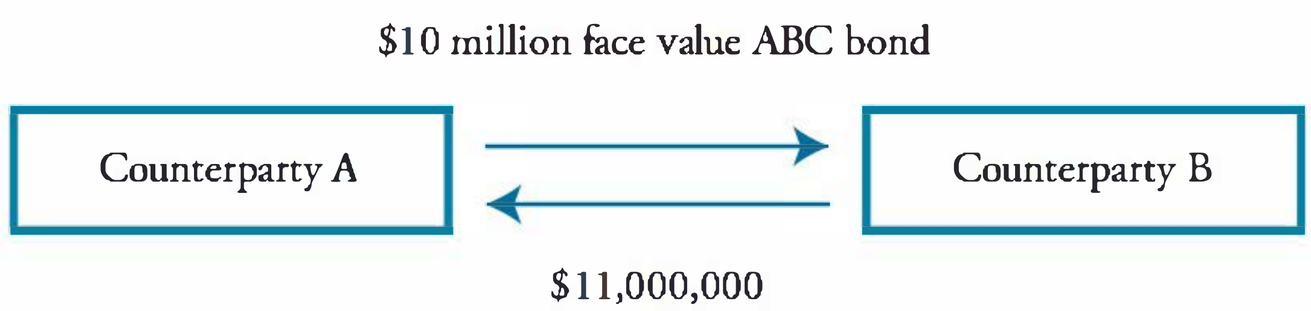
Mechanics of Repurchase Agreements

LO 49.1: Describe the mechanics of repurchase agreements (repos) and calculate the settlement for a repo transaction.

Economically, a **repurchase agreement** (i.e., **repo**) is a short-term loan secured by collateral. Mechanically, it is a contract between two parties where one party sells a security at a specified price with a commitment to buy back the security at a future date at another specified (higher) price. The difference between the sell and buy prices of the security is the implied interest (i.e., return) on the transaction. Repos are used by both borrowers needing short-term funds and by lenders needing short-term investments or access to hard-to-find collateral.

The term repo refers to the transaction from the *borrower*'s side; that is, from the side that sold the security with a promise to buy it back. When we examine the same transaction from the *lender's* side, the transaction is referred to as a **reverse repurchase agreement** (i.e., **reverse repo**). Figures 1 and 2 illustrate an example of a repo trade.

Figure 1: Repo Initiation



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Suppose that on May 1, counterparty A wishes to borrow $11 million for 31 days. It therefore sells ABC bonds with a face value of $10 million and a market value of $11 million to counterparty B, with a contract price of $11 million to reflect the bond's market value. Concurrently, counterparty A agrees to buy back the bond in 31 days at the contract price plus 0.3% interest (30 basis points).

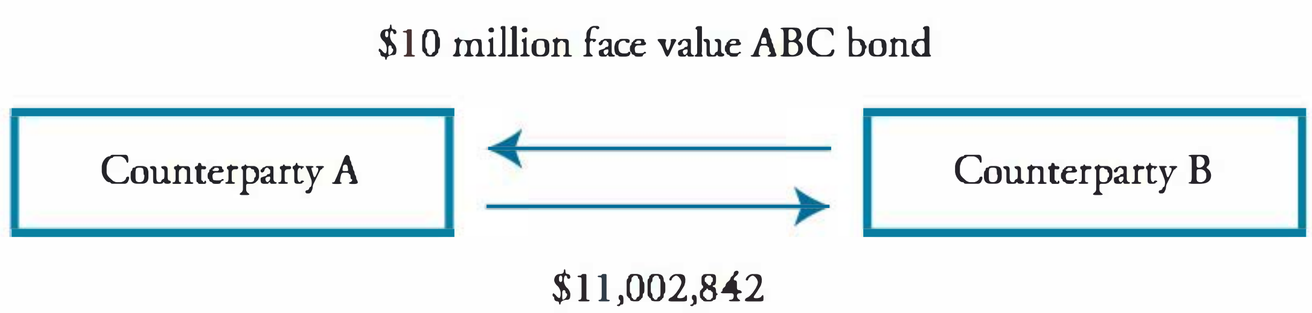
Professor's Note: Interest rates for repos are always quoted at an annualized rate, and the convention for most money market securities is to use an actual/360 day count.

The repurchase price in this example is computed as follows:

$$\$11{,}000{,}000 \times \left(1 + \frac{0.3\% \times 31}{360}\right) = \$11{,}002{,}841.67$$

As illustrated in Figure 2, on the June 1 termination of the repo trade, counterparty A will purchase back the $10 million face value ABC bond for $11,002,842.

Figure 2: Repo Termination (Settlement)



LO 49.2: Explain common motivations for entering into repos, including their use in cash management and liquidity management.

Borrowers in Repos

From the perspective of the *borrower*, repos offer relatively cheap sources of obtaining short-term funds. Relative to unsecured borrowing, repos allow the borrower to obtain funds at favorable rates because lenders are willing to accept lower returns (relative to unsecured transactions) in favor of the security of collateral.

Bond Financing

Repos can also be used to obtain cash to finance a long security position. Consider a financial institution in the previous example (as counterparty A) that just purchased the same $10 million face value ABC bond from a client in hopes of selling it to another investor for a profit. Until the new buyer is found, however, the financial institution needs to finance the purchase of the bond. It can do so by borrowing cash through an overnight repo trade (from counterparty B) and pledging the ABC bond as collateral, subject to any applicable haircuts. If the financial institution cannot immediately find a buyer, it needs to roll/renew its position. If the initial repo trade and the subsequent rolls are transacted with the same counterparty, the trade flow is similar to Figure 1. If the repo is renewed/

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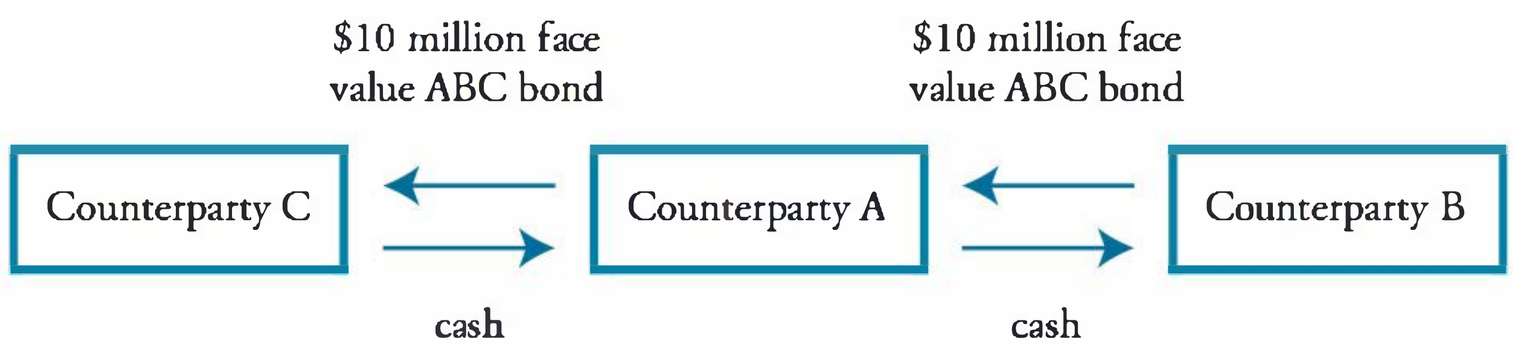
rolled with a different counterparty, the financial institution first needs to unwind the initial trade (with counterparty B) and then enter into a new repo trade with another counterparty (counterparty C). This is illustrated in Figure 3.

Similar to financing a bond purchase, the financial institution may also use repos to finance proprietary positions or to finance its inventory in order to make markets.

Figure 3: Back-to-Back Repo Trades



Liquidity Management

Firms can borrow funds in different ways. They can issue equity capital or issue long-term or short-term debt, either on a secured or unsecured basis. Repos offer secured short-term financing; however, they are considered less stable given that repos need to be repaid within a short time period, and they are subject to swings in market conditions and sentiment. By contrast, equity financing is considered the most stable financing form given that the issuing firm has no obligation to pay dividends and equity financing does not need to be paid back. However, given its stability, equity financing is the most expensive and requires the highest expected return. By contrast, repo financing is cheaper but less stable.

Firms need to balance this tradeoff between the costs of funding among the various alternatives and potentially being left without financing. This is referred to as **liquidity management.**

Lenders in Repos

From the perspective of the *lender*, repos can be used for either investing or for financing purposes as part of an entity's cash management or financing strategies.

Cash Management (Repos as Investment Vehicles)

Lenders use repos (taking the reverse repo side) for investing when they hold cash either for liquidity or safekeeping reasons and need short-term investing opportunities to generate return on their surplus cash position. For example, money market mutual funds hold cash for safekeeping on behalf of investors and therefore need low risk, short maturity investments to generate return rather than holding idle cash. Municipalities, on the other hand, have significant surplus cash generated from tax revenues. Municipalities are prohibited from investing in high-risk investments, and repos offer a low risk, collateral-secured investment opportunity.

Investors look for liquidity and tend to favor very short-term positions in **overnight repos**, which provide significant flexibility to the investor. Following each overnight repo

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transaction, the investor could re-evaluate its decision whether to continue lending cash. Investors may also transact in **open repos** by lending for a day under a contract that renews each day until it is canceled. Repos could have longer maturities out to several months, although typically the longer the maturity, the lower the overall demand.

In addition to liquidity, investors also prefer higher quality collateral. Repo collateral is generally limited to high-quality securities, including securities issued or guaranteed by governments and government-sponsored entities. Because the lender is faced with the risk of a decline in collateral value during the term of the repo transaction, repo agreements often require collateral haircuts. A **haircut** refers to discounting the value of the collateral posted in relation to its risk. In our earlier repo trade example, counterparty B may only lend $10.5 million against the $11 million market value of the ABC bond collateral received. Finally, repo transactions are also subject to margining and (daily) margin calls. A margin call requires a borrower to post additional collateral in a declining market, but it also allows the borrower to withdraw excess collateral in up markets.

Short Position Financing (Repos as Financing Vehicles)

Lenders may also use repos (as the reverse repo side) to finance short positions in bonds. Consider an investment management firm that has a view that interest rates will rise and bond prices will fall. It can take advantage of this view by obtaining the desired bond collateral through lending cash in a reverse repo trade. It would then short sell the bond received through the reverse repo and buy it back at the market price at a later date, hoping to benefit from the trade from a fall in prices. The transaction flows would be similar to what we previously illustrated in Figure 1 and Figure 2, with the investment management firm as counterparty B.

Counterparty Risk and Liquidity Risk

LO 49.3: Explain how counterparty risk and liquidity risk can arise through the use of repo transactions.

Repo transactions involve the exchange of cash as well as the exchange of collateral. As a result, both counterparty risk (credit risk) and liquidity risk are present.

Counterparty risk is the risk of borrower default or non-payment of its obligations, and it arises because the lender is exposed to the risk of a failure by the borrower to repay the repo loan and interest. Given, however, that repo loans are secured by collateral, this makes the lender much less vulnerable to a decline in the creditworthiness of the borrower. The lender can recover any amounts owed by simply selling the collateral. As a result, because repos are generally very short-term transactions secured by collateral, counterparty (credit) risk is less of a concern.

Liquidity risk is the risk of an adverse change in the value of the collateral and can be of particular concern to the lender. Even if the lender is less concerned with the credit risk of a counterparty given the security of collateral, the lender is still exposed to the risk of collateral illiquidity and to the value of the collateral declining during the repo term. Especially during times of market turbulence (as we will see in next LO), the value of

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collateral can decline significantly and its liquidity can dry up. This risk can be mitigated with the use of haircuts, margin calls, reducing the term of the repo, and accepting only higher quality collateral.

Repos During the Credit Crisis

LO 49.4: Assess the role of repo transactions in the collapses of Lehman Brothers and Bear Stearns during the 2007-2008 credit crisis.

Prior to the 2007–2009 credit crisis, the repo market was considered relatively liquid with stable demand by both borrowers and lenders. Borrowers often posted weaker quality collateral, including corporate bonds or mortgage-backed securities. This benefited both borrowers, who were able to post less desirable collateral, and lenders, who were able to obtain higher repo rates in exchange for accepting lower quality collateral. However, as the crisis escalated, lenders were reluctant to continue to accept these securities, and were increasingly demanding higher quality collateral and larger haircuts. At the extreme, they simply withdrew liquidity and stopped transacting in the markets. Borrowers that were the worst hit experienced collateral liquidations, capital declines, and ultimately bankruptcies. The case studies of Lehman Brothers and Bear Stearns provide important insights into the role of repo transactions in the demise of these once important institutions.

Repos and Lehman Brothers

JPMorgan Chase & Co. (JPM) was the tri-party repo clearing agent of Lehman Brothers Holdings, Inc. (Lehman). (In a tri-party repo agency arrangement, the repo trades are still executed between two counterparties; however, the collateral selection, payment, settlement, and repo management is outsourced to a third-party agent. Agents are essentially custodians and do not take on the risks of the transactions.) These tri-party repos were traded in the overnight market, and were transacted predominantly between institutional repo lenders and financial institution borrowers (including Lehman). Given that the trades were overnight transactions, they matured each morning, leaving the borrowers without funding during the rest of the day. To bridge this funding gap, JPM, as tri-party agent, was lending directly to Lehman on a secured basis during the day, typically without requiring haircuts on intraday advances. By August 2008, however, due to the increased risk in the repo markets, JPM began to phase in haircuts on intraday loans, with the loan amounts exceeding $100 billion in the final week of Lehman's bankruptcy.

Professor's Note: Lehman was one of the largest U.S. investment banks. The failure of Lehman in September 2008 was the largest in U.S. history ($600 billion in assets).

Both Lehman and JPM provide different viewpoints of the events leading up to Lehman's bankruptcy in September 2008. Despite the differing accounts, it is clear that the liquidity and value of collateral pledged in repo transactions declined during the crisis, and additional collateral and additional haircuts were necessary to mitigate the risks in repos.

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According to Lehman, JPM, despite a conflict of interest due to its agent and lender role, breached its duty to Lehman and took advantage of its insider status (being insider to Lehman's internal financial condition and proposed business plans). Lehman accused JPM of using its influence to drain close to $14 billion in collateral from Lehman during the last few days before the bankruptcy, despite already being in an overcollateralized position. Although Lehman agreed at the time to provide additional collateral, it did so unwillingly and simply because there were no viable alternatives.

According to JPM, however, JPM acted in good faith by providing continued funding to Lehman up until the last day, despite Lehman's deteriorating financial condition. When it became clear that the collateral posted to JPM by Lehman was illiquid with apparently overstated values, JPM's exposure to Lehman was growing at a time when Lehman's creditworthiness and financial condition was deteriorating. Nevertheless, JPM continued to lend money despite inadequate haircuts and collateral values. The close to $14 billion in additional collateral requested by JPM was significantly less than what was needed to cover JPM's true exposure.

Repos and Bear Stearns

Prior to 2007, Bear Stearns Companies, Inc., (Bear Stearns) relied on funding its borrowings primarily in the form of short-term unsecured commercial paper. By 2007, however, Bear Stearns switched from unsecured borrowing to a more stable form of borrowing through longer term, secured repo financing, which better positioned the firm to withstand market liquidity events. Given the high-quality collateral posted, the firm was able to obtain financing at favorable rates on a term basis.

Given the events of 2007–2009, lenders during this period became increasingly less willing to provide loans in the form of repo trades, and were especially averse to providing term (rather than overnight) repos. This led to a general shortening of repo terms, requiring larger haircuts, and requesting borrowers to post higher quality collateral. In early March 2008, Bear Stearns experienced a run on the bank that resulted from a general loss of confidence in the firm. This bank run led to a massive withdrawal of cash and unencumbered assets (i.e., assets that have not been committed or posted as collateral), and lenders refused to roll over their repo trades. The rapid decline in market confidence and withdrawal of capital ultimately led to Bear Stearns' collapse.

Professor's Note: Bear Stearns was a U.S. investment bank and brokerage firm that was bailed out by the Federal Reserve Bank of New York and subsequently sold to JPM in March 2008.

Collateral in Repo Transactions

LO 49.5: Compare the use of general and special collateral in repo transactions.

Repo trades can be secured either with general collateral or with specific (i.e., special) collateral.

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General Collateral

While lenders care about the quality of collateral delivered, under **general collateral** (GC), repo lenders are not concerned with receiving a particular security or class of securities as collateral. Instead, only the broad categories of acceptable securities are specified. The logic here is that when lenders are looking to receive a specific rather than generic security as collateral, this creates a demand for that security and lenders have to accept a lower return on the repo trade. GC trades suit investors in repos because they can obtain the highest repo rate for the collateral received.

The repo rate for trades secured with general collateral is called the **GC rate**. GC rates can be used for repos with U.S. Treasury collateral, and the overnight rate for U.S. Treasury collateral is referred to as "the" GC rate. In the United States, the GC repo rate is typically slightly below the federal funds rate, although repos with U.S. Treasury collateral are considered safer and in fact can trade below the federal funds rate. The difference between the federal funds rate and the GC rate is measured through the **fed funds-GC spread**. This spread widens when Treasuries become scarcer (the GC rate falls) or during times of financial stress, as was the case during the recent financial crisis.

Professor's Note: The federal funds rate is an interest rate that depository institutions in the United States charge each other for lending funds maintained at the Federal Reserve.

Special Collateral

When lenders are concerned with receiving a particular security as collateral, the collateral is referred to as **special collateral**, and the repo trade is called a **specials trade**. If you recall our discussion on financing as a motivation for repo lending, it should be clear that specials trades are particularly important in financing transactions used to obtain specific bonds. The repo rate for trades secured with special collateral is called the **special rate**.

In specials trading, the lender of cash is concerned with receiving a particular security in order to finance the purchase of a bond (for shorting), or to finance its inventory or proprietary positions. Lenders accepting special collateral face a trade-off between receiving the desired security and lending at below GC rates to receive the desired security. Special rates differ by security because there is a rate for each security for each term. Special rates are determined by market supply and demand; however, it is important to note that the supply and demand of the underlying security is not the same as the supply and demand of the specials trade itself. In fact, a bond that is in high demand in the market may not be in great demand as collateral for a specials trade. The reverse could equally be true.

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Special Spreads and the Auction Cycle

LO 49.6: Describe the characteristics of special spreads and explain the typical behavior of US Treasury special spreads over an auction cycle.

The difference between the GC rate and the special rate for a particular security and term is called a **special spread**. Special spreads are important because in the United States, they are tied closely to the U.S. government Treasury bond auctions, and the level and volatility of the spread can be an important gauge of market sentiment.

In the United States, federal government bonds are sold at auction based on a predetermined, fixed schedule. The most recent issue is called the **on-the-run** (OTR) or *current* issue, while all other issues are called **off-the-run** (OFR). Current OTR issues tend to be the most liquid, with low bid-ask spreads, that can be liquidated quickly even in large sizes. This liquidity makes them desirable for both long positions and short positions. For example, a repo lender would favor these securities for short positions because the shorts could be covered quickly and at a relatively low cost. The popularity of OTR issues as special collateral in repo trades historically resulted in lower repo rates and wider special spreads.

Several observations can be made by looking at the special spreads of OTR Treasury securities (OTR special spreads) and the auction-driven pattern of special spreads. First, OTR special spreads can be volatile each day depending on the special collateral. Second, spreads can fluctuate over time. Third, and most important, OTR special spreads are generally narrower (smaller) immediately after an auction but wider before auctions. They are narrower after auctions due to the extra supply of a new OTR security, which depresses special spreads. Spreads widen before auctions due to the substitutability of the special collateral as shorts change to the new OTR security.

The influence of auctions can also be observed from the term structure of individual OTR issues based on term special spreads (the difference between term GC rates and term special rates). Term special spreads are expected to decline immediately following the issue of the new OTR security but increase closer to the dates of the new auctions.

Special Spreads and Rate Levels

Special spreads generally move within a band that is capped at the GC rate (implying a floor of 0% for the special rate). When a trader short sells the OTR Treasury security but fails to deliver on settlement, the trader would not receive cash from the sale and would also miss out on a day's interest on the cash. To satisfy the settlement obligation to deliver the bond, the trader could borrow the bond in the overnight repo market and pay a special rate of 0% (essentially the trader provides free financing in exchange for receiving the desired bond). At any rate below 0%, no trader would borrower the bond. This puts both an effective lower bound and an effective cap of the special spread at the GC rate.

The special spread can also be tied to the penalty for failed trades. Until 2009, there was no penalty for failed trades. However, in light of the financial crisis and trillions of dollars in failed OTR deliveries, regulators adopted a penalty rate for failed trades, equal to the greater of 3% minus the federal funds rate, or zero. This means that as the federal funds rate

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increases, the penalty falls, and when the federal funds rate declines to zero, the penalty rate reaches its maximum at 3%. As a result, the new upper limit for the special spread is the penalty rate.

LO 49.7: Calculate the financing advantage of a bond trading special when used in a repo transaction.

The premium trading value of OTR bonds is due both to their liquidity and financing advantage as we previously discussed. The liquidity advantage stems from the ability to sell these bonds quickly for cash. The financing value stems from the ability to lend the bonds at a cheap special rate and use the cash to lend out at higher GC rates. This financing value is dependent on the trader's expectation of how long the bond will continue trading at its special rate before the rate moves higher toward the GC rate.

Let's assume that an OTR bond is issued on January 1 and trades at a special spread of 0.18%. A trader expects the bond to trade at GC rates past March 31. The financing value of the OTR bond is therefore the value over 90 days. The value of $100 of cash at the spread of 0.18% is:

$$\$100 \times \frac{90 \times 0.18\%}{360} = \$0.045$$

Thus, the financing value is 4.5 cents per $100 market value of the bond.

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Key Concepts

LO 49.1

Repurchase agreements, or repos, are bilateral contracts where one party sells a security at a specified price with a commitment to buy back the security at a future date at a higher price. From the perspective of the borrower we refer to repos, while from the perspective of the lender we refer to reverse repos. Repos are valued based on a simple time value of money calculation.

LO 49.2

From the perspective of the borrower, repos offer relatively cheap sources of obtaining short-term funds. Balancing the cost of funding (e.g., through repos) and other sources of funds (including potentially no funding) is called liquidity management.

From the perspective of the lender, repos can be used for either investing (cash management) or for financing purposes (e.g., to finance short bond positions).

LO 49.3

Repos give rise to both counterparty risk and liquidity risk. Counterparty (credit) risk is the risk of borrower default or non-payment of its obligations. Liquidity risk is the risk of an adverse change in the value of the collateral. Counterparty risk is mitigated with collateral, while liquidity risk is mitigated with haircuts, margin calls, shorter repo terms, and higher quality collateral.

LO 49.4

During the recent financial crisis, lenders were increasingly demanding higher quality collateral and larger haircuts and even withdrew liquidity altogether. Borrowers experienced collateral liquidations and capital declines, leading to several high profile company failures and bankruptcies. The failures of Bear Stearns and Lehman Brothers illustrate these events.

LO 49.5

Repo trades can be secured either with general collateral or with specific collateral. Lenders (as investors) in general collateral (GC) repo trades are not concerned with receiving a specific security, and only the broad categories of acceptable securities are specified. GC trades suit investors in repos because they can obtain the highest repo rate for the collateral received. Lenders (as financing participants) in special collateral repo trades (specials trades) are concerned with receiving a particular security as collateral. The particular security received can then be used to finance the purchase of a bond (for shorting) or to finance its inventory or proprietary positions.

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LO 49.6

The difference between the GC rate and the special rate for a particular security and term is called a special spread. Special spreads are tied closely to Treasury bond auctions, and the level and volatility of the spread can be an important gauge of market sentiment. Special spreads are generally narrower immediately after an auction, but widen before auctions. Spreads generally move within a band that is capped at the GC rate (implying a floor of 0% for the special rate).

Following the recent financial crisis, regulators adopted a penalty rate for failed trades at the greater of 3% minus the federal funds rate, or zero. As a result, the penalty rate becomes the new upper limit for the special spread.

LO 49.7

The financing value of the bond is the ability to lend the bonds at a relatively cheap special rate and use the cash to lend out at higher GC rates. This financing value is dependent on the trader's expectation of how long the bond will continue trading at its special rate.

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Concept Checkers

1. Pasquini Investments (Pasquini) is a private brokerage looking for 30-day financing of $25 million of its accounts payable but is unsure whether the appropriate investment is a term repurchase agreement (repo) or a term reverse repo agreement. Pasquini is willing to post AAA-rated government bonds as collateral. The bonds have a face value of $27 million and a market value of $25 million. The firm is quoted a rate of 0.5% for the transaction. Which of the following choices most accurately reflects the contract type and the contract price needed by Pasquini?

	Contract type	Contract price
A.	Repo	$27,011,250
B.	Reverse repo	$25,010,417
C.	Repo	$25,010,417
D.	Reverse repo	$27,011,250

2. Posting collateral and requiring collateral haircuts are important risk mitigants in repo transactions with respect to which of the following risks?

	Posting collateral	Collateral haircuts
A.	Market risk	Interest rate risk
B.	Credit risk	Interest rate risk
C.	Market risk	Liquidity risk
D.	Credit risk	Liquidity risk

3. Kotra Bank Holdings, Inc., (Kotra) is currently weighing the cost of its funding against the risk of being left without financing. The term that best describes Kotra's activities is:
   A. counterparty (credit) risk.
   B. specials trading.
   C. liquidity management.
   D. overnight funding.

4. In a presentation to management, a bond trader makes the following statements about repo collateral:

   Statement 1: *"The difference between the federal funds rate and the general collateral rate is the special spread."*

   Statement 2: *"During times of financial crises, the spread between the federal funds rate and the general collateral rate widens."*

   Which of the trader's statements are accurate?
   A. Both statements are incorrect.
   B. Only Statement 1 is correct.
   C. Only Statement 2 is correct.
   D. Both statements are correct.

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5. The latest on-the-run (OTR) Treasury bond issued on March 1 is trading at a special spread of 0.25%. Traders expect the bond to trade at general collateral (GC) rates past June 30. The financing value of the OTR bond is therefore the value over 122 days. Given this information, the value of lending $100 of cash is closest to:
   A. $0.085.
   B. $0.250.
   C. $0.305.
   D. $0.847.

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Concept Checker Answers

1. **C** Given that Pasquini is a borrower in the repo market, the transaction is a repo from the perspective of the firm (but a reverse repo from the perspective of the lender). The contract price is calculated as follows:

$$\$25,000,000 \times \left(1 + \frac{0.5\% \times 30}{360}\right) = \$25,010,417$$

2. **D** Collateral is an important counterparty credit risk mitigant. Repo loans are secured by collateral, which makes the lender much less vulnerable to a decline in the creditworthiness of the borrower. Collateral haircuts are important in mitigating liquidity risk in repo transactions. The lender is exposed to the risk of the value of the collateral declining during the repo term, which can be mitigated by requiring (higher) haircut values, that is, discounts to the value of the posted collateral.

3. **C** The process of weighing the cost of its finding against the risk of being left without financing is called *liquidity management*. Counterparty (credit) risk is the risk of borrower default or non-payment of its obligations. In specials trading, a lender of cash initiates a repo trade in order to receive a particular security (special collateral). Overnight funding refers to borrowing and lending in the overnight market.

4. **C** The trader's first statement is incorrect. The difference between the federal funds rate and the general collateral (GC) rate is known as the *fed funds-GC spread*. The *special spread* is the difference between the GC rate and the special rate for a particular security.

   The trader's second comment is correct. During times of financial crises, the spread between the federal funds rate and the general collateral rate widens as the willingness to lend Treasury securities declines, lowering the GC rate (thereby increasing the spread).

5. **A** The financing value of $100 of cash at a spread of 0.25% is calculated as:

$$\$100 \times \frac{122 \times 0.25\%}{360} = \$0.0847 \text{ or } 8.47 \text{ cents}$$

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

Estimating Liquidity Risks

Topic 50

Exam Focus

This topic addresses the calculation of liquidity cost and applies this value to the value at risk measure. We will see how to compute liquidity-adjusted VaR (LVaR) when considering both a constant spread and an exogenous spread approach. Be familiar with how to make these calculations, particularly for the constant spread approach. Also, understand the concept of cash flow at risk (CFAR) and how liquidity is impacted during a crisis.

Liquidity Risk

LO 50.1: Define liquidity risk and describe factors that influence liquidity, including the bid-ask spread.

Liquidity risk is the degree to which a trader cannot trade a position without excess cost, risk, or inconvenience. When liquidity risk exists, there can be several types of price uncertainty. First, the usual market quote of the average of the bid and ask prices becomes less meaningful because the spread is wider, which means the market quote is even farther from either the buy or sell transaction price. Second, a larger bid-ask spread means a higher cost to get in and out of the position. Third, the actual price of either a buy or sell order is less certain because the assets do not trade frequently, and the quoted bid and ask prices will probably not be the prices of the respective sell and buy transactions when actually executed. There is also an increased risk in that the spread can change (i.e., it is stochastic), which will increase the risks of trading.

Liquidity is a function of the type of market and its characteristics. It depends on factors such as the number of traders in the market, the frequency and size of trades, the time it takes to carry out a trade, the cost, and the risk of the transaction not being completed. It also depends on the type of asset and the degree to which the asset is standardized. A less standardized asset will have higher liquidity risk. A forward contract has much more liquidity risk than a futures contract, for example, because the forward contract is not a standardized contract. Over-the-counter (OTC) derivatives of all types usually have relatively high liquidity risk.

Bid-Ask Spread

The bid-ask spread is a cost of liquidity. A wider (narrower) spread indicates lower (higher) liquidity. If an asset becomes less liquid, the spread increases, and the costs of trading the asset increase. The risk of liquidity changing, and changes in the spread, should be included with other measures of market risk. The spread can also change as a result of the activities of a given trader when liquidity is endogenous, which is described in the next LO.

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Exogenous vs. Endogenous Liquidity

LO 50.2: Define exogenous and endogenous liquidity.

Exogenous liquidity refers to the bid-ask spread not being affected by the individual trades made by investors. This is more likely to be the case when the trades are relatively small. **Endogenous liquidity** refers to when a given trade can influence the liquidity risk of the trade (i.e., a trader submitting a buy or sell order that increases the spread). If an investor attempts to purchase a large block of an asset, for example, the buy order may have an impact on the spread and increase the cost over that indicated by the initial bid-ask prices. This can also happen when an investor tries to liquidate an asset. This type of endogeneity problem is more likely in illiquid markets and when the trade is large relative to the market.

In summary, for endogenous markets, if a trader attempts to liquidate (buy) a large position, the trader should expect the bid (ask) price to fall (increase) and the bid-ask spread to widen. The trader should include such a market reaction when estimating liquidity costs and risks. In both the endogenous and exogenous case, the bid-ask spread is still a function of the factors already mentioned (the number of traders, the standardization of the asset, low transactions costs, etc).

Liquidity-Adjusted VaR

LO 50.3: Describe the challenges of estimating liquidity-adjusted VaR (LVaR).

One of the challenges of estimating liquidity-adjusted value at risk (LVaR) is choosing the best method. As in most choices, there is a tradeoff between sophistication and ease of implementation, and it is worth noting that sophistication and usefulness are not necessarily positively correlated. It is recommended to find approaches that are transparent in their assumptions and simple to implement (e.g., implementable with just a spreadsheet). A good way to do this is to determine liquidity "add-ons" that allow a researcher to modify original VaR estimates that did not include factors for illiquidity. In addition to addressing liquidity, the approach can also assess the impact of assumptions on estimates of VaR.

Another challenge is liquidity adjustments that are compatible with the basic VaR approach and each other. This is because different methods look at different aspects of illiquidity, and it can be helpful to combine 'add-ons' that give the best overall liquidity adjustment. In other words, two less sophisticated methods may be much better than one really good sophisticated method.

Another challenge is to check how the liquidity adjustment changes other inputs, such as the confidence level, holding period, or any other parameters (i.e., the sensitivity of the other inputs to the liquidity adjustment). The researcher should be aware of some basic relationships (e.g., an increase in the holding period should lower the level of the liquidity adjustment).

The researcher should try to calibrate the model against real data (e.g., check if the bid-ask spread parameters are empirically plausible), and properly stress test the model, as well as backtest the model. The researcher should be aware that there is probably not a single, best

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approach that would exclude the use of all others. Furthermore, using different approaches can help highlight different liquidity concerns.

LO 50.4: Describe and calculate LVaR using the constant spread approach and the exogenous spread approach.

The **constant spread approach**, as the name implies, calculates LVaR assuming the bid-ask spread is constant. This makes the liquidity cost equal to half the spread multiplied by the size of the position to be liquidated. The liquidity cost (LC) to add on to the initial VaR estimate is then:

$$LC = 0.5 \times V \times \text{spread}$$

where:
V = value of the position

$$\text{spread} = \frac{(\text{ask price} - \text{bid price})}{(\text{ask price} + \text{bid price}) / 2}$$

Recall that VaR quantifies the maximum loss for a given confidence level over a particular holding period. For example, a typical VaR calculation may indicate a 1% probability of losses exceeding $10 million over a five-day holding period. LVaR is calculated using the following formula assuming a constant spread:

$$LVaR = (V \times z_\alpha \times \sigma) + [0.5 \times V \times \text{spread}]$$

$$LVaR = VaR + LC$$

where:
V = asset (or portfolio) value
z_α = confidence parameter
σ = standard deviation of returns

Professor's Note: Notice that VaR in this example is dollar VaR as opposed to percentage VaR.

The confidence level of the estimate is $1 - \alpha$ (e.g., 5% level of significance (α) = 95% confidence level). Note that the larger the spread, the larger the calculated LVaR. Since liquidity risk incorporates selling the asset, not a full "round trip," only half of the spread is used.

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Example: Computing LVaR

Suppose that ABC Company has a current stock price of $100 and a daily standard deviation of 2%. The current bid-ask spread is 1%. Calculate LVaR at the 95% confidence level. Assume a constant spread.

Answer:

$$\text{LVaR} = (100 \times 1.65 \times 0.02) + (0.5 \times 100 \times 0.01) = \$3.80$$

The previous discussion involved the use of normal VaR (i.e., VaR assuming asset prices are normally distributed). In practice, asset prices are lognormally distributed as was illustrated in the FRM Part I curriculum when we examined the Black-Scholes-Merton option pricing model. In this assigned reading, the author uses **lognormal VaR** to calculate the liquidity-adjusted VaR. The conventional lognormal VaR, with no adjustment for liquidity risk, is calculated in the following fashion:

$$\text{Lognormal VaR} = [1 - \exp(\mu - \sigma \times z_\alpha)] \times V$$

where:
μ = mean return

The liquidity-adjusted VaR is then calculated as follows:

$$\text{LVaR} = \text{VaR} + \text{LC} = [1 - \exp(\mu - \sigma \times z_\alpha) + 0.5 \times \text{spread}] \times V$$

Using the simplifying assumption of $\mu = 0$, the ratio of LVaR to VaR becomes:

$$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{\text{spread}}{2 \times [1 - \exp(-\sigma \times z_\alpha)]}$$

This expression indicates that the liquidity adjustment will increase (decrease) when there is an increase (decrease) in the spread, a decrease (increase) in the confidence level, and a decrease (increase) in the holding period.

Professor's Note: Notice that the calculation of lognormal VaR and normal VaR will be similar when we are dealing with short-time periods and practical return estimates.

Example: Computing LVaR to VaR ratio (constant spread)

Assume the following parameters: $\mu = 0$, $\sigma = 0.012$, spread = 0.02, and a 95% confidence level. **Compute** the LVaR to VaR ratio.

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Answer:

$$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{0.02}{2 \times [1 - \exp(-0.012 \times 1.65)]} = 1.51$$

The increase from VaR to LVaR is just over 50%, from only a 2% spread. This demonstrates that even a small spread can translate into a surprisingly large liquidity adjustment to VaR.

LVaR can also be calculated given the distribution characteristics of the spread. This is the foundation underlying the **exogenous spread approach**. If you are given the mean and standard deviation of the spread, you would apply the following formula:

$$\text{LVaR} = \text{VaR} + 0.5 \times [(\mu_S + z'_\alpha \times \sigma_S)] \times V$$

Professor's Note: We add the confidence parameter times the volatility of the spread to the mean of the spread since the liquidity adjustment increases the value at risk. Also, notice that the confidence parameter (or z-score) used for the uncertainty of the spread is labeled differently. The confidence parameter, in this case, is a value to be determined.

The exogenous spread approach assumes that the spread is stochastic and that the trades of a single trader do not affect the spread. The spread could follow one of many distributions; for example, the normal distribution or a more leptokurtic distribution (historically, the distribution of the spread has been highly non-normal with excess amounts of kurtosis). Once having assumed a distribution, the researcher can estimate the LVaR using Monte Carlo simulation by simulating values for both *V* and the spread, incorporating the spread into *V* to get liquidity-adjusted prices, and then infer the liquidity-adjusted VaR from the distribution of simulated liquidity-adjusted prices.

Example: Computing LVaR (assuming normal VaR)

Suppose that ABC Company has a current stock price of $100 and a daily standard deviation of 2%. The mean of the bid-ask spread is 2%, and the standard deviation of the bid-ask spread is 1%. **Calculate** LVaR at the 95% confidence level assuming the confidence parameter of the spread is equal to 3.

Answer:

$$\text{LVaR} = (100 \times 1.65 \times 0.02) + \frac{1}{2} 100 \times (0.02 + 3 \times 0.01) = \$5.8$$

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The researcher can determine the optimal value of z'_α using some suitably calibrated Monte Carlo exercise [Bangia et al. (1999)[1] assume a value of three for z'_α]. Applying lognormal assumptions, the LVaR using the exogenous spread approach is the lognormal VaR plus the liquidity adjustment:

$$\text{LVaR} = \text{VaR} + \text{LC} = V \times \{[1 - \exp(\mu - \sigma \times z_\alpha)] + [0.5 \times (\mu_S + z'_\alpha \times \sigma_S)]\}$$

It is worth noting that if σ_S equals zero, then this expression becomes the LVaR formula for the constant spread approach where μ_S = spread. Thus, this approach is simply the constant spread approach with an added expression to allow for a stochastic spread.

We can now apply the familiar LVaR to VaR ratio:

$$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{\text{LC}}{\text{VaR}} = 1 + \frac{(\mu_S + z'_\alpha \times \sigma_S)}{2 \times [1 - \exp(-\sigma \times z_\alpha)]}$$

Example: Computing LVaR to VaR ratio (exogenous spread)

A researcher estimates the mean and standard deviation of the spread to be 0.02 and 0.005, respectively. He also estimates that $\mu = 0$ and $\sigma = 0.012$ for the underlying returns distribution. Using a 95% confidence level, **compute** the ratio of LVaR to VaR. Assume the confidence parameter for the spread, z'_α, is equal to 3.

Answer:

$$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{(0.02 + 3 \times 0.005)}{2 \times [1 - \exp(-0.012 \times 1.65)]} = 1.89$$

The result here, when compared to the previous answer, demonstrates how including the possibility of the spread being random (stochastic) can increase the liquidity adjustment. In this case, it almost doubles from 51% to 89%.

Endogenous Price Approaches

LO 50.5: Describe endogenous price approaches to LVaR, their motivation and limitations, and calculate the elasticity-based liquidity adjustment to VaR.

Both the constant spread approach and the exogenous spread approach assume that prices do not change in response to trading (i.e., prices are exogenous). This may not always be the case, and it may be necessary to make a liquidity adjustment for endogenous prices. In the case of selling for example, there may be downward pressure on prices, which causes a loss. VaR should include an adjustment for the possibility of this loss. The adjustment should be larger if the market prices are more responsive to trades.

1. Bangia, A.F. Diebold, T. Schuermann, and J. Stroughair. (1999). "Liquidity on the outside." *Risk* 12 (June): 68–73.

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Of the various ways to include an adjustment, a relatively simple method uses the concept of **elasticity**, *E*. In this case, it is the proportional change in price divided by the proportion of the market traded:

$$E = \frac{\Delta P/P}{\Delta N/N}$$

where:
$\Delta N/N$ = size of the trade relative to the entire market

Generally, it is the case that $E < 0$ and $\Delta N/N > 0$. A researcher can estimate values for *E* and $\Delta N/N$ and input them into an expression for LVaR as follows:

$$LVaR = VaR \times \left(1 - \frac{\Delta P}{P}\right) = VaR \times \left(1 - E \times \frac{\Delta N}{N}\right)$$

$$\frac{LVaR}{VaR} = 1 - E \times \frac{\Delta N}{N}$$

The approach is very convenient because the adjustment is independent of the computation of VaR and its assumptions, and the ratio of LVaR to VaR is a function of only two inputs. The obvious limitation is its narrow focus and that it entirely ignores bid-ask spreads and transactions costs. On the other hand, a researcher can easily combine this adjustment with one of the other liquidity adjustments by simply multiplying the effects:

$$\left.\frac{LVaR}{VaR}\right|_{combined} = \left.\frac{LVaR}{VaR}\right|_{exogenous} \times \left.\frac{LVaR}{VaR}\right|_{endogenous}$$

Example: Endogenous price approach

A trader has a position worth 10% of the size of the market (i.e., $\Delta N/N = 0.1$) and estimates that $E = -0.4$ so that $\Delta P/P = E \times \Delta N/N = -0.4 \times 0.1 = -0.04$. **Compute** the ratio of LVaR to VaR based only on endogenous factors and the combined LVaR to VaR ratio assuming the ratio for the exogenous approach is 1.89.

Answer:

$$\left.\frac{LVaR}{VaR}\right|_{endogenous} = 1 - (-0.04) = 1.04$$

Thus, the adjustment for endogeneity will increase the total adjustment for liquidity by 4%. Using the liquidity adjustment for the exogenous approach yields the following combined result:

$$\left.\frac{LVaR}{VaR}\right|_{combined} = 1.89 \times 1.04 = 1.97$$

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Jarrow and Subramanian (1997)[2] offer a more sophisticated method called the **liquidity discount VaR**, where the trader maximizes expected utility by liquidating the position within a certain period of time. It incorporates both exogenous and endogenous market liquidity, spread cost, spread risk, an endogenous holding period, and an optimal liquidation policy. It does so with three modifications: (1) uses an optimal holding period based on the trader's expected-utility optimization problem, (2) adds the average liquidity discount to the trader's losses, and (3) has the volatility measure include the volatility of the time to liquidation and the volatility of the liquidity discount factor, as well as the volatility of the underlying market price.

Liquidation, Transaction Costs, and Market Price Impact

As with most financial activities, there are tradeoffs to consider when executing a trade. Attempting to sell quickly will usually increase the transactions costs and may have an unfavorable impact on the selling price. Taking more time to sell can increase the exposure to exogenous and unfavorable price changes. A trader should recognize the tradeoff and identify a set of efficient trading strategies that produce the minimum remaining risk exposure at any given point in time, for any given expected cost. The trader should choose the strategy that best fits his risk aversion. A more (less) risk averse trader would choose a strategy that executes more (less) quickly. A more (less) quick execution will reduce (increase) price uncertainty with higher (lower) transactions costs.

Liquidity at Risk

LO 50.6: Describe liquidity at risk (LaR) and compare it to VaR, describe the factors that affect future cash flows, and explain challenges in estimating and modeling LaR.

Liquidity at risk (LaR) is also known as **cash flow at risk** (CFaR) and is the maximum likely cash outflow over the horizon period at a specified confidence level. A positive (negative) value for LaR means the worst outcome will be associated with an outflow (inflow) of cash. LaR is similar in concept to VaR, but instead of a change in value, it deals with a cash flow. LaR is also distinct from liquidity-related losses, but they are related.

As an example, an investor has a large market risk position that is hedged with a futures position. If the hedge is a good one, the basis risk is small, and the VaR should be small. There is the possibility of margin calls on the futures position, however, and this means there is the possibility of a cash outflow equal to the size of that position. In summary, the hedged position has a small VaR but a large LaR. At the other extreme, European options have zero LaR until expiration, but potentially large VaR prior to maturity.

The following is a list of factors that influence cash flows and LaR:

- Borrowing or lending.
- Margin requirements on market risk positions that are subject to daily marking to market.
- Collateral obligations, such as those on swaps, which can generate inflows or outflows of cash from changes in market factors, such as interest rates.

2. Jarrow, R.A. and A. Subramanian. (1997). "Mopping up liquidity." *Risk* 10 (December): 170–173.

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- Short explicit options or implicit options (e.g., convertibility and call features).
- Changes in risk management policy (e.g., a change in the type of hedge), which may change mark-to-market requirements.

Two other considerations are as follows: (1) LaR can increase when the firm is facing hard times (e.g., a credit downgrade increases the rate on bank loans); and (2) there are positions that are similar in terms of market risk (e.g., a futures versus an options hedge), but are very different in terms of LaR.

As a practical matter for the firm attempting to estimate LaR, consider using the firm's VaR procedures to estimate the VaRs of marginable securities and then combine this LaR estimate with comparable figures from other sources of liquidity risk within the organization to produce an integrated measure of firm-wide liquidity risk. The point is to use the existing and accepted VaR procedures to estimate liquidity risks. It is obviously ad hoc, however, and a firm facing complex liquidity risks should build a more appropriate model. This would involve identifying and modeling the variables indicated in the following list:

- The certain cash flows (e.g., from U.S. Treasury investments).
- The unconditional uncertain cash flows (e.g., from risky bonds).
- The conditional uncertain cash flows (e.g., those that only result if a certain decision is made, such as making an investment).
- Other conditioning variables that might trigger cash flows.

Having identified the factors, the manager can construct an appropriate engine to estimate the risks. Estimating the LaR may only require a variance-covariance approach, or it may require a more advanced simulation approach.

Role of Liquidity During Crisis

LO 50.7: Explain the role of liquidity in crisis situations and describe approaches to estimating crisis liquidity risk.

In a crisis, assumptions concerning the level of liquidity and other properties that are reasonable in a "normal" market may not hold. Such crises have occurred in 1987, 1992, 1998, and 2007–2009. Some event usually precipitates the crisis, such as a large fall in some asset prices, which leads to lower demand and wider bid-ask spreads. The time needed for selling orders to be executed increases. Market liquidity falls at the very time the market needs it.

Many things change during the course of a crisis, and a researcher needs a model that takes into account the distinctive features of a crisis (e.g., large losses, high bid-ask spreads). **CrashMetrics** may be one way to address this. As an example, the following is the profit/loss on a derivative position based on a **delta-gamma approximation**:

$$\Pi = \delta\Delta S + \frac{\gamma}{2}(\Delta S)^2$$

where:
ΔS = change in the stock price

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Taking the derivative of this measure with respect to ΔS and solving for ΔS gives the change that produces the maximum loss: $\Delta S = -\delta/\gamma$, and that maximum loss in absolute value terms is:

$$\max(\text{loss}) = -\min(\Pi) = \frac{\delta^2}{2\gamma}$$

For a derivative position that requires margin and mark-to-market, letting ***m*** equal the margin requirement, the worst-case cash outflow is simply ***m*** times this amount: $m \times \delta^2/(2\gamma)$. This approximation can be more precise with the inclusion of the effects of other Greeks (e.g., thetas), counterparty risk, and other factors.

Another method for examining the liquidity consequences associated with worst-case scenarios is to apply the basic procedure above to an extreme-value method estimated with expected shortfall (ES). The cash flow would then be m × ES.

These two variations of estimating the worst-case cash flow do not address many real-world complications. A researcher might also wish to address the complications with simulations designed for specific complications. Those complications include:

- The discreteness of credit events.
- The interdependency of credit events.
- The interaction of credit and market risk factors.
- Complications arising from the use of credit-enhancement methods, such as netting arrangements, periodic settlement, credit derivatives, credit guarantees, and credit triggers.

Crisis-scenario analysis is an alternative to the probabilistic approaches described previously. This would involve analyzing the potential problems of a particular event (e.g., the failure of a major institution) and working through the specific details of how this might occur. This has the advantage of working through scenarios at a chosen level of detail and accounting for complications and interactions. The problem is that there will be a lot of subjectivity, and the results will depend heavily on the assumptions used.

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Key Concepts

LO 50.1

Liquidity risk is the degree to which a trader cannot trade a position without excess cost, risk, or inconvenience. Liquidity depends on factors such as the number of traders in the market, the frequency and size of trades, the time it takes to carry out a trade, the cost, and the risk of the transaction not being completed. It also depends on the type of asset and the degree to which the asset is standardized.

A wider (narrower) bid-ask spread indicates lower (higher) liquidity. If an asset becomes less liquid, the spread increases, and the costs of trading the asset increase.

LO 50.2

Exogenous liquidity refers to the bid-ask spread not being affected by the individual trades made by investors. This is more likely to be the case when the trades are relatively small.

Endogenous liquidity refers to when a given trade can influence the liquidity risk of the trade (i.e., a trader submitting a buy or sell order that increases the spread).

LO 50.3

The main challenge in estimating liquidity is finding the best method. One approach is finding adjustments to add on to the basic VaR. The researcher must understand how the inputs affect the "add-ons" and, if there are more than one, how the add-ons interact.

LO 50.4

The constant spread approach assumes the bid-ask spread is constant and the liquidity cost is simply, LC = 0.5 × spread × V, which can be added into the VaR formula.

$$\text{VaR} = [1 - \exp(\mu - \sigma \times z_\alpha)] \times V$$

$$\text{LVaR} = \text{VaR} + \text{LC} = [1 - \exp(\mu - \sigma \times z_\alpha) + 0.5 \times \text{spread}] \times V$$

LO 50.5

To account for endogeneity, a trader may estimate the elasticity of the price to the proportion of the market in a given large trade, denoted *E*, the proportion itself, denoted ΔN/N, and adjust the VaR formula.

$$\text{LVaR} = \text{VaR} \times \left(1 - \frac{\Delta P}{P}\right) = \text{VaR} \times \left(1 - E \times \frac{\Delta N}{N}\right)$$

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LO 50.6

Liquidity at risk (LaR) is also known as cash flow at risk (CFaR) and is the maximum likely cash outflow over the horizon period at a specified confidence level.

LaR can be very different from the VaR of the same position. For example, a bond hedged with a futures contract has low VaR but high LaR from the possible margin call on the futures contract.

Factors that affect future cash flows are: borrowing or lending, margin requirements, collateral obligations, options positions, and changes in risk management policy.

LO 50.7

Many things change during the course of a crisis, and a researcher needs a model that takes into account the distinctive features of a crisis (e.g., large losses, high bid-ask spreads).

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Concept Checkers

1. Suppose that portfolio XYZ has a $1,000,000 portfolio invested in a stock that has a daily standard deviation of 2%. The current bid-ask spread of that stock is 1%. Assuming a constant spread, what is the liquidity-adjusted VaR (normal VaR) at the 95% confidence level?
   A. $5,000.
   B. $38,000.
   C. $44,200.
   D. $43,000.

2. Which of the following actions would most likely increase liquidity risk?
   A. A rapid execution of orders.
   B. A higher level of standardization of the asset.
   C. An increase in the number of traders and a decrease in the size of those trades.
   D. A decrease in the number of traders and an increase in the size of those trades.

3. When a given trade can influence the liquidity risk of a trade, this type of liquidity is known as:
   A. exogenous liquidity.
   B. undefined liquidity.
   C. endogenous liquidity.
   D. operational liquidity.

4. Assuming the following parameters: $\mu = 0$, $\sigma = 0.006$, spread = 0.01, and a 95% confidence level, the ratio of LVaR to VaR is closest to:
   A. 1.08.
   B. 1.51.
   C. 1.66.
   D. 2.04.

5. A trader has a position worth 5% of the size of the market (i.e., $\Delta N/N = 0.05$) and estimates that the elasticity of price to size of trade is: $E = -0.2$. The ratio of LVaR to VaR based only on endogenous factors is closest to:
   A. 0.99.
   B. 1.01.
   C. 1.05.
   D. 1.40.

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Concept Checker Answers

1. **B** LVaR = (1,000,000 × 1.65 × 0.02) + (0.5 × 1,000,000 × 0.01) = $38,000

2. **D** Larger and fewer traders will ultimately lower liquidity and increase liquidity risk.

3. **C** It is "endogenous" because it is determined by the trading activity itself.

4. **B** $$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{0.01}{2 \times [1 - \exp(-0.006 \times 1.65)]} = 1.508$$

5. **B** $\Delta P/P = E \times \Delta N/N = -0.2 \times 0.05 = -0.01$

$$\left.\frac{\text{LVaR}}{\text{VaR}}\right|_{\text{endogenous}} = 1 - (-0.01) = 1.01$$

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

Assessing the Quality of Risk Measures

Topic 51

Exam Focus

This topic focuses primarily on model risk and model errors, with specific criticisms of the value at risk (VaR) model. It is important to understand model risk and the factors that could result in variability in VaR estimates. It is also important to understand the challenges associated with mapping risk factors to positions in making VaR calculations. Be ready to explain how incorrect mapping factors can understate certain risks including reputational, liquidity, market, and basis risk. The second part of this topic focuses on two specific case studies on the failures in strategies during 2005 and 2007–2009 related to modeling errors and the underestimation of key risks.

Model Risk

LO 51.1: Describe ways that errors can be introduced into models.

Models are highly useful in simulating real-life scenarios; however, they can suffer from several risks. **Model risk** is the risk of incorrect trading or risk management decisions due to errors in models and model applications, which can lead to trading losses and give rise to legal, reputational, accounting, and regulatory risk. Biases in models themselves do not necessarily cause model risk; however, inaccurate or inappropriate inputs can create distortions in the model.

There are several ways in which errors can be introduced into models. These include bugs in the programming of model algorithms, securities valuations or hedging, variability of value at risk (VaR) estimates, or inaccurate mapping of positions to risk factors.

For example, bugs in programming occurred in May 2008 when Moody's used flawed programming to incorrectly assign AAA ratings to certain structured credit products. It happened again in October 2011 when bugs in the quant programming used by AXA Rosenberg[1] led to investor losses. For Moody's, model risk was related to reputational and liquidity risk because the model errors had been discovered prior to being made public and coincided with a change in ratings methodology that resulted in no change to the ratings of certain products. As a result, Moody's was suspected of tailoring its model to the desired ratings, which damaged the company's reputation. For AXA Rosenberg, the discovery of the model error had not been made public in a timely manner, leading to both regulatory fines and considerable reputational damage to the firm.

1 AXA Rosenberg Group, LLC is a division of the French insurance company AXA.

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Model errors in securities valuations or in hedging can create losses within a firm and lead to market risk and operational risk. *Market risk* is the risk of buying overvalued (or, at a minimum, fairly valued) securities in the market that are thought to be undervalued. *Operational risk* is the risk of recording unprofitable trades as profitable.

Relying on market prices rather than model prices through marking positions to market can theoretically avoid model errors and reduce valuation risk. A problem with this approach, however, is that certain positions, including long-term bank commercial loans, are difficult to mark-to-market due to infrequent trading and complexities in valuation.

Variability of VaR Estimates

LO 51.2: Describe how horizon, computational and modeling decisions can impact VaR estimates.

LO 51.3: Explain how model risk and variability can arise through the implementation of VaR models and the mapping of risk factors to portfolio positions.

Risk management is typically implemented via computer systems that help to automate gathering data, making computations, and generating reports. These systems can be made available commercially, and are typically used by smaller firms, while larger firms tend to use their own in-house systems, often in combination with commercial models. The implementation process for computing risk is usually referred to as the firm's *VaR model*, although the general computation process can apply to any risk measure other than VaR.

Data preparation is crucial in risk measurement systems. There are three types of data involved:

1. *Market data* is time series data (usually asset prices) that is used in forecasting the distribution of future portfolio returns. Market data involves obtaining the time series data, removing erroneous data points, and establishing processes for missing data. All of these steps can be costly but necessary.

2. *Security master data* is descriptive data on securities, including maturity dates, currency, and number of units. Building and maintaining data for certain securities, including equities and debt, can be challenging; however, it is critical from a credit risk management perspective.

3. *Position data* matches the firm's books and records but presents challenges as data must be collected from a variety of trading systems and across different locations.

Once the data is collected, software is used to compute the risk measures using specific formulas, which are then combined with the data. Results are then published in documents for reporting by managers. All of these steps can be performed in numerous ways and can lead to several issues within the risk measurement system. We focus on two of these issues: the variability of the resulting measures and the appropriate use of data.

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Variability in risk measures, including VaR, is both a benefit and a problem. Managers have significant discretion and flexibility in computing VaR, and parameters can be freely used in many different ways. This freedom in measuring VaR leads to two significant problems in practice:

1. *Lack of standardization of VaR parameters*. Given the variability in VaR measurements and managers' discretion, parameters including confidence intervals and time horizons can vary considerably, leading to different measurements of VaR.

2. *Differences in VaR measurements*. Even if VaR parameters were standardized, differences in measuring VaR could lead to different results. These include differences in the length of the time series used, techniques for estimating moments, mapping techniques (discussed in the next section) and the choice of risk factors, decay factors in using exponentially weighted moving average (EWMA) calculations, and the number of simulations in Monte Carlo analysis.

Varying parameters can lead to materially different VaR results. For example, one study using different combinations of parameters, all within standard practice, of portfolios consisting of Treasury bonds and S&P 500 index options indicated that VaR results differed considerably by a factor of six or seven times. A simple read of the different VaR models published in the annual reports of some of the larger banks can give an indication of the variability in their measurements.

Risk Factor Mapping for VaR Calculations

Mapping refers to the assignment of risk factors to positions. Mapping choices can also impact VaR results. These could include practical choices among alternatives where each alternative has its benefits and disadvantages. For example, managers have a choice between cash flow mapping and duration-convexity mapping for fixed income securities. *Cash flow mapping* leads to greater accuracy (each cash flow is mapped to a fixed income security with an approximately equal discount factor); however, *duration-convexity mapping* requires fewer and less complex computations, reducing costs and potential data errors as well as model risks.

It may also be difficult to locate data that addresses specific risk factors. One example is the previously widespread practice of mapping residential mortgage-backed securities (RMBS) or other securitized products to corporate credit spreads of the same rating. Because data on securitization spreads is typically not widely available, using a proxy risk factor of generic corporate bond spreads can be misleading, especially since previously lower spreads on securitizations widened considerably more during the recent financial crisis than did corporate spreads. This is an example of model risk and the inefficiency of VaR estimates in modeling large movements in market prices.

Incorrect mapping to risk factors can create risks such as liquidity risk and basis risk. **Liquidity risk** arises from divergences in model and market prices. For example, convertible bonds can be mapped to risk factors including implied volatilities, interest rates, and credit spreads based on the theoretical (model) price of the convertible bond using a replicating portfolio. However, significant divergences in model and market prices are difficult to capture with market data, and as a result, VaR estimates based on the replicating portfolio can considerably understate risk, creating liquidity risk.

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Basis risk is the risk that a hedge does not provide the required or expected protection. Basis risk arises when a position or its hedge is mapped to the same set of risk factors, which can be done when it is difficult to distinguish between two closely related positions. While this results in a measured VaR of zero, the positions have significant basis risk. Basis risk is also present in the risk modeling of securitization exposures where securitizations are hedged with corporate credit default swap (CDS) indices of similar ratings.

Other strategies can also lead to misleading VaR estimates. For example, **event-driven strategies** have outcomes that are close to binary and depend on a specific event occurring, including mergers or acquisitions, bankruptcy, or lawsuits. For these trades, the range of results cannot be measured based on historical return data. **Dynamic strategies** are another example, where risk is generated over time rather than at a specific point in time.

Credit Market in Early 2005

LO 51.4: Identify reasons for the failure of the long-equity tranche, short-mezzanine credit trade in 2005 and describe how such modeling errors could have been avoided.

Credit Trade Description and Modeling Issues

Volatility in credit markets in the spring of 2005 caused significant modeling errors from both misinterpretation and incorrect application of models. Trades incurred losses as only certain dimensions of risks were hedged, while others were ignored.

A popular strategy in credit markets for hedge funds, banks, and brokerages was to sell protection on the equity tranche and buy protection on the junior (mezzanine) tranche of the CDX.NA.IG index, the investment-grade CDS index. As a result, the trade was long credit and credit spread risk on the equity tranche and short credit and credit spread risk on the mezzanine tranche. The trade was primarily executed on the IG3 and IG4 index series. The trade was designed to be default-risk neutral at initiation with equal credit spread sensitivities on the two legs. The motivation of the trade was to have a positively convex payoff profile with the two positions benefiting from credit spread volatility, while earning a positive net spread on the positions (positive carry). This allowed trades to have a position similar to delta-hedged, long option portfolios by receiving, rather than paying, time value.

The hedge ratio for the delta-hedged portfolio then determined the dollar amount of the mezzanine to be shorted for every dollar of the long equity. In other words, the hedge ratio was the ratio of the profit and loss impact of a 1 bp widening of the CDX index on the equity and mezzanine tranches. The proper hedge ratio then allowed for the creation of a portfolio based on the CDX index that, at the margin, was default-risk neutral. The CDX trade benefited from a large change in credit spreads and essentially behaved like an option straddle on credit spreads with an option premium paid to the owner of the option. The hedge ratio for the CDX index was around 1.5 to 2 in early 2005, which resulted in a net flow of spread income to the long equity/short mezzanine trade.

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The critical error in the trade, however, was that it was set up at a specific value of implied correlation. A static correlation was considered a critical flaw as the deltas that were used in setting up the trade were partial derivatives that ignored any changes in correlation. With changes in credit markets, changing correlations doubled the hedge ratio to close to 4 by the summer of 2005. As a result, traders now needed to sell protection on nearly twice the notional value of the mezzanine tranche to maintain portfolio neutrality. Stated differently, as long as correlations remained static, the trade remained profitable. However, once correlations declined and spreads did not widen sufficiently, the trade became unprofitable.

Therefore, while the model did not ignore correlation, it assumed a static correlation and instead focused on anticipated gains from convexity. The error could have been corrected by stress testing correlation or by employing an overlay hedge of going long, single-name protection in high default-probability names.

Credit Market Example

Problems in credit markets were already evident by the spring of 2005. The problems were largely related to the automobile industry, specifically the original equipment manufacturers (OEMs), including Ford, Chrysler, and General Motors (GM), which had been experiencing troubles for some time. OEMs were particularly important in the U.S. investment-grade bond market, and the emerging threat of a downgrade to junk status rattled markets. Although the OEMs were not directly part of the CDX.NA.IG index, several of their related finance companies were. Outside of OEMs, several auto parts manufacturers were included in two series of the index, the IG3 and IG4 indices.

The immediate priority of the OEMs in early 2005 was to secure a relief from the United Auto Workers (UAW) union of health benefit commitments to retirees. When GM and the UAW were unable to reach an agreement in the spring of 2005, which coincided with the announcement of large losses for GM, GM and Ford were downgraded to junk status by S&P and Moody's. This created a sharp widening of corporate spreads, including the spreads on the automotive finance companies and other industry names. Several auto parts manufacturers filed for Chapter 11 bankruptcy protection. As a result, the market was now anticipating the possibility of defaults in the IG3 and IG4 indices, and the probability of extreme losses became real. In addition, the convertible bond market was also experiencing a selloff that resulted in widening of spreads. The IG indices widened in line with the credit spread widening of the index constituents. The mark-to-market value and the implied correlation of the equity tranche dropped sharply. The implied correlation fell given that (1) the auto parts supplier bankruptcies were in the IG4 series, which led to close to 10% of the portfolio now close to default, and (2) the widening of the IG4 series was constrained by hedging, which led to a fall in correlation. Participants could hedge short credit positions in the equity tranche by selling credit protection on the mezzanine tranche or the IG4 index series. Concurrently, the mezzanine tranche saw a small widening as market participants were covering their positions by selling protection on the mezzanine tranche (that is, they were taking on credit risk). These events led to the unwinding of the equity/mezzanine tranche trade with the relative value trade experiencing large losses.

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Risk Underestimation in 2007–2009

LO 51.5: Identify two major defects in model assumptions which led to the underestimation of systematic risk for residential mortgage backed securities (RMBS) during the 2008-2009 financial downturn.

The subprime RMBS valuation and risk models have been widely employed by credit rating agencies to assign bond ratings, by traders and investors in bond valuations, and by issuers in structuring RMBS. During the 2007–2009 financial downturn, two major defects in model assumptions became apparent:

1. *Assumption of future house price appreciation.* The RMBS risk model generally assumed that future house prices would rise, or at least not fall, based on relatively few historical data points. When house prices actually did drop beginning in 2007, this incorrect assumption led to a significant underestimation of the potential default rates and systematic risk in RMBS because the credit quality of the loans was dependent on borrowers' ability to refinance without additional equity.

2. *Assumption of low correlations.* The RMBS model assumed low correlations among regional housing markets, implying that loan pools from different geographical regions were well diversified. When house prices declined, correlations increased and loan defaults were much higher than previously expected under the model stress scenarios.

These two model errors led to a significant underestimation of systematic risk in subprime RMBS returns. When mortgage default rates began to increase, rating agencies were required to downgrade most issues, and by the end of 2009, approximately 45% of the initially AAA-rated U.S. RMBS had been downgraded. The downgrades of RMBS from their AAA-equivalent ratings shocked markets and exposed the degree to which systemic risk had been underestimated and mispriced.

There have been several explanations proposed for the inaccuracy of the rating models. First, the compensation of rating agencies by bond issuers led to a potential conflict of interest scenario that resulted in lower ratings standards. Second, an increase in demand for higher rated bonds with a modestly higher yield resulted in searching for yield. Finally, mapping problems led to misleading risk measurement results, as highly rated securitized products were frequently mapped to highly rated corporate bond spread indices. This resulted in incorrect VaR estimates, as incorrect mappings indicated it would be unlikely that bonds would decline significantly in value. In reality, the most highly rated RMBS lost a significant portion of their value, declining close to 70% during the subprime crisis, while lower investment-grade RMBS lost virtually all of their value.

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Key Concepts

LO 51.1

Model risk is the risk of incorrect trading or risk management decisions due to errors in models and model applications, which can lead to trading losses and potential legal, reputational, accounting, liquidity, and regulatory risk. Errors can be introduced into models through programming bugs, securities valuations or hedging, VaR estimates, and position mappings.

LO 51.2

Firms use software to compute the risk measures from the data collected using specific formulas, which can be performed in a variety of ways and lead to potential issues. Variability in risk measures, including lack of uniformity in the use of confidence intervals and time horizons, can lead to variability in VaR estimates. Other factors can also cause variability, including length of time series, ways of estimating moments, mapping techniques, decay factors, and number of simulations.

LO 51.3

Mapping refers to the assignment of risk factors to positions, and mapping choices can considerably impact VaR results.

Cash flow mapping results in greater accuracy of estimates. Duration-convexity mapping requires fewer risk factors and less complex computations, which reduces costs, data errors, and model risks. Locating data that addresses specific risk factors may also be difficult.

Liquidity risk arises from large divergences in model and market prices that are difficult to capture with market data, and as a result, VaR estimates based on replicating portfolios can understate risk and create liquidity risk.

Basis risk is the risk that a hedge does not provide the required or expected protection. Basis risk arises when a position or its hedge is mapped to the same set of risk factors.

LO 51.4

Volatility in credit markets in the spring of 2005 fueled by company bankruptcies and losses led to defaults in the IG3 and IG4 index series of the CDX.NA.IG index, causing large selloffs that resulted in widening spreads. This also resulted in modeling errors from both misinterpretation and incorrect application of models, which led to trade losses.

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LO 51.5

Two significant model errors in the RMBS valuation and risk models led to a significant underestimation of systematic risk in subprime RMBS returns during 2007–2009. First, the RMBS risk model assumed future house prices to rise or at least stay flat. The eventual decline in house prices starting in 2007 led to a significant underestimation of the potential default rates and systematic risk in RMBS. Second, the RMBS model assumed low correlations among regional housing markets. When house prices declined, correlations and loan defaults increased.

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Concept Checkers

1. Due to a recently discovered error in its valuation model, Samuelson, Inc. had previously recorded certain trades as profitable even though the positions were unprofitable. The risk that best characterizes this error is:
   A. operational risk.
   B. liquidity risk.
   C. market risk.
   D. hedge risk.

2. Duane Danning is a junior risk analyst at a large risk management firm. He has been asked to assess the firm's risk modeling practices and evaluate potential ways in which errors could be introduced into models. In his analysis, Danning indicates that errors can be introduced into models through programming bugs and errors in VaR estimates but rarely through incorrect position mappings. Danning's analysis is most accurate with regard to:
   A. only programming bugs and incorrect position mappings.
   B. only programming bugs and errors in VaR estimates.
   C. only errors in VaR estimates.
   D. only incorrect position mappings.

3. An advantage of duration mapping over cash flow mapping is that duration mapping:
   A. is more accurate than cash flow mapping, thus reducing mapping errors.
   B. uses cash flows that are mapped to specific fixed income securities without the use of approximations.
   C. uses more complex computations, thus reducing data errors and model risk.
   D. uses fewer risk factors, thus reducing data errors and model risk.

4. A common trade during 2004 and 2005 was to sell protection on the equity tranche and buy protection of the mezzanine tranche of the CDX.NA.IG index. Which of the following statements regarding this trade is least accurate?
   A. The trade was set up to be default-risk neutral at initiation.
   B. The trade was short credit spread risk on the equity tranche and long credit spread risk on the mezzanine tranche.
   C. The main motivation for the trade was to achieve a positively convex payoff profile.
   D. The trade was designed to benefit from credit spread volatilities.

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5. Which of the following two model errors in the RMBS valuation and risk models are considered to have contributed the most to a significant underestimation of systematic risk in subprime RMBS returns during 2007–2009?
   A. The assumption of future house price appreciation and the assumption of high correlations among regional housing markets.
   B. The assumption of future house price declines and the assumption of high correlations among regional housing markets.
   C. The assumption of future house price appreciation and the assumption of low correlations among regional housing markets.
   D. The assumption of future house price declines and the assumption of low correlations among regional housing markets.

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Concept Checker Answers

1. **A** Recording trades as profitable that have, in fact, lost money is an example of operational risk.

2. **B** Danning's analysis is most accurate with regard to only programming bugs and errors in VaR estimates. Incorrect position mappings can also lead to material errors in risk models.

3. **D** Duration mapping (or duration-convexity mapping) requires the use of fewer risk factors and less complex computations, thus reducing costs, data errors, and model risks. Cash flow mapping results in greater accuracy of estimates, however, because cash flows are mapped to specific fixed income securities without the use of approximations.

4. **B** The trade was long credit and credit spread risk on the equity tranche and *short* credit and credit spread risk on the mezzanine tranche. The other statements are accurate.

5. **C** The two model errors considered to have contributed the *most* to a significant underestimation of systematic risk were (1) the assumption of future house price appreciation, and (2) the assumption of low correlations among regional housing markets.

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

Liquidity and Leverage

Topic 52

Exam Focus

This topic analyzes the effects of liquidity and leverage on firm risk. For the exam, understand the distinction between transactions liquidity and funding liquidity, and the role banks play in providing liquidity. Also, be able to calculate a firm's leverage ratio and the leverage effect, and know how to construct the economic balance sheet given trades such as buying stock on margin, selling stock short, and taking positions in derivatives. Finally, be able to explain tightness, depth, and resiliency as they relate to liquidity risk.

Sources of Liquidity Risk

LO 52.1: Differentiate between sources of liquidity risk, including balance sheet/funding liquidity risk, systematic funding liquidity risk, and transactions liquidity risk, and explain how each of these risks can arise for financial institutions.

LO 52.10: Explain interactions between different types of liquidity risk and explain how liquidity risk events can increase systemic risk.

Liquidity is defined in many ways in financial markets. In general, an asset is liquid if it is "close to cash." This means that the asset can be sold quickly, cheaply, and without moving the price "too much." A market is liquid if positions can be unwound quickly, cheaply (i.e., at low transactions costs), and without undue price deterioration.

Liquidity has two essential properties, which relate to two essential forms of risk. **Transactions liquidity** deals with financial assets and financial markets. **Funding liquidity** is related to an individual's or firm's creditworthiness. Risks associated with liquidity include:

- **Transactions** (or **market) liquidity risk** is the risk that the act of buying or selling an asset will result in an adverse price move.
- **Funding liquidity risk** or **balance sheet risk** results when a borrower's credit position is either deteriorating or is perceived by market participants to be deteriorating. It also occurs when the market as a whole deteriorates. Under these conditions, creditors may withdraw credit or change the terms of credit (e.g., increase the required collateral for the loan). The position may, as a result, be unprofitable or may need to be unwound. Balance sheet risks are higher when borrowers fund longer term assets with shorter term liabilities. This is called a **maturity mismatch**. Maturity mismatching is often profitable for firms because short-term investors bear less risk and have a lower required rate of return. This means that short-term debt financing contributes less to the overall cost of capital of a borrowing firm. The incentive to maturity mismatch is even greater when the yield curve is upward sloping. However, funding long-term assets with short-term

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financing exposes the borrower to **rollover risk** (sometimes called cliff risk), the risk that the debt cannot be refinanced or can only be refinanced at escalating rates.

- **Systemic risk** is the risk that the overall financial system is impaired due to severe financial stress. With this risk, credit allocation is impaired across the financial system.

Risks associated with liquidity are interrelated and can exacerbate problems. For example, if collateral requirements are increased, a counterparty may be forced to unwind a position early and at a potential loss. In this case, the increase in funding liquidity risk increases the transactions liquidity risk.

An important connection between funding and transactions liquidity is leverage. An investor with a long position may be forced to sell an asset if future funding for the asset dries up. This in turn would reduce the number of potential asset holders, leading to a reduction in asset valuation. It may be the case that this decline in price is temporary, however, the length of the depressed asset price could be long enough to adversely impact the solvency of the investor who initially purchased the asset. A rapid deleveraging of assets could lead to a "debt-deflation crisis."

Transactions liquidity could also impair funding liquidity. For example, if a hedge fund is facing redemptions, it is forced to raise cash by selling assets and therefore must decide which assets to sell first. Selling highly liquid assets will lead to fewer adverse price impacts, but will leave the hedge fund with a more illiquid portfolio. On the other hand, selling highly illiquid assets will increase realized losses, which may put additional pressure on the portfolio from a funding liquidity standpoint.

The level of economy-wide liquidity directly impacts the level of systemic risk. When market conditions deteriorate, liquidity tends to become constrained just when investors need it the most. Liquidity risk events could potentially become systemic risk events through disruptions in payment, clearing, and settlement systems. Severe stress to the financial system would impact market participants simultaneously, suggesting that the illiquidity or insolvency of one counterparty may have a domino effect on other market participants throughout the system.

Liquidity Transformation by Banks

LO 52.2: Summarize the asset-liability management process at a fractional reserve bank, including the process of liquidity transformation.

Commercial bank assets are typically longer-term and less liquid than bank liabilities (e.g., deposits). Wholesale funding (i.e., non-deposit sources of funding like commercial paper, bonds, and so on) is generally longer term but deposits are "sticky." Depositors generally change banks only if impelled to by a move or some other extenuating circumstance. Deposits make up approximately 60% of bank liabilities in the United States.

Banks only expect a fraction of deposits and other liabilities to be redeemed at any point in time. As a result, they do not hold all the deposits in liquid assets, but make loans with deposits instead. For example, a bank might take in $100 of deposits, hold $10 for redemptions, and lend the remaining $90. This is known **as a fractional-reserve bank** and the process of using deposits to finance loans is known as **asset-liability management** (ALM).

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The bulk of banks in history have been fractional-reserve banks. The alternative to a fractional-reserve system is one in which the bank uses owners' money (i.e., equity) or money raised in capital markets to make loans, and keeps in reserve cash or highly liquid assets equal to its deposits.

If withdrawals are greater than the bank's reserves, the bank is forced into a **suspension of convertibility**. This means the bank will not be able to, as expected by depositors, convert deposits immediately into cash. In the extreme, there may even be a **run on the bank**. In the case of a bank run, depositors who are concerned about bank liquidity may attempt to get money out of the bank before other depositors and lenders. While rollover risk associated with other short-term financing is less extreme than bank runs, it does increase the fragility of banks. Higher capital reduces bank fragility.

Frozen commercial paper markets in the wake of the Lehman Brothers failure illustrated the fragility of bank funding. Commercial funding couldn't be placed and thus fell dramatically after the Lehman bankruptcy. It became nearly impossible to roll over longer term paper and very short-term paper rose to account for approximately 90% of the market. The Federal Reserve stepped in after the Lehman bankruptcy and created the Commercial Paper Funding Facility (CPFF) and the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF).

Structured Credit Products and Off-Balance Sheet Vehicles

LO 52.3: Explain the liquidity characteristics and risks of structured credit products.

Structured credit products, such as asset-based securities (ABSs) and mortgage-backed securities (MBSs), match investor funding needs with pooled assets. Because these products are maturity matched, they are not subject to funding liquidity issues. However, investor financing for structured credit products can create liquidity risk when investors rely on short-term financing. This type of financing was one of the main drivers of the recent subprime crisis and the increase in leverage in the financial system leading up to the crisis. Two types of short-term financing include: (1) securities leading (i.e., applying structured credit products as collateral to short-term loans), and (2) off-balance sheet vehicles.

Special-purpose vehicles (SPVs) serve as off-balance sheet vehicles by issuing secured debt in the form of asset-backed commercial paper (ABCP). **ABCP conduits** finance purchases of assets, such as securities and loans, with ABCP. They receive liquidity and credit support via credit guarantees. **Structured investment vehicles** (SIVs) differ slightly from ABCP conduits because they do not receive full liquidity and credit support.

Prior to the subprime crisis, both ABCP conduits and SIVs profited from the spread between funding costs and asset yields. The assets held by these vehicles typically had longer maturities than the ABCP that fund the assets. In addition to maturity transformation, these vehicles also provided liquidity transformation. This was accomplished by creating ABCP that was more liquid and had shorter terms than the assets held in the conduit and SIV. However, despite being off-balance sheet, which permitted firms to hold less capital, these vehicles did not entirely transfer risk. As a result, they still contributed to the leverage issues and fragility of the financial system during the recent subprime crisis.

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Systematic Funding Liquidity Risk

LO 52.4: Describe specific liquidity challenges faced by money market mutual funds and by hedge funds, particularly in stress situations.

Systematic funding risks were apparent in many market sectors during the subprime mortgage crisis. As loans become shorter term, lenders and borrowers are exposed to greater liquidity risks. Borrowers must be able to refinance in order to repay short-term loans. The risk is systematic in that it affects borrowers and lenders at the same time.

Liquidity issues arose during the recent financial crisis for a variety of investment strategies including:

- **Leveraged buyouts** (LBOs). Leveraged loans became the dominate type of syndicated bank loans as LBOs and private equity grew before the crisis. Leveraged loans accounted for a large part of collateralized loan obligations (CLOs) and collateralized debt obligations (CDOs), which provided funding for LBOs. During the subprime mortgage crisis, LBO deals fell apart as funding dried up. Some loans, called "hung loans," had not been distributed to investors and demand dried up. Banks incurred significant losses as prices fell sharply.
- **Merger arbitrage hedge funds**. Hedge funds engaged in merger arbitrage experienced losses in the early stages of the subprime mortgage crisis. After a merger is announced, the target's stock price typically increases and the acquirer's price sometimes declines due to increased debt. The merger arbitrage strategy exploits the difference between the current and announced acquisition prices. Hedge funds experienced large losses as mergers were abandoned when financing dried up.
- **Convertible arbitrage hedge funds**. Convertible arbitrage strategies rely on leverage to enhance returns. Credit is extended by broker-dealers. When financing becomes unavailable due to market conditions, as experienced in the 2007–2009 financial crisis, convertible bond values drop precipitously. The funding liquidity problem was compounded by redemptions (i.e., a market liquidity problem). Also, because there is a limited clientele investing in convertible bonds, when the clientele develops a dislike for the product due to deteriorating market conditions, it is difficult to sell the assets without large price declines. The gap between convertible bond prices and replicating portfolios widened dramatically during the financial crisis, but it still did not bring arbitrage capital into the market.

The broader point is that investment strategies, such as merger arbitrage, convertible arbitrage, and leveraged buyouts, are not only exposed to idiosyncratic risks, but also to systematic risks (i.e., systematic funding risks in this case). The risks are soft risks because they are difficult to relate to a particular series of asset returns. Instead, analysts must examine data on credit and liquidity spreads as well as quantitative and anecdotal data on the availability of credit in the market to understand the probability of a liquidity freeze.

Money market mutual fund (MMMF) investors can write checks and make electronic bank transfers. Like banks, MMMFs are obligated to repay investors/depositors on demand. In general, underlying MMMF assets are high credit quality instruments with short maturities (e.g., a few weeks to a few months). However, the values of the underlying assets in the fund, despite their relative safety, are subject to change. As such, redemptions may be limited if asset values fall. The liabilities of MMMFs are, therefore, more liquid than their investments, similar to banks.

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MMMFs use a form of accounting called the amortized cost method, under the Securities and Exchange Commission's (SEC) Rule 2a – 7. This means that MMMF assets do not have to be marked-to-market each day, as required for other types of mutual funds. The reason behind the difference is that extremely short-term securities are not likely to revalue based on changes in interest rates and credit spreads. MMMFs set a notional value of each share equal to $1.00. However, credit write-downs cannot be disregarded and it is possible for net asset values (NAVs) to fall below $1.00. This is known as **breaking the buck**.

Liquidity risk can also cause NAVs to fall below $1.00. MMMFs, like depository institutions, are subject to runs. If a large proportion of investors try to redeem shares in adverse market conditions, the fund may be forced to sell money market paper at a loss. This can potentially result in write-downs and breaking the buck.

Economics of the Collateral Market

LO 52.5: Describe transactions used in the collateral market and explain risks that can arise through collateral market transactions.

Collateral markets have two important purposes. First, they enhance the ability of firms to borrow money. Cash is only one type of asset that is borrowed. Securities are also borrowed in collateral markets. Second, collateral markets make it possible to establish short positions in securities.

Firms with excess cash are more willing to lend at a low rate of interest if the loan is secured by collateral. Securities are used as collateral for secured loans. Collateralized loans can be short term or longer term. Overnight loans are often extended automatically. The full value of the securities is not lent in a collateralized loan. The difference is called a **haircut**. For example, a lender may be willing to lend $95 against $100 of collateral.

Collateral values fluctuate and most collateralized borrowing arrangements require that variation margin be paid to make up the difference (called **remargining**). Variation margin is the additional funds a broker requests so that the initial margin requirement keeps up with losses. The haircut ensures that the value of the collateral can fall by a certain percentage (i.e., 5% in the previous example) and still leave the loan fully collateralized. The variation margin protects the lender.

Collateralized loans are used to finance securities or other assets or trades. The securities pledged to one firm are often loaned or pledged again, hence the collateral circulates. This process is known as **rehypothecation** or **repledging**.

The role of collateral has expanded in contemporary finance, hand-in-hand with the development of securitization. Securitization creates securities that can be pledged as collateral for credit. Securitized assets generate cash flows, may appreciate in value, and can be used as collateral for other transactions.

Life insurance companies own large portfolios of high-quality assets. They may use these assets for collateralized loans to borrow at low rates and reinvest at higher rates. Hedge funds pledge securities to finance portfolios at rates cheaper than unsecured loans.

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Markets for collateral take the following forms:

- **Margin loans.** Margin loans are used to finance security transactions. The margin loan is collateralized by the security and is often provided by the broker intermediating the trade. The broker maintains custody of the securities in a street name account (i.e., securities are registered in the name of the broker rather than the owner). This structure makes it easier to seize and sell securities to meet margin calls. An added advantage to the broker is that securities in street name accounts can be used for other purposes, such as lending to other customers for short sales. In practice, the broker uses the customer's collateral to borrow money in the money market to provide margin loans to customers. The margin loan to the broker is collateralized by the repledged customer collateral. The Federal Reserve's Regulation T sets the initial margin requirement for securities purchases at 50%. **Cross-margin agreements** are used to establish the net margin position of investors with portfolios of long and short positions. In general, cross margin involves transferring excess margin in one account to another account with insufficient margin, resulting in lower overall margin for the investor.
- **Repurchase agreements** or **repos.** Repurchase agreements, also known as repos and RPs, are another form of collateralized short-term loans. They involve the sale of a security at a forward price agreed upon today. The interest on the loan is implied from the difference between spot and forward prices of the securities. While traditionally collateral had little or no credit risk (collateral was usually Treasury bills), today acceptable collateral encompasses whole loans, high-yield bonds, and structured credit products. Repos allow banks and other firms to finance inventories of structured credit products and allow for high investment grade ratings for senior tranches of asset-backed securities (ABSs) and collateralized debt obligations (CDOs).
- **Securities lending.** Securities lending involves the loan of securities to another party in exchange for a fee, called a **rebate.** The lender of the securities continues to receive the dividends and interest cash flows from the securities. Lenders of securities are often hedge funds or other large institutional investors of equities. Securities are held in street name accounts to make them available for lending to traders who want to short stocks. Fixed income securities lending typically involves the loan of Treasury securities for cash. The cash is invested in a higher risk bonds and the investor's objective is to earn the spread between the two.
- **Total return swaps.** In a total return swap (TRS), one party pays a fixed fee in exchange for the total return (both income and capital gains) on a reference asset, typically a stock. The advantage is that the party paying the fee can earn the return from the underlying asset without owning the asset. The party providing the return (such as a hedge fund) is, in essence, short the asset.

Professor's Note: Securities lending, like repurchase agreements, are often structured as sales of securities, not loans of securities, so the holder of the collateral can rehypothecate the securities, or even sell them in a timely fashion if the loan is not repaid.

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Leverage Ratio and Leverage Effect

LO 52.6: Describe the relationship between leverage and a firm's return profile and calculate the leverage effect.

A firm's **leverage ratio** is equal to its assets divided by equity (total assets / equity). That is:

$$L = \frac{A}{E} = \frac{(E+D)}{E} = 1 + \frac{D}{E}$$

For an all-equity financed firm, the ratio is equal to 1.0, its lowest possible value. As debt increases, the leverage ratio (i.e., multiplier) increases. For example, a firm with $100 of assets financed with $50 debt and $50 equity has a leverage ratio equal to 2.0 ($100 / $50 = 2).

Return on equity (ROE) is higher as leverage increases, as long as the firm's return on assets (ROA) exceeds the cost of borrowing funds. This is called the **leverage effect**. The leverage effect can be expressed as:

$$r_E = Lr_A - (L-1)r_D$$

where:
r_A = return on assets
r_E = return on equity
r_D = cost of debt
L = leverage ratio

It may help to think of this formula in words as follows:

ROE = (leverage ratio × ROA) – [(leverage ratio – 1) × cost of debt]

For a firm with a zero cost of debt, return on equity is magnified by the leverage factor; however, debt is not free. Thus, return on equity (ROE) increases with leverage, but the cost of borrowing, because there is more debt, also increases. The L – 1 factor multiplies the cost of debt by the proportion of the balance sheet financed with debt. For example, with a leverage ratio of 2, 50% of the balance sheet is financed with debt and 50% with equity. So for every $2 of assets, $1 comes from shareholders and $1 comes from borrowed funds. We multiply the cost of debt by 1 in this case. If the leverage ratio is 4, 25% is financed with equity and 75% is financed with debt. Thus, for every $4 of assets, $1 is equity and $3 is borrowed funds. In the formula, we multiply the cost of debt by 3. The higher the leverage factor, the bigger the multiplier but also the higher the debt costs. Leverage amplifies gains but also magnifies losses. That is why leverage is often referred to as a double-edged sword.

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The effect of increasing leverage is expressed as:

$$\partial r_E / \partial L = r_A - r_D$$

where:
∂r_E = change in retained earnings
∂L = change in the leverage ratio

This formula implies that, given a change in the leverage ratio, ROE changes by the difference between ROA and the cost of debt.

The equity in the denominator of the leverage ratio depends on the entity. If it is a bank, it may be the book value of the firm. It might also be calculated using the market value of the firm. The net asset value (NAV) of a fund is the appropriate denominator for a hedge fund. The NAV reflects the current value of the investors' capital in the fund.

Example: Computing firm ROE (total assets = $2)

Martin, Inc., a U.S. manufacturing company, has an ROA equal to 5%, total assets equal to $2, and equity financing equal to $1. The firm's cost of debt is 2%. **Calculate** the firm's ROE.

Answer:

$$r_E = Lr_A - (L - 1)r_D$$

$$r_E = [(2 / 1) \times 5\%] - [(2 - 1) \times 2\%] = 8\%$$

Example: Computing firm ROE (total asset = $4)

Martin, Inc., a U.S. manufacturing company, has an ROA equal to 5%, total assets equal to $4, and equity financing equal to $1. The firm's cost of debt is 2%. **Calculate** the firm's ROE.

Answer:

$$r_E = Lr_A - (L - 1)r_D$$

$$r_E = [(4 / 1) \times 5\%] - [(4 - 1) \times 2\%] = 14\%$$

Given a cost of debt of 2%, increasing the leverage factor from 2 to 4 increased the firm's ROE from 8% to 14%.

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Leverage is also influenced by the firm's hurdle rate (i.e., required ROE). For example, assume a firm's hurdle rate (i.e., ROE) is 10%, ROA equals 6%, and its cost of debt equals 2%. The firm will choose a leverage ratio of 2.0. That is:

$$ROE = (2 \times 6\%) - (1 \times 2\%) = 10\%$$

Explicit and Implicit Leverage

LO 52.7: Explain the impact on a firm's leverage and its balance sheet of the following transactions: purchasing long equity positions on margin, entering into short sales, and trading in derivatives

Purchasing stock on margin or issuing bonds are examples of using leverage explicitly to increase returns. However, there are other transactions that have implicit leverage. It is important to understand the **embedded leverage** in short positions and derivatives, such as options and swaps. By constructing economic balance sheets for investors and/or firms, it is possible to measure the implicit leverage of these transactions.

Margin Loans and Leverage

First, consider margin loans. The stock purchased with the margin loan is collateral for the loan. The haircut (h) is the borrower's equity and $1 - h$ is loaned against the market value of the collateral. The leverage is calculated as $1 / h$. The Federal Reserve requires that an investor put up a minimum of 50% equity (i.e., $h = 50\%$) in a stock purchase using borrowed funds.

First, assume that a firm has $100 cash invested by the owners (i.e., no borrowed funds). The balance sheet in this case is:

Assets		*Liabilities and Equity*	
		Debt	$0
Cash	$100	Equity	$100
Total assets	$100	TL and OE	$100

If the firm uses the cash to purchase stock, the balance sheet is:

Assets		*Liabilities and Equity*	
		Debt	$0
Stock	$100	Equity	$100
Total assets	$100	TL and OE	$100

Thus, the leverage ratio is equal to 1 (i.e., $100 / $100 or 1.0 / 1.0).

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Next, assume that the firm uses 50% borrowed funds and invests 50% (i.e., h = 50%) equity to buy shares of stock. Immediately following the trade, the margin account balance sheet has 50% equity and a $50 margin loan from the broker. That is:

Assets		*Liabilities and Equity*	
		Margin loan	$50
Stock	$100	Equity	$50
Total assets	$100	TL and OE	$100

The full economic balance sheet as a result of the borrowed funds (remember, owners put in $100 of equity initially so the firm now has $100 of stock and $50 of cash) is:

Assets		*Liabilities and Equity*	
Cash	$50	Margin loan	$50
Stock	$100	Equity	$100
Total assets	$150	TL and OE	$150

Thus, the leverage ratio has increased to 1.5 (i.e., $150 / $100 or 1 / 0.667). Note that the broker retains custody of the stock to use as collateral for the loan.

Short Positions and Leverage

In a short trade, the investor borrows the shares of stock and sells them. The transaction lengthens the balance sheet because the cash generated from the short sale along with the value of the borrowed securities appear on the balance sheet.

Assume the firm borrows $100 of stock and sells it short. The firm has an asset equal to the proceeds from selling the stock and a liability equal to the value of the borrowed shares. However, the firm cannot use the cash for other investments as it is collateral. It ensures that the stock can be repurchased and returned to the lender. It is in a segregated short account. In the event that the stock price increases rather than decreases, the firm must also put $50 in a margin account.

Immediately following the trade, the margin account and short account has $50 equity and a $50 margin loan from the broker.

Assets		*Liabilities and Equity*	
$150 due from broker:			
Margin	$50	Borrowed stock	$100
Short sale proceeds	$100	Equity	$50
Total assets	$150	TL and OE	$150

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The firm's full economic balance sheet given the short sale is:

Assets		*Liabilities and Equity*	
Cash	$50	Borrowed stock	$100
Due from broker	$150	Equity	$100
Total assets	$200	TL and OE	$200

Thus, the leverage ratio has increased to 2.0 (i.e., $200 / $100 or 1 / 0.50). The leverage is higher in this case than in the previous margin example because the full value of the stock is borrowed in a short transaction. Leverage is inherent in the short position but is a choice in the long position. The firm only borrows 50% of the balance of the stock in the long position.

If the short position plays a hedging role in the portfolio, the position will reduce market risk. This means that leverage will overstate the overall risk because it ignores the potential risk reducing benefits of the short positions. As such, a distinction must be made between gross and net leverage. **Gross leverage** is the value of all the assets, including cash generated by short sales, divided by capital. **Net leverage** is the ratio of the difference between the long and short positions divided by capital.

Derivatives and Leverage

Derivatives allow an investor to gain exposure to an asset or risk factor without actually buying or selling the asset. Derivatives also allow investors to increase leverage. Although derivatives are generally off-balance sheet, they should be included on the economic balance sheet as they affect an investor's returns. Derivatives are synthetic long and short positions. To estimate the economic balance sheet, find the **cash-equivalent market value** for each type of derivative. Derivatives include:

- **Futures, forward contracts, and swap contracts.** These contracts are linear and symmetric to the underlying asset price. The amount of the underlying instrument represented by the derivative is set at the initiation of the contract so values can be represented on the economic balance sheet by the market value of the underlying asset. These contracts have zero net present values (NPVs) at initiation.
- **Option contracts.** These contracts have a non-linear relationship to the underlying asset price. The amount of the underlying represented by the option changes over time. The value can be fixed at any single point in time by the option delta. Thus, on the economic balance sheet, the cash equivalent market values can be represented by the delta equivalents rather than the market values of the underlying assets. These contracts do not have zero NPVs at initiation because the value is decomposed into an **intrinsic value** (which may be zero) and a **time value** (which is likely not zero).

In this next example, the counterparty is assumed to be the prime broker or broker-dealer executing the positions. This means that margin will be assessed by a single broker on a portfolio basis.

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First, assume the firm enters a 1-month currency forward contract and is short $100 against the euro and the 1-month forward exchange rate is $1.25 per euro. The balance sheet is:

Assets		*Liabilities and Equity*	
$100 equivalent of €80 bank deposit		Broker loan	$100

Now, assume the firm buys a 3-month at-the-money call option on a stock index with an underlying index value of $100. The call's delta is currently 50%. The transaction is equivalent to using a $50 broker loan to buy $50 of the stock index. That is:

Assets		*Liabilities and Equity*	
$50 long index position	$50	Broker loan	$50

Next, assume the firm enters a short equity position via a total return swap (TRS). The firm pays the total return on $100 of ABC stock and the cost of borrowing the ABC stock (i.e., the short rebate). This is equivalent to taking a short position in ABC. Assuming the market price of ABC is $100, we have:

Assets		*Liabilities and Equity*	
$100 due from broker (proceeds from short sale)	$100	Borrowed ABC stock	$100

Finally, assume the firm adds short protection on company XYZ via a 5-year credit default swap (CDS) with a notional value of $100. This position is equivalent to a long position in a par-value 5-year floating rate note (FRN) financed with a term loan.

The firm's combined economic balance sheet that includes all of the derivatives positions is:

Assets		*Liabilities and Equity*	
Cash	$50	Short-term broker loan	$150
Due from broker	$150		
$50 margin			
$100 short sale proceeds		Term loan	$100
Equivalent of €80 bank deposit	$100	Borrowed ABC stock	$100
Long equity index	$50		
XYZ FRN	$100	Equity	$100
Total assets	$450	TL and OE	$450

The firm has increased its leverage to 3.5 in its long positions. The long positions combined with the short position (the ABC TRS) means the firm has gained economic exposure to securities valued at $450 using $50 of cash.

Notice that computing leverage is complex when derivatives are used. Also, correctly interpreting leverage is important since risk may be mitigated if short positions are used to hedge. For example, currency and interest rate risks can be hedged accurately. However, the positions are of the same magnitude as the underlying assets. If the positions are carried on the economic balance sheet, leverage will be overstated and other material risks in the portfolio may be ignored.

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Sources of Transactions Liquidity Risk

LO 52.8: Explain methods to measure and manage funding liquidity risk and transactions liquidity risk.

An asset is liquid if it resembles money. That is, it can be exchanged for goods or services quickly and at a certain value. However, assets have to be liquidated in order to buy goods and services because we do not have a barter economy.

Transactions liquidity implies that an asset can be bought or sold without moving its price. However, large transactions may move an asset's price because they create a short-term imbalance between supply and demand. Transactions liquidity risk is fundamentally related to the costs of searching for a counterparty, the institutions required to assist in that search, and the costs of inducing a counterparty to hold a position.

In order to understand transactions liquidity risk, it is important to understand market microstructure fundamentals. These fundamentals are:

- **Trade processing costs.** The first cost is associated with finding a counterparty in a timely fashion. In addition, processing costs, clearing costs, and the costs of settling trades must also be considered. These costs do not typically increase liquidity risk except in circumstances, either natural or man-made, where the trading infrastructure is affected.
- **Inventory management.** Dealers provide trade immediacy to market participants. The dealer must hold long or short inventories of assets and must be compensated by price concessions. This risk is a volatility exposure.
- **Adverse selection.** There are informed and uninformed traders. Dealers must differentiate between liquidity or noise traders and information traders. Information traders know if the price is wrong. Dealers do not know which of the two are attempting to trade and thus must be compensated for this lemons risk through the bid-ask spread. The spread is wider if the dealer believes he is trading with someone who knows more than he does. However, the dealer does have more information about the flow of trading activity (i.e., is there a surge in either buy or sell orders).
- **Differences of opinion.** It is more difficult to find a counterparty when market participants agree (e.g., the recent financial crisis where counterparties were afraid to trade with banks because everyone agreed there were serious problems) than when they disagree. Investors generally disagree about the correct or true price on an asset and about how to interpret new information about specific assets.

These fundamentals differ across different types of market organizations. For example, in a quote-driven system, common in over-the-counter (OTC) markets, market makers are expected to publicly post 2-way prices or quotes and to buy or sell at those prices within identified transaction size limits. In contrast, order-driven systems, typically found on organized exchanges, are more similar to competitive auction models. Typically the best bids and offers are matched throughout the trading session.

Liquidity risks are introduced when bid-ask spreads fluctuate, when the trader's own actions impact the equilibrium price of the asset (called **adverse price impact**) and when the price of an asset deteriorates in the time it takes a trade to get done (called **slippage**).

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In general, regulators have focused more on credit and market risks and less on liquidity risk. Liquidity risk is difficult to measure. However, since the financial crisis, more attention is being paid to measuring liquidity risks in a firm.

Transactions Cost

LO 52.9: Calculate the expected transactions cost and the spread risk factor for a transaction, and calculate the liquidity adjustment to VaR for a position to be liquidated over a number of trading days.

Assuming that daily changes in the bid-ask spread are normally distributed, the 99% confidence interval on the transactions cost in dollars is:

$$+/- \ P \times \tfrac{1}{2}(s + 2.33\sigma_s)$$

where:

P = an estimate of the next day asset midprice, usually set to *P*, the most recent price observation

s = expected or typical bid-ask spread calculated as: (ask price – bid price) / midprice

σ_s = sample standard deviation of the spread

This confidence interval estimates the expected transactions costs in dollar terms. The $\tfrac{1}{2}(s + 2.33\sigma_s)$ component is referred to as the 99% **spread risk factor**.

Example: Computing transactions cost

Brieton, Inc., recently traded at an ask price of $100 and a bid price of $99. The sample standard deviation of the spread is 0.0002. **Calculate** the expected transactions cost and the 99% spread risk factor for a transaction.

Answer:

midprice = (100 + 99) / 2 = 99.50

s = (100 – 99) / 99.5 = 0.01005

transactions cost = 99.50 × ½[0.01005 + 2.33(0.0002)] = $0.523

spread risk factor = ½[0.01005 + 2.33(0.0002)] = 0.005258

Note that in this example, we use the current midprice as the estimate for the next day asset midprice.

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Adjusting VaR for Position Liquidity

Liquidity-adjusted value at risk (LVaR) is a tool used to measure the risk of adverse price impact. The trader will often liquidate the position over a period of days in order to ensure an orderly liquidation of the position.

Professor's Note: The actual calculation of liquidity-adjusted VaR (using constant and exogenous spread approaches) was shown in Topic 50. Here we discuss how VaR may be overstated when adjusting for different time horizons (via the square root of time rule) since this adjustment does not account for the liquidation of positions over the time period of analysis.

Adjusting VaR for liquidity requires an estimate of the number of days it will take to liquidate a position. The number of trading days is typically denoted *T*. Assuming the position can be divided into equal parts across the number of trading days and liquidated at the end of each trading day, a trader would face a 1-day holding period on the entire position, a 2-day holding period on a fraction (T – 1) / T of the position, a 3-day holding period on a fraction (T – 2) / T of the position, and so on. The 1-day position VaR adjusted by the square root of time is estimated for a given position as:

$$\text{VaR}_t \times \sqrt{T}$$

However, this formula overstates VaR for positions that are liquidated over time because it assumes that the whole position is held for *T* days. To adjust for the fact that the position could be liquidated over a period of days, the following formula can be used:

$$\text{VaR}_t \times \sqrt{\frac{(1+T)(1+2T)}{6T}}$$

For example, if the position can be liquidated in four trading days (T = 4), the adjustment to the overnight VaR of the position is 1.3693, which means we should increase VaR by 37%. This is greater than the initial 1-day VaR, but less than the 1-day VaR adjusted by the square root of *T*.

Measuring Market Liquidity

Factors such as tightness, depth, and resiliency are characteristics used to measure market liquidity.

- **Tightness (or width)** refers to the cost of a round-trip transaction, measured by the bid-ask spread and brokers' commissions. The narrower the spread, the tighter it is. The tighter it is, the greater the liquidity.
- **Depth** describes how large an order must be to move the price adversely. In other words, can the market absorb the sale? The market can likely absorb a sale by an individual investor without an adverse price impact. However, if a large institution sells, it will likely adversely impact the price.
- **Resiliency** refers to the length of time it takes lumpy orders to move the market away from the equilibrium price. In other words, what is the ability of the market to bounce back from temporary incorrect prices?

Both depth and resiliency affect how quickly a market participant can execute a transaction.

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Funding Liquidity Risk Management

Redemption requests, especially in times of market stress, may require hedge fund managers to unwind positions rapidly, exposing the fund to transactions liquidity risk. If this happens to many funds at once, fire sales may result. Hedge funds manage liquidity via:

- **Cash.** Cash can be held in money market accounts or Treasury bills and unencumbered liquidity. Cash is not wholly without risk, however, because money market funds may suspend redemptions in times of stress or crisis, and broker balances are at risk if the broker fails.
- **Unpledged assets.** Unpledged assets, also called assets in the box, are assets not currently being used as collateral. They are often held with a broker. Price volatility of the assets affects their liquidity. Only Treasury securities, and more specifically Treasury bills, may be used as collateral during a financial crisis. Even government agency securities were not sufficient collateral during the 2007–2009 financial crisis. Unpledged assets can be sold, rather than pledged, to generate liquidity. However, in times of market stress, asset prices are often significantly depressed.
- **Unused borrowing capacity.** This is not an unfettered source of liquidity as unused borrowing capacity can be revoked by counterparties by raising haircuts or declining to accept pledged assets as collateral when it is time to rollover the loan. These loans are typically very short term and credit can, as it did during the 2007–2009 financial crisis, disappear quickly.

During the crisis, a systemic risk event, hedge funds that had not experienced large losses still faced a liquidity crisis as investors, seeking liquidity themselves, issued redemption requests.

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Key Concepts

LO 52.1

Liquidity has two essential properties, which relate to two essential forms of risk. Transactions liquidity deals with financial assets and financial markets and is related to the ability to sell an asset quickly, cheaply, and without moving the price too much. Funding liquidity is related to individual's or firm's creditworthiness.

LO 52.2

Banks only expect a fraction of deposits and other liabilities to be redeemed at any point in time. As a result, they do not hold all deposits in liquid assets, but make loans with deposits instead. This is known as a fractional-reserve bank and the process of using deposits to finance loans is known as asset-liability management (ALM).

LO 52.3

Investor financing for structured credit products can create liquidity risk when investors rely on short-term financing. Two types of short-term financing include: (1) securities leading and (2) off-balance sheet vehicles. During the subprime crisis, off-balance sheet vehicles (e.g., structured investment vehicles) provided both maturity and liquidity transformation for banks.

LO 52.4

Systematic funding risks were apparent in many market sectors during the subprime mortgage crisis. Liquidity issues arose during the recent financial crisis for a variety of investment strategies.

Money market mutual funds (MMMFs) have net assets (NAVs) equal to $1.00. However, credit write-downs can result in net asset values falling below $1.00. This is known as breaking the buck. Liquidity risk can also cause NAVs to fall below $1.00.

LO 52.5

Collateral markets enhance the ability of firms to borrow money. They also make it possible to establish short positions in securities. Cash and securities may be borrowed in the market for collateral.

Firms with excess cash are more willing to lend at a low rate of interest if the loan is secured by collateral. The full value of the securities is not lent. The difference is called a haircut.

Collateralized loans are used to finance securities or other assets or trades. The securities pledged to one firm are often loaned or pledged again, hence the collateral circulates. This process is known as rehypothecation or repledging.

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LO 52.6

A firm's leverage ratio is equal to its assets divided by equity. That is:

$$L = \frac{A}{E} = \frac{(E+D)}{E} = 1 + \frac{D}{E}$$

Return on equity (ROE) is higher as leverage increases, as long as the firm's return on assets (ROA) exceeds the cost of borrowing funds. This is called the leverage effect. The leverage effect can be expressed as:

$$r_E = Lr_A - (L-1)r_D$$

LO 52.7

There is embedded leverage in short positions and derivatives such as options and swaps. Economic balance sheets can be constructed to help investors and/or firms measure the implicit leverage of these transactions.

LO 52.8

Transactions liquidity implies that an asset can be bought or sold without moving its price. Transactions liquidity risk is fundamentally related to the costs of searching for a counterparty, the institutions required to assist in that search, and the costs of inducing a counterparty to hold a position.

To understand transactions liquidity risk, one must understand market microstructure fundamentals. Trade processing costs, inventory management, adverse selection (i.e., dealing with informed versus uninformed traders), and differences of opinions regarding asset prices affect transactions liquidity.

Factors such as tightness, depth, and resiliency are characteristics used to measure market liquidity. Tightness (or width) refers to the cost of a round-trip transaction, measured by the bid-ask spread and brokers' commissions. Depth describes how large an order must be to move the price adversely. Resiliency refers to the length of time it takes lumpy orders to move the market away from the equilibrium price.

Hedge funds manage liquidity via cash, unpledged assets, and unused borrowing capacity. In times of market stress, redemption requests may require hedge fund managers to unwind positions rapidly, exposing the fund to transactions liquidity risk. If this happens to many funds at once, fire sales may result.

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LO 52.9

Assuming that daily changes in the bid-ask spread are normally distributed, the 99% confidence interval on the transactions cost in dollars is:

$$+/- \ P \times \tfrac{1}{2}(s + 2.33\sigma_s)$$

The spread risk factor is equal to $\tfrac{1}{2}(s + 2.33\sigma_s)$.

Liquidity-adjusted VaR is a tool used to measure the risk of adverse price impact. Traders will often liquidate positions over a period of days in order to ensure an orderly liquidation of the position.

LO 52.10

Risks associated with liquidity are interrelated and can exacerbate problems. For example, an increase in funding liquidity risk can lead to an increase in transactions liquidity risk. Also, severe stress to the financial system from a liquidity risk event would impact market participants simultaneously, suggesting that the illiquidity or insolvency of one counterparty may impact other market participants.

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Concept Checkers

1. Jackson Grimes, a trader for Glenn Funds, works on the repurchase agreement (repo) desk at his firm. Markets have been highly volatile but Glenn Funds has a large capital base and is sound. Grimes reports to the CEO that in the last month, the firm Glenn Funds borrows from has been consistently increasing collateral requirements to roll over repos. From the perspective of Glenn Funds, this represents:
   A. systematic risk.
   B. transactions liquidity risk.
   C. balance sheet risk.
   D. maturity transformation risk.

2. Chris Clayton, an analyst for a private equity fund, noticed that merger arbitrage strategies at several hedge funds experienced large losses in late 2007 to early 2008. These losses were likely due to:
   A. abandoned merger plans due to a lack of available financing.
   B. target prices falling precipitously due to stock market corrections.
   C. acquirers filing for bankruptcy as the subprime mortgage crisis unfolded.
   D. idiosyncratic risks surrounding the merger arbitrage strategy.

3. With respect to the valuation of money market mutual fund (MMMF) assets, funds:
   A. are not required to mark-to-market the underlying assets daily.
   B. must reflect changes in the values of underlying assets that are the result of changes in credit risks but may ignore value changes that are the result of changes in interest rates.
   C. will set the notional values of each of the underlying assets equal to $1.00.
   D. are not allowed to invest in any asset with a rating below AAA because asset values must not fluctuate outside of a 10% range around the historical value in order to keep the notional value equal to $1.00.

4. Charleston Funds intends to use leverage to increase the returns on a convertible arbitrage strategy. The return on assets (ROA) of the strategy is 8%. The fund has $1,000 invested in the strategy and will finance the investment with 75% borrowed funds. The cost of borrowing is 4%. The return on equity (ROE) is closest to:
   A. 4%.
   B. 32%.
   C. 20%.
   D. 12%.

5. Brett Doninger recently placed an order to sell a stock when the market price was $42.12. The market was volatile and, by the time Doninger's broker sold the stock, the price had fallen to $41.88. In the market, this phenomenon is known as:
   A. adverse selection.
   B. transactional imbalance.
   C. slippage.
   D. the spread risk factor.

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Concept Checker Answers

1. C Funding liquidity risk or balance sheet risk results when a borrower's credit position is either deteriorating or is perceived by market participants to be deteriorating. It also occurs when the market as a whole deteriorates. Under these conditions, creditors may withdraw credit or change the terms of credit. In this case, the lender is increasing the haircut and is thus changing the terms of credit. Glenn Fund's creditworthiness does not actually have to decline for a lender to withdraw credit or change the terms of credit.

2. A Systematic funding risks were apparent in many market sectors during the subprime mortgage crisis. Hedge funds engaged in merger arbitrage experienced losses in the early stages of the subprime mortgage crisis. After a merger is announced, the target's stock price typically increases and the acquirer's price sometimes declines due to increased debt. The merger arbitrage strategy exploits the difference between the current and announced acquisition prices. Hedge funds experienced large losses as mergers were abandoned when financing dried up.

3. A MMMFs use a form of accounting called the amortized cost method, under the Securities and Exchange Commission's (SEC) Rule 2a – 7. This means that MMMF assets do not have to be marked-to-market each day, as required for other types of mutual funds. However, the values of the underlying assets in the fund, despite their relative safety, are subject to change. As such, redemptions may be limited if asset values fall.

4. C debt = \$1,000 × 0.75 = \$750
leverage ratio = total assets / equity
leverage ratio = \$1,000 / \$250 = 4

$$r_E = Lr_A - (L - 1)r_D$$

where:
r_A = return on assets
r_E = return on equity
r_D = cost of debt
L = leverage ratio

return on equity = 4(8%) – [(4 – 1)(4%)] = 32% – 12% = 20%

5. C Liquidity risks are introduced when bid-ask spreads fluctuate, when the trader's own actions impact the equilibrium price of the asset (called adverse price impact), and when the price of an asset deteriorates in the time it takes a trade to get done. When the price deteriorates in the time it takes to get a trade done, it is called slippage.

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

The Failure Mechanics of Dealer Banks

Topic 53

Exam Focus

Understanding the key failure mechanics for dealer banks is crucial for mitigating liquidity and solvency risks. Liquidity risks are accelerated when counterparties or prime broker clients question the solvency of a large dealer bank and, in turn, limit their exposure. This results in increased liquidity risk and insolvency risk for the bank and increased systemic liquidity risk for the financial markets in which dealer banks play commingled roles. Dealer banks play key roles as prime brokers, securities underwriters, special purpose entities (SPE), and as counterparties in the over-the-counter (OTC) derivatives and repo markets. Diseconomies of scope in risk management and corporate governance were revealed by the recent market crisis. Thus, new policies to alleviate dealer bank risks were implemented to address off-balance sheet risks, capital requirements, leverage, liquidity risks, clearing banks, and adverse selection effects in "toxic" asset markets.

Functions of Dealer Banks

LO 53.1: Describe the major lines of business in which dealer banks operate and the risk factors they face in each line of business.

Large dealer banks provide a variety of intermediary functions in the markets for over-the-counter (OTC) derivatives, repurchase agreements, and securities. In addition, large dealer banks act as a prime broker for hedge funds and provide asset management for wealthy individuals and institutions.

Large dealer banks play an important function in the **OTC derivatives market.** Dealer banks transfer the risk of the derivatives positions requested by counterparties by creating new derivatives contracts with other counterparties. Examples of types of OTC derivatives are interest rate swaps, collateralized debt obligations (CDOs), collateralized mortgage obligations (CMOs), and credit default swaps (CDSs).

Counterparty risk in the OTC market refers to the risk that one or more of the counterparties will default on their contractual obligations. The total amount of wealth does not change as derivatives transfer wealth from one counterparty to another as contingencies are realized over time. However, if a counterparty incurs large losses, their derivatives contracts incur frictional bankruptcy costs that result in distress costs for their counterparties. Dealer banks are often counterparties to other dealer banks and large market players. Therefore, the solvency and liquidity problems of one large dealer bank can quickly result in increased systemic risk and a potential liquidity crisis.

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If the dealer bank does not have the liquidity to function, they will become insolvent. The failure of a large dealer bank would result in increased systemic risk for the OTC market. When counterparties question the solvency of a dealer bank, they will take actions to reduce their exposure and exit their positions. For example, the default of Lehman Brothers in September of 2008 not only disrupted the OTC derivatives markets, but the repercussions were also felt by other financial markets and institutions.

Another important function of large dealer banks is in the short-term repurchase or **repo market**. Large dealer banks finance significant fractions of another dealer bank's assets through repos. Prior to the recent crisis, dealer banks used overnight repos to finance holdings of agency securities, corporate bonds, Treasuries, mortgages, and collateralized debt obligations (CDOs) with little incremental capital. Some large dealer banks had very high leverage due to the lack of capital requirements for these repos. The high leverage caused significant solvency risk when the use of subprime mortgages as collateral was questioned.

The systemic and firm specific risk is significantly increased if a repo counterparty questions the solvency of a dealer bank. Counterparties are unlikely to renew repos, and the repo creditors may be legally required to sell collateral immediately. Without a government or central bank stepping in as a lender of last resort, dealer banks have no place to turn when repos are not renewed. As many dealer banks act as counterparties for other positions, the solvency of one dealer bank is likely to have a ripple effect and greatly increase the systemic risk of these markets.

Dealer banks provide investment banking functions through the management and underwriting of securities issuances. These investment banking functions also include advising corporations regarding mergers and acquisitions and merchant banking functions, such as the buying and selling of oil, metals, and other commodities. These functions provide an important source of revenue for dealer banks. An additional strain on liquidity is caused by the lack of cash inflows when issuers question the solvency of the dealer bank and take their business elsewhere. This can lead to systemic risk as new issues and the liquidity of existing issues are halted, as few institutions are able or willing to fill the void when a large dealer bank's solvency or liquidity are questioned.

Large dealer banks act as a **prime broker** to large investors such as hedge funds. In this context, the services provided by the dealer banks include custody of securities, clearing, securities lending, cash management, and reporting. When the solvency of a prime broker is questionable, a hedge fund could demand cash margin loans from the dealer that are backed by securities. The prime broker may not be able to use those same securities as collateral with other lenders who may also question their solvency. Thus, the dealer bank's liquidity position is weakened if large clients reduce their exposure by exiting their positions or entering new positions to offset their risk.

In addition, if prime broker clients leave, then their cash and securities are no longer in the pool of funds to meet the dealer bank's liquidity needs for other clients. A systemic shortage of collateral and a liquidity crisis can result from the reduction of collateral securities caused by the flight of prime brokerage clients. Systemic risk is even greater when hedge funds do not mitigate their exposure through diversification. Prior to the recent financial crisis, hedge funds had significant positions with only a few dealer banks.

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Dealer banks also provide an important function as a counterparty for derivatives for brokerage clients. Dealer banks sometimes operate "internal hedge funds" and private equity partnerships. Off-balance sheet entity functions such as internal hedge funds, structured investment vehicles, and money market funds can have substantial losses. The dealer banks have an incentive to voluntarily support these entities to protect their reputation and franchise value. When a dealer bank shows signs of distress, counterparties and others may begin to exit their relationships, which severely increases the dealer bank's liquidity risk.

In addition, large dealer banks provide traditional commercial banking functions, such as gathering deposits for corporate and consumer lending. The risks for a dealer bank are similar to a traditional bank with respect to these functions. However, prior to the recent financial crisis, dealer banks did not have access to the discount window (borrowing money from the central bank), and their accounts were not federally insured. For these reasons, a run on the bank's deposits was more likely to lead to a liquidity crisis. With increased concerns of the solvency of large dealer banks, the availability of credit across the industry was threatened. This had the potential to lead to severe market slowdowns if borrowers were unable to obtain credit.

Dealer Bank Markets

Large dealer banks operate in markets that are outside the scope of traditional bank-failure resolution mechanisms, such as conservatorship or receivership. The dealer banks are organized under the umbrella of holding companies in order to provide the wide variety of commercial banking, merchant banking, investment banking, brokerage, and off-balance sheet partnership activities. In addition, dealer banks often have large asset-management divisions that provide custody of securities, cash management, brokerage, and alternative investments vehicles. Dealer banks are also typically the general partner with limited partner clients.

In the primary securities market, dealer banks are the security underwriter. They buy equity and bond securities from issuers and sell them to institutions and investors over a period of time. Dealer banks also play a major role in the secondary securities market in providing liquidity to the market. They are the primary intermediary in the OTC securities markets by assisting in the private negotiation between investors and corporations, municipalities, certain national governments, and securitized credit products. Dealer banks are also actively involved in publicly traded equity markets by acting as brokers, custodians, securities lenders, and facilitating large block trades.

A major market in which dealer banks operate is the repurchase agreements, or **repos**, market. Repos are short-term cash loans collateralized by securities. In the repo market, one counterparty borrows cash from another counterparty. The majority of repos are for a very short period of time, such as overnight. The loans are collateralized by government bonds, corporate bonds, mortgages, agency securities, or other securities such as CDOs. In order to reduce counterparty risk, a clearing bank often acts as a third party and holds the collateral. The clearing bank facilitates the trade and somewhat reduces the risk of default for the lender. It is common for counterparties to renew these positions on a continuous basis as long as the solvency of the dealer bank is not questioned. It is not uncommon for these counterparties to be another dealer bank.

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Dealer banks are usually counterparties in the OTC derivatives market. The most prominent OTC derivatives are interest rate swaps where variable rate commitments often linked to the London Interbank Offering Rate (LIBOR) are exchanged for a fixed rate for a specific time period. Dealer banks typically perform what is known as a "matched book" dealer operation. They transfer the risk of the derivatives positions requested by counterparties by creating new derivatives contracts with other counterparties, who are oftentimes other dealer banks. Thus, dealer banks have large OTC derivatives exposures with other dealer banks. In addition to dealing with interest rate swaps, dealers are often counterparties in CDSs. In these contracts, the dealer bank transfers the default risk rather than the interest rate risk for the counterparties involved in the contracts.

Some large dealer banks are very active in off-balance sheet financing. In these markets, a bank can sell residential mortgages or other loans to a special purpose entity (SPE). The SPE compensates the sponsoring bank for the assets with the proceeds of debt that it issues to third-party investors or hedge funds. The SPE pays for the principal and interest of the debt issued with the cash flows from the mortgages or other assets that were purchased from the sponsoring bank. Thus, the SPE holds the collateralized pool of assets and provides an innovative product for hedge funds and other investors to purchase. These SPEs also provide a means for financial institutions to diversify their exposure by transferring risk to other investors who are either in or outside the financial industry.

For example, prior to the recent financial crisis, dealer banks were actively participating as sponsor banks for structured investment vehicles (SIVs), which are a form of a special purpose entity. The SIV finances residential mortgages or other debt obligations with short-term debt sold to other investors in the form of CDOs and CMOs.

Before the recent crisis, banks were not required to include the off-balance sheet assets and debt obligations in minimum capital requirement and accounting reports. Thus, some dealer banks became highly leveraged as they were allowed to operate much larger loan purchases and origination businesses with a limited amount of capital. The fall in residential housing values in the summer of 2007 led to the rise of mortgage defaults, which threatened the ability of the SIV to make payments. As short-term creditors became concerned with the solvency of the SIVs, they refused to renew loans, and this created a liquidity and solvency issue for SIVs. Dealer banks had to provide support to SIVs to protect its reputation and franchise value.

Diseconomies of Scope

As mentioned, dealer banks act as holding companies in order to provide a wide variety of commercial banking, prime brokerage, investment banking, asset management, and off-balance sheet activities. The recent financial crisis caused many to question the ability of dealer banks to manage risks properly. It is sometimes argued that forming large bank holding companies results in economies of scope with respect to information technology, marketing, and financial innovation. However, the recent financial crisis clearly identified diseconomies of scope in risk management and corporate governance. The executive management and board of directors did not fully understand or control the risk taking activities within their organizations.

For example, prior to their insolvency, Bear Stearns and Lehman relied heavily on overnight repos with leverage ratios above 30. These dealer banks held these assets on their balance

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sheets with little incremental capital. Management did not properly manage the amount of off-balance sheet risk the bank was exposed to. Thus, the over-leveraged positions made it impossible to overcome the liquidity and solvency issues that quickly arose when the values of the bank's assets were questioned. Increased awareness or more appropriate risk models may have prevented the insolvency of these dealer banks.

Liquidity Concerns for Dealer Banks

LO 53.2: Identify situations that can cause a liquidity crisis at a dealer bank and explain responses that can mitigate these risks.

A liquidity crisis for a dealer bank is accelerated if counterparties try to reduce their exposure by restructuring existing OTC derivatives with the dealer or by requesting a novation (as discussed in the following). The flight of repo creditors and prime brokerage clients can also accelerate a liquidity crisis. Lastly, the loss of cash settlement privileges is the final collapse of a dealer bank's liquidity.

As mentioned previously, when OTC derivatives counterparties question the solvency of a dealer bank, they will begin to reduce their exposures to the dealer. A counterparty could reduce their exposure by borrowing from the dealer or by entering into new offsetting derivatives contracts with the dealer. A counterparty may also request to have in-the-money options revised to at-the-money strike prices and, thus, reduce their exposure to the dealer by receiving cash from the option position.

Another means that a counterparty has of reducing their exposure to a dealer is through a **novation** to another dealer. For example, a hedge fund may use a credit default swap from a dealer to protect themselves from a loss on a borrower. If the hedge fund was concerned about the solvency of the dealer bank, they could request a novation from another dealer bank to protect themselves from default arising from the original dealer bank. Although these novations are often granted by dealer banks, in the case of Bear Stearns, the request was denied, which raised additional concerns regarding the solvency of Bear Stearns. In addition to decreasing the reputation capital and franchise value of this dealer bank, the liquidity position was also under increased stress. A novation could result in the removal of the cash collateral of the original dealer bank and transfer of this collateral to the second dealer bank.

Central clearing mitigates the liquidity risk caused by derivatives counterparties exiting their large dealer bank exposures. OTC derivatives are novated or "cleared" to a central clearing counterparty that stands between the original counterparties. The use of a central clearing counterparty also mitigates the systemic risk of financial markets and institutions when the solvency of a large dealer bank is questioned. However, the use of central clearing counterparties is only effective with derivatives that contain relatively standard terms. Thus, this was not an effective means of dealing with the infamous customized AIG credit derivatives.

Further liquidity pressure can arise if derivative counterparties desire to reduce their exposure by entering new contracts that require the dealer bank to pay out cash. For example, a dealer bank may try to signal their strength to the market by quoting competitive bid-ask spreads on an OTC option. If the bid price is then accepted, the dealer

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must settle with a cash payment to the counterparty which reduces their liquidity. If the dealer refuses to quote competitive bid prices, it may further signal their liquidity concerns to the market.

Money market funds, securities lenders, and other dealer banks finance significant fractions of a dealer bank's assets through short-term repurchase agreements. As mentioned previously, if the repo counterparty questions the solvency of a dealer bank, they are unlikely to renew repos. In this event, the repo creditors may have an incentive, or be legally required, to sell the collateral immediately. If the sale of the collateral is less than the cash position, then the dealer counterparty may face litigation for the improper disposal of assets. Without a government or central bank stepping in as a lender of last resort, dealer banks have no place to turn when repos are not renewed. They could reinvest their cash in new repos, but other counterparties are unlikely to take these positions if the dealer bank's solvency is questioned.

The dealer bank can mitigate the liquidity risk caused by a run of short-term creditors by establishing lines of bank credit, holding cash and liquid securities, and by laddering the maturities of its liabilities. When a dealer bank ladders its liabilities, the maturities are spread out over time so that only a small fraction of its debt needs to be refinanced overnight. In 2008, the New York Federal Reserve Bank created the Primary Dealer Credit Facility to finance securities of investment banks. Immediately following the failure of Lehman, the remaining two dealer banks, Morgan Stanley and Goldman Sachs, became regulated bank holding companies. As a bank holding company, the firms gained access to the discount window and could turn to the government for financial support, including FDIC deposit insurance and loan guarantees.

Prime brokerage accounts are a source of cash inflows for large dealer banks. In normal circumstances, the cash and securities of prime brokerage clients are a source of liquidity for the bank. In the United Kingdom, assets from client prime brokerage accounts are commingled with the bank's own assets. However, in the United States, dealer banks are allowed to pool the money together into a separate account from the bank's own funds. Thus, the prime broker is able to use the cash from one client to help meet the liquidity needs of another client.

As mentioned previously, when the solvency of a prime broker is questionable, a hedge fund could demand cash margin loans from the dealer that are backed by the securities held in their account with the prime broker. The prime broker may not be able to use those same securities as collateral with other lenders who may question their solvency. Lenders may not find any incentive to lend to the questionable dealer bank. Thus, even without a run by prime brokerage accounts, considerable strain could be placed on the dealer bank's liquidity position.

In addition, if prime broker clients do leave on short notice, then their cash and securities are no longer in the pool of funds to meet the needs of other clients. In this case, the dealer bank must use its own cash to meet liquidity needs. The reduction of collateral securities caused by the flight of prime brokerage clients can lead to a systemic shortage of collateral and a liquidity crisis. In the future, hedge funds are likely to mitigate their exposure to a few dealer banks by diversifying their sources of prime brokerage with custodian banks.

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Under normal conditions, a clearing bank may extend daylight overdraft privileges to clearing customers who are creditworthy. However, when the solvency of a dealer bank is questioned, the clearing bank may refuse to process transactions that are insufficiently funded by the dealer bank's cash fund account. For example, in the case of Lehman's default, J.P. Morgan Chase was the clearing bank that invoked its "full right of offset." Under this legal right, J.P. Morgan Chase was able to offset their exposures using Lehman's cash, and at the same time, discontinued to make cash payments during the day on Lehman transactions that would bring Lehman's account below zero. The failure to meet its transactions obligations on that day forced Lehman into bankruptcy. To mitigate this risk in the future, "emergency banks" are proposed to act as either a clearing bank or a tri-party repo "utility."

LO 53.3: Compare a liquidity crisis at a dealer bank to a traditional bank run.

The basic economic principles causing a liquidity crisis, and potentially the insolvency of a large dealer bank, are not that different from the traditional retail bank run. Banks may finance illiquid assets with short-term deposits. However, an unexpected liquidity demand from depositors or the inability of borrowers to repay their loans may lead to concerns about the solvency of the bank. If the concern persists, a bank run could lead to liquidity problems, and the concern about the bank's failure could end up as a self-fulfilling prophecy.

While the basic economic principles of a bank run are similar for large dealer banks and retail banks, the institutional mechanisms and the systemic destructiveness are very different. For example, dealer banks play an essential role in providing liquidity in the OTC derivatives and securities markets. When the solvency of a dealer bank is questioned, counterparties of these markets and prime brokerage clients begin to reduce their exposure to the dealer. The OTC derivatives counterparty may reduce their exposure by borrowing from the dealer, entering new offsetting derivatives contracts with the dealer, or requesting a novation. A counterparty may also request to receive cash from options positions that are in-the-money by having them revised to at-the-money. Prime broker clients may remove collateral and cash, which results in further accelerating the liquidity crisis. The fact that dealer banks are often counterparties to other dealer banks increases the systemic risk in the financial markets where dealer banks play essential roles.

Another area that dealer banks are very active involving liquidity is the repo markets. Especially in cases where the dealer banks are highly leveraged, the liquidity position is severely threatened when the dealer bank's solvency is questioned and counterparties are unwilling to renew repo positions overnight. Thus, a dealer bank is involved in many functions that result in increased liquidity pressures that traditional banks are not exposed to.

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Polices to Alleviate Dealer Bank Risks

LO 53.4: Describe policy measures that can alleviate firm-specific and systemic risks related to large dealer banks.

The 2009 Public Private Investment Partnership (PPIP) was instituted by the U.S. Treasury Department's 2008 **Troubled Asset Relief Program** (TARP) to help dealer banks and the financial industry recover from the crisis at hand. One of the policy objectives was to mitigate the effect of adverse selection in the market for "toxic" assets, such as the CDOs backed by subprime mortgages. Adverse selection is the principle that buyers are only willing to buy the assets at a deep discount due to the information asymmetries that exist regarding the asset's true value. A dealer bank may be forced to sell illiquid assets in order to meet liquidity needs. This results in additional losses due to the lack of demand for those assets. The PPIP subsidizes bidders of "toxic assets" by offering below-market financing rates and absorbing losses beyond a predetermined level.

The United States Federal Reserve System and the Bank of England provided new secured lending facilities to large dealer banks when they were no longer able to obtain credit from traditional counterparties or the repo market. When the dealer bank's solvency is questioned, tri-party clearing banks are likely to limit their exposure to the dealer bank. A tri-party repo utility is proposed as an alternative and would be designed to have fewer conflicting incentives and less discretion in rolling over a dealer's repo positions. New standards could be adapted for transaction documentation, margin requirements, and daily substitution of collateral with respect to repos. These standards could be incorporated through either the new repo utility or traditional tri-party clearing approaches.

Another potential approach is the creation of an "emergency bank" that could manage the orderly unwinds of repo positions of dealer banks with liquidity difficulties. The central bank would grant access to the discount window for the emergency bank to insulate critical clearing banks from losses during this unwinding process.

Capital requirements will most likely be increased and include off-balance sheet positions in an effort to reduce the leverage positions of dealer banks. The separation of tri-party repo clearing from other clearing account functions would also reduce a dealer bank's leverage by tightening the dealer's cash-management flexibility.

Central clearing will reduce the threat of OTC derivatives counterparties fleeing a questionable dealer bank. Although this would not eliminate the liquidity effect resulting from a derivative counterparty reducing their exposure to a particular dealer bank, it would reduce the total exposure to the dealer that would need to be managed through clearing.

Some large dealer banks and financial institutions are viewed as being "too-big-to-fail" based on the systemic risk their insolvency would place on the financial markets. Therefore, another proposed resolution for large dealer banks with questionable solvency that are deemed too-big-to-fail is to provide bridge banks similar to the approach used for traditional banks.

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Key Concepts

LO 53.1

Large dealer banks are active participants in over-the-counter (OTC) derivatives, repo, and securities markets. Their functions in these markets, as well as asset managers and prime brokers, result in a variety of liquidity risks when their solvency is questioned and counterparties reduce their exposure with them.

LO 53.2

A liquidity crisis is accelerated when prime broker clients or counterparties in the OTC derivatives or repo markets question the solvency of a dealer bank and desire to exit their positions or reduce their exposures with the dealer bank.

LO 53.3

The basic economic principles of a liquidity crisis for a dealer bank are similar to a traditional bank run. However, the institutional mechanisms and systemic destructiveness are much more widespread for a dealer bank.

LO 53.4

The creation of emergency banks in the form of tri-party repo utilities and clearing banks are policy proposals to mitigate firm specific and systemic liquidity risk in the OTC derivatives and repo markets. The U.S. Treasury Department's 2008 Troubled Asset Relief Program (TARP) was designed to mitigate adverse selection in "toxic" asset markets by providing below market financing and absorbing losses above a pre-specified amount.

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Concept Checkers

1. A dealer bank's liquidity crisis is least likely to be accelerated by:
   A. the refusal of repurchase agreement creditors to renew their positions.
   B. the flight of prime brokerage clients.
   C. a counterparty's request for a novation through another dealer bank.
   D. depositors removing their savings from the dealer bank.

2. Banks are most likely to diversify their exposure to a specific asset class such as mortgages by grouping these assets together and selling them to:
   A. hedge funds.
   B. government agencies.
   C. the U.S. Federal Reserve.
   D. special purpose entities.

3. The formation of large bank holding companies results in diseconomies of scope with respect to:
   A. risk management.
   B. technology.
   C. marketing.
   D. financial innovation.

4. One potential solution for mitigating the liquidity risk caused by derivatives counterparties exiting their large dealer bank exposures is most likely the:
   A. use of central clearing.
   B. use of a novation through another dealer bank.
   C. requirement of dealer banks to pay out cash to reduce counterparty exposure.
   D. creation of new contracts by counterparties.

5. Which of the following items is not a policy objective of the U.S. Treasury Department's 2008 Troubled Asset Relief Program to help dealer banks recover from the subprime market crisis?
   A. Provide below-market financing rates for bidders of "toxic" assets.
   B. Absorb losses beyond a pre-specified level.
   C. Force the sale of illiquid assets in order to better determine the "true" value.
   D. Mitigate the effect of adverse selection.

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Concept Checker Answers

1. D A liquidity crisis for a dealer bank is accelerated if counterparties try to reduce their exposure by restructuring existing OTC derivatives with the dealer or by requesting a novation. The flight of repo creditors and prime brokerage clients can also accelerate a liquidity crisis. Lastly, the loss of cash settlement privileges is the final collapse of a dealer bank's liquidity.

2. D Banks can diversify their exposure to a specific asset class, such as mortgages, by grouping these assets together and selling them to special purpose entities.

3. A Some argue that information technology, marketing, and financial innovation result in economies of scope for large bank holding companies. Conversely, the recent financial crisis raised the concern that the size of bank holding companies creates diseconomies of scope with respect to risk management.

4. A One potential solution for mitigating the liquidity risk caused by derivatives counterparties exiting their large dealer bank exposures is the use of central clearing through a counterparty. However, central clearing is only effective when the underlying securities have standardized terms. The reduction of a counterparty's exposure through novation, entering new offsetting contracts, or requiring a dealer bank to cash out of a position will all reduce the liquidity of the dealer bank.

5. C The U.S. Treasury Department's 2008 Troubled Asset Relief Program was designed to create policies to help dealer banks recover from the subprime market crisis by mitigating the effect of adverse selection, by providing below-market financing rates for bidders of "toxic" assets, and by absorbing losses beyond a pre-specified level. Forcing the sale of illiquid assets would worsen the liquidity position of the troubled dealer bank.

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

Stress Testing Banks

Topic 54

Exam Focus

This topic focuses on the use of bank stress testing to determine if liquidity and capital are adequate. The discussion focuses primarily on capital adequacy but notes that the issues are similar with respect to liquidity. For the exam, understand the details of the 2009 Supervisory Capital Assessment Program (SCAP), the first stress testing required after the 2007–2009 financial crisis. Also, be able to explain the issue of coherence in stress testing and describe the challenges with modeling the balance sheet using stress tests in the context of the stress test horizon. Finally, understand the differences in disclosure between U.S. and European stress tests and the way that stress test methodologies and disclosure have changed since the 2009 SCAP.

Stress Testing

In the wake of the 2007–2009 financial crisis, regulators and other policymakers realized that standard approaches to risk assessment, such as regulatory capital ratio requirements, were not sufficient. At that point, supervisory **stress testing** became a popular tool for measuring bank risk. There was a "pop-quiz" quality to the post-financial crisis stress tests. They were difficult to manipulate because they were sprung on banks at short notice. As a result, the information provided by the stress tests to regulators and the market was truly new. This allowed financial markets to better understand bank risks and, as a result, regain a level of trust in the banking sector.

The goal of stress testing, as well as capital/liquidity and "economic capital/liquidity" (i.e., internal, bank-specific) models, is to assess how much capital and liquidity a financial institution needs to support its business (i.e., risk taking) activities. It is relatively easy for banks to swap out of lower risk assets and into higher risk assets. Stress testing provides clarity about the true risk and soundness of banks.

Stress testing is an old tool that banks and other firms have used to examine risk. It asks the question "what is the institution's resilience to deteriorating conditions?" and simulates financial results given various adverse scenarios. Stresses are generally of two basic types: scenarios or sensitivities. An example of a scenario is a severe recession. An example of sensitivity is a significant increase in interest rates. Risk managers can stress test the sensitivity of a single position or loan or an entire portfolio.

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Supervisory Capital Assessment Program (SCAP)

LO 54.1: Compare and contrast the features and scope of stress tests before and after the Supervisory Capital Assessment Program (SCAP).

In the wake of the financial crisis, there was much uncertainty about the soundness of the U.S. banking system. Regulators needed to assess the capital strength of financial institutions. If there was a gap between what a bank needed in terms of capital and what it had, regulators had to find a credible way to "fill the hole." The 2009 U.S. bank stress test, known as the **Supervisory Capital Assessment Program** (SCAP), was meant to serve that purpose. It was the first macro-prudential stress test after the 2007–2009 financial crisis. Macro-prudential regulation focuses on the soundness of the banking system as a whole (i.e., focuses on systematic risks) while micro-prudential regulation focuses on the safety and soundness of the individual institution.

At this point the Federal government planned to infuse equity capital into banks that were undercapitalized based on stress testing. The Treasury intended to borrow money and "downstream" it as equity in banks via the Treasury's Capital Assistance Program (CAP). If banks could not convince investors to fill the hole (i.e., infuse banks with needed equity capital), current investors would be diluted by the government's equity investment. In the end, 19 SCAP banks were required to raise $75 billion within six months. The undercapitalized banks raised $77 billion of Tier 1 common equity and did not need to draw on the CAP funds.

Prior to 2009, stress testing was relatively simple. Figure 1 summarizes the differences in stress testing pre-SCAP and post-SCAP.

Figure 1: Comparison of Stress Testing Pre-SCAP and Post-SCAP

Pre-SCAP	*Post-SCAP*
Primarily assessed exposure to single-shocks (e.g., volatility increases OR interest rate increases OR increasing unemployment).	Considers broad macro-scenarios and market-wide stresses with multiple factors occurring/changing at once, as evidenced in the 2007–2009 financial crisis.
Focused on specific bank products or business units (e.g., lending or trust).	Focuses on the whole firm, a more comprehensive look at the effect of the stress scenarios on the institution.
Typically focused on earnings shocks (i.e., losses) but not on capital adequacy.	Explicitly focuses on capital adequacy. Considers the post-stress common equity threshold to ensure that a bank remains viable.
Focused exclusively on losses.	Focuses on revenues, costs, and projected losses.
Stress testing was static in nature.	Stress testing is now dynamic and path dependent.

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Challenges in Designing Stress Tests

LO 54.2: Explain challenges in designing stress test scenarios, including the problem of coherence in modeling risk factors.

One of the challenges of designing useful stress tests is **coherence**. The sensitivities and scenarios must be extreme but must also be reasonable or possible (i.e., coherent). Problems are inherently multi-factored, making it more difficult to design a coherent stress test. For example, an increase in volatility can lead to credit markets freezing. High unemployment and falling equity prices often go hand-in-hand. It is not sufficient to specify one potential problem (i.e., risk factor) because the others do not remain fixed. The supervisor's key challenge is to specify the joint outcomes of all relevant risk factors.

Additionally, not everything goes bad at once. For example, if some currencies are depreciating, others must be appreciating. If there is a "flight to quality," there must also be safe haven assets in the stress model. So while it is important to look at, for example, what happens if U.S. Treasury debt becomes riskier and is no longer a safe haven, the model would at the same time have to identify the "risk-free" asset(s) in which capital would flee under those circumstances.

The problem is even greater when designing stress scenarios for marked-to-market portfolios of traded securities and derivatives. Risk is generally managed with a value at risk (VaR) system. Hundreds of thousands of positions in the trading book must be mapped to thousands of risk factors, tracked on a daily basis. The data that results is used to estimate volatility and correlation parameters. It is very difficult to find coherent outcomes in such a complex, multi-dimensional universe.

The 2009 SCAP tested rather simple scenarios with three variables: growth in GDP, unemployment, and the house price index (HPI). Historical experience was used for the market risk scenario (i.e., the financial crisis—a period of "flight to safety," the failure of Lehman, and higher risk premia). While the market risk scenario did not test for something new, the overall framework achieved coherence of financial and other stresses of the time period.

One thing to note is that prior to 2011 all supervisory stress tests imposed the same scenarios on all banks (i.e., a one-size-fits-all approach to stress testing). In recognition of the problem, the 2011 and 2012 Comprehensive Capital Analysis and Review (CCAR) asked banks to submit results from their own stress scenarios in addition to the supervisory stress scenario in an attempt to reveal bank-specific vulnerabilities. This was an important step forward from the 2009 SCAP as it gave supervisors a sense of what banks think are the high risk scenarios. This provides regulators with not only bank-specific (i.e., micro-prudential) insight but also improves macro-prudential supervision as it highlights common risks across banks that may have been underemphasized or unnoticed before.

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Challenges in Modeling Losses and Revenues

LO 54.3: Identify and explain challenges in modeling a bank's losses and revenues over a stress test horizon period.

Current stress tests are based on macro-scenarios (e.g., unemployment, GDP growth, the HPI). One concern is how to translate the macro-risk factors employed in stress testing into micro (i.e., bank-specific) outcomes related to revenues and losses. Supervisors need to map from macro-factors into intermediate risk factors that drive losses in specific products and geographic areas. Although not limited to these products, geographic differences are especially important in modeling losses in both commercial and residential real estate lending.

Credit card losses are particularly sensitive to unemployment figures. For example, unemployment was 12.9% in Nevada in July 2011, 3.3% in North Dakota, and the national unemployment rate was 9.1%. Credit card loss rates varied dramatically from region to region during this period. The geographic diversity with respect to macro-factors makes a "one-size-fits-all" stress testing regime less meaningful.

Geography is not the only difference supervisors must contend with. Risks affect different asset classes in different ways. For example, during recessions people buy fewer automobiles overall. However, if a person needs a car during a recession, he is more likely to buy a used car. Thus, if default rates increase, loss given default (LGD) (i.e., loss severity) may not increase as much.

The business cycle also affects different industries at different times. Consider the airline industry versus the healthcare industry during a recession. Airplanes are collateral for loans to airlines. If the airline industry is depressed, the bank gets stuck with collateral that is very difficult to sell except at extremely depressed prices. Healthcare is somewhat recession-proof but that doesn't mean the bank can transform an airplane it is stuck with into a hospital. These factors increase the difficulty of mapping broader macro-factors to bank-specific stress results.

Modeling revenues over a stress test horizon period is much less developed than modeling losses. The 2009 SCAP did not offer much clarity on how to calculate revenue during times of market stress. The main approach to modeling revenue is to divide a bank's total income into interest and non-interest income. The yield curve can be used to estimate interest income, and it can reflect credit spreads during stress testing scenarios; however, it remains unclear how bank profitability is directly influenced by the net impact of changing interest rates. Estimating noninterest income, which includes fees and service charges, is even more difficult to model. This is alarming given the steady increase in noninterest income among U.S. banks.

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Challenges in Modeling the Balance Sheet

LO 54.4: Explain the challenges in modeling a bank's balance sheet over a stress test horizon period.

The typical stress test horizon is two years. Over this period, both the income statement and balance sheet must be modeled to determine if capital is adequate post-stress. Generally speaking, capital is measured as a ratio of capital to assets. There are different types of capital (e.g., Tier 1 and Tier 2) but in general (and for the sake of simplicity), capital can be defined as common equity. **Risk-weighted assets** (RWA) are computed based on the Basel II risk weight definitions. For example, agency securities have a lower risk weight than credit card loans.

In a stress model, the beginning balance sheet generates the first quarter's income and loss from the stressed scenario, which in turn determines the quarter-end balance sheet. At that point, the person modeling the risk must consider if any assets will be sold or originated, if capital is depleted due to other actions such as acquisitions or conserved as the result of a spin-off, if there are changes made to dividend payments, if shares will be repurchased or issued (e.g., employee stock or stock option programs), and so on. These decisions make modeling the balance sheet over the stress horizon quite difficult. The stress model doesn't determine if it would be a good time to sell a subsidiary or lower dividend payments.

The challenges of balance sheet modeling exist under both static and dynamic modeling assumptions. The bank must maintain its capital (and liquidity) ratios during all quarters of the stress test horizon. At the end of the stress horizon the bank must estimate the reserves needed to cover losses on loans and leases for the next year. This means that a two-year horizon stress test is actually a three year stress test (i.e., a T-year stress test requires the bank to estimate required reserves to cover losses for T+1 years).

Stress Test Comparisons

LO 54.5: Compare and contrast the 2009 SCAP stress test, the 2011 and 2012 CCAR, and the 2011 EBA Irish and EBA European stress tests in their methodologies and key findings.

Disclosure was a significant feature of the 2009 SCAP. It disclosed projected losses for each of the 19 participating banks for eight asset classes. It also disclosed resources the bank had to absorb losses other than capital (e.g., pre-provision net revenue and reserve releases if available). This high level of disclosure created transparency. It allowed investors and the market to check the severity of stress tests and to comprehend stress test outcomes at the individual bank level. Before the 2009 SCAP, banks only reported realized losses, not forecasted losses (i.e., possible losses given the stress scenario).

The 2011 CCAR required only that macro-scenario results be published, not bank level results. This differed dramatically from the 2009 SCAP requirements. The market had to figure out whether a bank had passed the test or not (i.e., market participants had to "do the math" themselves). For example, if a bank increased its dividend, it was assumed by the market to have "passed" the stress test. However, the 2012 CCAR disclosed virtually the

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same amount and detail of bank level stress data as the 2009 SCAP (i.e., bank level loss rates and losses by major asset classes). The regulatory asset classes are:

1. First and second lien mortgages.
2. Commercial and industrial (C&I) loans.
3. Commercial real estate loans.
4. Credit card lending.
5. Other consumer loans.
6. Other loans.

One of the key contributions of the CCAR was that in both 2011 and 2012 the CCAR required banks to submit the results of their own scenarios, both baseline and stress, not just supervisory stress test results. The Fed also reported dollar pre-provision net revenue (PPNR), gains and losses on available-for-sale and held-to-maturity securities, and trading and counterparty losses for the six institutions with the largest trading portfolios. These firms were required to conduct the trading book stress test. The numbers that were reported were supervisory estimates, not bank estimates, of losses under the stress scenario.

In contrast, the 2011 European Banking Authority (EBA) Irish and 2011 EBA European-wide stress tests, both disclosed after the CCAR, contained considerable detail. In the Irish case, the report contained a comparison of bank and third party estimates of losses. The EBA data was available in electronic, downloadable form. Ireland needed credibility, having passed the Committee of European Bank Supervisors (CEBS) stress test in July 2010 only to need considerable aid four months later. In general, the faith in European supervisors was harmed and only by disclosing detailed information on bank-by-bank, asset-class, country, and maturity bucket basis could the market interpret the data and draw its own conclusions about individual bank risks. Figure 2 summarizes the differences among the various stress test regimes.

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Figure 2: Comparison of Macro-prudential Stress Tests

Stress Test	*Methodologies*	*Disclosure*	*Findings*
SCAP (2009). All banks with $100 billion or more in assets as of 2008 year end were included.	Tested simple scenarios with three dimensions, GDP growth, unemployment, and the house price index (HPI). Historical experience was used for the market risk scenario (i.e., the financial crisis—a period of "flight to safety," the failure of Lehman, and higher risk premia). A "one-size-fits-all" approach.	First to provide bank level projected losses and asset/ product level loss rates.	19 SCAP banks were required to raise $75 billion within six months. The undercapitalized banks actually raised $77 billion of Tier 1 common equity and none of the banks were forced to use the Treasury's Capital Assistance Program funds.
CCAR (2011)	In recognition of "one-size-fits-all" stress testing, CCAR asked banks to submit results from their own baseline and stress scenarios.	Only macro-scenario results were published.	
CCAR (2012)	Banks were again asked to submit their own baseline and stress test results.	Similar in detail to SCAP 2009— bank level and asset/ product level loss rates disclosed.	
EBA Irish (2011)	Similar in design to EBA Europe 2011.	Comparison of bank and third party projected losses; comparison of exposures by asset class and geography. Data is electronic and downloadable.	After passing the 2010 stress tests, 2011 stress tests revealed Irish banks needed €24 billion. Greater disclosure in 2011 resulted in tightening credit spreads on Irish sovereign and individual bank debt.
EBA Europe (2011). [formerly the Committee of European Bank Supervisors (CEBS)] 90 European banks were stress tested.	Specified eight macro-factors (GDP growth, inflation, unemployment, commercial and residential real estate price indices, short and long-term government rates, and stock prices) for each of 21 countries. Specified over 70 risk factors for the trading book. It also imposed sovereign haircuts across seven maturity buckets.	Bank level projected losses. Comparisons of exposures by asset class and geography. Data is electronic and downloadable.	Eight banks were required to raise €2.5 billion.

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The key benefit of greater disclosure is transparency. Transparency is especially important in times of financial distress. However, during "normal" times, the costs of disclosure may outweigh the benefits. For example, banks may "window dress" portfolios, making poor long-term investment decisions to increase the likelihood of passing the test. Traders may place too much weight on the public information included in stress test disclosure and be disincentivized to produce private information about financial institutions. This harms the information content of market prices and makes prices less useful to regulators making policy decisions.

One thing to note is that prior to the CCAR 2011 requirements, all supervisory stress tests imposed the same scenarios on all banks (i.e., a one-size-fits-all approach to stress testing). In recognition of the problem, the 2011 and 2012 CCAR asked banks to submit results from their own scenarios in addition to the supervisory stress scenario in an attempt to reveal bank-specific vulnerabilities.

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Key Concepts

LO 54.1

After the 2007–2009 financial crisis, it was clear that traditional risk measures such as regulatory capital ratios were insufficient. Supervisory stress-testing became an important risk-assessment tool at that point.

The goal of stress testing is to assess how much capital and liquidity a financial institution needs to support its business (i.e., risk taking) activities.

The 2009 U.S. bank stress test, known as the Supervisory Capital Assessment Program (SCAP), was the first macro-prudential stress test after the 2007–2009 financial crisis.

LO 54.2

One of the challenges regulators face is designing coherent stress tests. The sensitivities and scenarios must be extreme but must also be reasonable and possible (i.e., coherent). Problems are inherently multi-factor, making it more difficult to design a coherent stress test.

LO 54.3

Current stress tests are based on macro-scenarios (i.e., unemployment, GDP growth, the HPI). One concern is how to translate the macro-risk factors employed in stress tests into micro (i.e., bank specific) outcomes related to revenues and losses. Supervisors must be able to map from macro-factors into intermediate risk factors that drive losses in specific products and geographic areas.

LO 54.4

In a stress model, the starting balance sheet generates the first quarter's income and loss from the stressed scenario, which in turn determines the quarter-end balance sheet. The bank must maintain its capital (and liquidity) ratios during all quarters of the stress test horizon, typically two years.

LO 54.5

Disclosure was a significant feature of the 2009 SCAP. This high level of disclosure lead to transparency and allowed investors and the market the ability to check the severity of the stress tests and the outcomes of the stress at the individual bank level.

In 2011, CCAR required only macro-scenario results be published, not bank level results, differing significantly from the 2009 SCAP requirements. The 2012 CCAR disclosed virtually the same amount and detail of bank level stress data as the 2009 SCAP. The EBA Irish and the EBA Europe required significant disclosures as well. The disclosures were needed to increase trust in the European banking system.

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Concept Checkers

1. Which of the following changes in stress testing was not the result of the 2009 Supervisory Capital Assessment Program (SCAP)?
   A. Banks are now required to provide the results of their own scenario stress tests.
   B. Stress scenarios are now broader in nature.
   C. Stress testing now focuses on the whole firm.
   D. Stress testing now focuses on revenues, costs, and losses.

2. Piper Hook, a bank examiner, is trying to make sense of stress tests done by one of the banks she examines. The stress tests are multi-factored and complex. The bank is using multiple extreme scenarios to test capital adequacy, making it difficult for Hook to interpret the results. One of the key stress test design challenges that Hook must deal with in her examination of stress tests is:
   A. multiplicity.
   B. efficiency.
   C. coherence.
   D. efficacy.

3. Greg Nugent, a regulator with the Office of the Comptroller of the Currency, is presenting research on stress tests to a group of regulators. He is explaining that macro-variable stress testing can be misleading for some banks because of geographical differences in macro risk factors. He gives the example of the wide range of unemployment rates across the U.S. following the 2007–2009 financial crisis. Which type of loan did Nugent most likely identify as having losses tied to unemployment rates?
   A. Residential real estate loans.
   B. Credit card loans.
   C. Commercial real estate loans.
   D. Industrial term loans.

4. A risk modeler has to make assumptions about acquisitions and spinoffs, if dividend payments will change, and if the bank will buy back stock or issue stock options to employees. These factors make it especially challenging to:
   A. get a CAMELS rating of 2 or better.
   B. determine if the bank has enough liquidity to meet its obligations.
   C. meet the Tier 1 equity capital to risk-weighted assets ratio.
   D. model a bank's balance sheet over a stress test horizon.

5. One of the key differences between the 2011 CCAR stress test and the 2011 EBA Irish stress test is that:
   A. the CCAR did not require banks to provide results from their own stress scenarios.
   B. the EBA Irish did not find any banks in violation of capital adequacy requirements.
   C. the CCAR required disclosure of macro-level, not bank level, scenario results.
   D. the EBA Irish allowed for 1-year stress horizons.

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Concept Checker Answers

1. A The 2009 U.S. bank stress test, known as the Supervisory Capital Assessment Program (SCAP), was the first macro-prudential stress test after the 2007–2009 financial crisis.

   The 2011 CCAR, not the 2009 SCAP, required that banks provide results of their own stress scenarios along with supervisory stress scenarios.

2. C One of the challenges of designing useful stress tests is coherence. The sensitivities and scenarios must be extreme but must also be reasonable or possible (i.e., coherent). Problems are inherently multi-factored, making it more difficult to design a coherent stress test. Hook is dealing with the possibly incoherent results of the bank's stress tests.

3. B Credit card losses are particularly sensitive to unemployment figures. For example, unemployment was 12.9% in Nevada in July 2011, 3.3% in North Dakota, and the national unemployment rate was 9.1%. Credit card loss rates varied dramatically from region to region during this period. Residential mortgages are affected by unemployment as well but people are generally more likely to quit paying credit card bills before mortgages.

4. D In a stress model, the starting balance sheet generates the first quarter's income and loss from the stressed scenario, which in turn determines the quarter-end balance sheet. At that point the person modeling the risk must consider if any assets will be sold or originated, if capital is depleted due to other actions such as acquisitions or conserved as the result of a spin-off, if there are changes made to dividend payments, if shares will be repurchased or issued (e.g., employee stock or stock option programs), and so on. This makes it challenging to model the balance sheet over the stress horizon.

5. C The 2011 CCAR required banks to provide results from their own stress scenarios but the EBA Irish did not. After the 2011 EBA Irish tests, €24 billion was required to increase the capital of several banks. The 2011 CCAR, unlike the SCAP and the 2012 CCAR, only required the disclosure of macro-level scenario results. The EBA Irish did not change the stress horizon from two years to one year.

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

Basel I, Basel II, and Solvency II

Topic 55

Exam Focus

This topic provides an overview of the international capital standards put in place by the Basel Committee on Banking Supervision. Basel I (1988) contained the first steps toward risk-weighting bank activities on- and off-balance sheet to relate required capital to risk. Basel I was the first to set a capital to risk-weighted assets requirement, but it only considered credit risk, not market or operational risk. Basel II took a more sophisticated approach to measuring bank credit risk, market risk, and operational risk. For the exam, understand the contribution Basel II makes to risk measurement, and know the differences between the methods used to calculate various risks. Also, know the difference between Basel II and Solvency II, a similar international standard for insurance companies, and the likely repercussions a firm will face if it breaches the standards. In addition, be able to calculate a bank's required capital under the various regimes. One of the recurring themes in this topic is the difference between a standardized approach for measuring risk, used by less sophisticated banks (and insurance companies), and an internal approach that is firm specific and more complex but often lowers required capital because it allows banks to use their own model inputs and considers the correlations between assets.

LO 55.1: Explain the motivations for introducing the Basel regulations, including key risk exposures addressed, and explain the reasons for revisions to Basel regulations over time.

Prior to 1988, bank capital regulations were inconsistent across countries and ignored the riskiness of individual banks. Requirements were stated as minimum ratios of capital to total assets or as maximum ratios of total assets to capital. Some countries and/or regulatory authorities were more diligent in their enforcement of capital regulations than others. As banks became increasingly global, banks operating in countries with more lax standards were perceived to have a competitive advantage over banks operating in countries with strict enforcement of capital regulations.

There were additional problems with the existing regime. First, high risk loans from international banks to lesser developed countries such as Mexico and Brazil raised questions about the adequacy of existing capital to cover potential losses. Second, banks used "accounting games" to record some of these transactions, masking risk. Third, bank transactions were becoming more complex. Off-balance sheet transactions in over-the-counter (OTC) derivatives like interest rate swaps, currency swaps, and options were growing. These off-balance sheet deals did not affect total assets, and thus did not affect the amount of capital a bank was required to keep, providing fuel to the growing belief that total assets did not reflect a bank's total risk. In 1988, the Basel Committee put forth its first guidance to set international risk-based capital adequacy standards, called the 1988 BIS Accord, now commonly known as Basel I.

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Basel I

LO 55.2: Explain the calculation of risk-weighted assets and the capital requirement per the original Basel I guidelines.

Basel I put forth two capital requirements:

1. The bank's total assets to capital ratio had to be less than 20 (i.e., capital to total assets had to be greater than 1/20 or 5%). This capital requirement was similar to the requirements in many countries prior to 1988.

2. The bank's on- and off-balance sheet items had to be used to calculate **risk-weighted assets** (RWA). RWA is intended to measure a bank's total credit exposure. The ratio of capital to risk-adjusted assets is called the **Cooke ratio**, after Peter Cooke from the Bank of England. Basel I stipulated that the Cooke ratio must exceed 8%.

Most banks met the first requirement. However, the risk-based capital requirement (i.e., the second requirement) was the key change to capital regulation. The process for calculating risk-weighted assets includes assigning a risk weight that reflects the bank's credit risk exposure, to each of the on- and off-balance sheet items. A sample of some of the risk weights assigned to various asset categories is shown in Figure 1.

Figure 1: Risk Weights for On-Balance Sheet Items

Risk Weight (%)	*Asset Category*
0%	Cash, gold, claims on Organisation of Economic Co-operation and Development (OECD) countries such as U.S. Treasury bonds and insured residential mortgages
20%	Claims on OECD banks and government agencies like U.S. agency securities or municipal bonds
50%	Uninsured residential mortgages
100%	Loans to corporations, corporate bonds, claims on non-OECD banks

Example: Risk-weighted assets

The assets of Blue Star Bank consist of $20 million in U.S. Treasury bills, $20 million in insured mortgages, $50 million in uninsured mortgages, and $150 million in corporate loans. Using the risk weights from Figure 1, **calculate** the bank's risk-weighted assets.

Answer:

$$(0.0 \times \$20) + (0.0 \times \$20) + (0.5 \times \$50) + (1.0 \times \$150) = \$175 \text{ million}$$

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Off-balance sheet items are expressed as a **credit equivalent amount**. The credit equivalent amount is, in essence, the loan principal that is considered to have the same credit risk. This means the bank "converts" off-balance sheet items into on-balance sheet equivalents for the purpose of calculating risk-based capital. The weight is then multiplied by the principal amount (i.e., the credit equivalent amount) of the item to arrive at a risk-weighted value. A **conversion factor** is applied to the principal amount of the instrument for non-derivatives. Off-balance sheet items that are similar, from a credit perspective, to loans (e.g., banker's acceptances), have a conversion factor of 100%. Other off-balance sheet items, such as note issuance facilities, have lower conversion factors.

For interest rates swaps and other over-the-counter (OTC) derivatives, the credit equivalent amount is calculated as:

$$\max(V, 0) + a \times L$$

where:
V = current value of the derivative to the bank
a = add-on factor
L = principal amount

The first term in the equation [max(V, 0)] reflects the bank's current exposure. If the counterparty defaults and *V*, the current value of the derivative, is positive, the bank will lose *V*. If the counterparty defaults and *V* is negative, the exposure is 0 (i.e., no gain or loss to the bank). The **add-on amount** (a × L) allows for the possibility that the bank's exposure may increase in the future. Add-on factors are higher for higher risk derivatives (e.g., longer maturities, riskier underlying assets). A sample of add-on factors is shown in Figure 2.

Figure 2: Add-on Factors as a Percent of Principal for Derivatives

Remaining Maturity in Years	*Interest Rate*	*Exchange Rate and Gold*	*Equity*	*Other Commodities*
< 1 year	0.0	1.0	6.0	10.0
1 to 5 years	0.5	5.0	8.0	12.0
> 5 years	1.5	7.5	10.0	15.0

Example: Credit equivalent amounts for off-balance sheet items

Blue Star Bank has entered a $175 million interest rate swap with a remaining maturity of three years. The current value of the swap is $2.5 million. Using the add-on factors in Figure 2, **calculate** the swap's credit equivalent amount.

Answer:

The add-on factor is 0.5% of the interest rate swap principal.

credit equivalent amount = $2.5 + (0.005 × $175) = $3.375 million

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The credit equivalent amount is multiplied by the risk weight for the counterparty to calculate risk-weighted assets. Risk weights are similar to those shown in Figure 1 with the exception of corporate counterparties. If the counterparty is a corporation, the risk weight is 50%. If the counterparty is an OECD bank, the risk weight is 20%.

Example: Calculating risk-weighted assets for an off-balance sheet item

In the previous example, Blue Star Bank entered an interest rate swap that had a credit equivalent amount of $3,375,000. **Calculate** the risk-weighted assets assuming (1) the counterparty is an OECD bank and (2) the counterparty is a corporation.

Answer:

RWA assuming counterparty is an OECD bank: $3,375,000 × 0.2 = $675,000

RWA assuming counterparty is a corporation: $3,375,000 × 0.5 = $1,687,500

The total RWAs of the bank are calculated by summing the on- and off-balance sheet risk-weighted items as follows:

$$\sum_{i=1}^{N} w_i L_i + \sum_{j=1}^{M} w_j C_j$$

where:

w_i = the risk weight of the counterparty of the *i*th on-balance sheet item
L_i = principal of the *i*th on-balance sheet item
w_j = the risk weight of the counterparty of the *j*th off-balance sheet item
C_j = credit equivalent amount of the *j*th off-balance sheet item

The bank must maintain at least 8% capital to risk-weighted assets.

Example: Calculating risk-based capital

Using the information from the previous three examples, **calculate** Blue Star Bank's required capital, assuming the swap counterparty is a corporation.

Answer:

($175 million + $1.6875 million) × 0.08 = $14.135 million

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According to Basel I, capital has two components, Tier 1 capital and Tier 2 capital.

Tier 1 capital (or core capital) consists of items such as:

- Equity (subtract goodwill from equity).
- Non-cumulative perpetual preferred stock.

Tier 2 capital (or supplementary capital) consists of items such as:

- Cumulative perpetual preferred stock.
- Certain types of 99-year debentures.
- Subordinated debt with an original maturity greater than five years (where the subordination is to depositors).

Equity capital (i.e., Tier 1) absorbs losses. Supplementary capital (i.e., Tier 2) is subordinate to depositors and thus protects depositors in the event of a bank failure. At least 50% of capital must be Tier 1. This means there is a 4% Tier 1 capital to risk-weighted assets requirement (i.e., 8% × 0.5). Half of the Tier 1 requirement has to be met with common equity. Under Basel I, some countries required banks to have more capital than required by The Accord.

Professor's Note: Basel I had a number of shortcomings that were remedied over the coming years with new capital accords. For example, Basel I treats all corporate loans the same in terms of capital requirements. The creditworthiness of the borrower is ignored. Also, Basel I did not include a model of default correlation.

Market Risk Capital Requirements

LO 55.3: Describe and contrast the major elements—including a description of the risks covered—of the two options available for the calculation of market risk:

- **Standardized Measurement Method**
- **Internal Models Approach**

The goal of the **1996 Amendment** to the 1988 Basel Accord was to require banks to measure market risks associated with trading activities and maintain capital to back those risks. Banks must **mark-to-market** (i.e., *fair value accounting*) bonds, marketable equity securities, commodities, foreign currencies, and most derivatives that are held by the bank for the purpose of trading (referred to as the *trading book*). Banks do not have to use fair value accounting on assets they intend to hold for investment purposes (referred to as the *banking book*). This includes loans and some debt securities. The 1996 Amendment proposed two methods for calculating market risk:

1. Standardized Measurement Method.

2. Internal Model-Based Approach.

Standardized Measurement Method. This method assigns a capital charge separately to each of the items in the trading book. It ignores correlations between the instruments. Banks with less sophisticated risk management processes are more likely to use this approach.

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Internal Model-Based Approach. This method involves using a formula specified in the amendment to calculate a value at risk (VaR) measure and then convert the VaR into a capital requirement. Capital charges are generally lower using this method because it better reflects the benefits of diversification (i.e., correlations between the instruments). As such, banks with more advanced risk management functions prefer the internal models approach.

Risks covered by the VaR model include movements in broad market variables such as interest rates, exchange rates, stock market indices, and commodity prices.

The VaR model does not incorporate company-specific risks such as changes in a firm's credit spread or changes in a company's stock price. The **specific risk charge** (SRC) captures company-specific risks. For example, a corporate bond has interest rate risk, captured by VaR, and credit risk, captured by the SRC. Tier 3 capital consisting of short-term subordinated, unsecured debt with an original maturity of at least two years could be used to meet the market risk capital requirement at the time of the amendment. Tier 3 capital has subsequently been eliminated under Basel III.

LO 55.4: Calculate VaR and the capital charge using the internal models approach, and explain the guidelines for backtesting VaR.

According to the 1996 Amendment, the market risk VaR is calculated with a 10-trading day time horizon and a 99% confidence level. The market risk capital requirement is calculated as:

$$\max(VaR_{t-1}, m_c \times VaR_{avg}) + SRC$$

where:
VaR_{t-1} = previous day's VaR
VaR_{avg} = the average VaR over the past 60 trading days
m_c = multiplicative factor
SRC = specific risk charge

The multiplicative factor must be at least three, but may be set higher by bank supervisors if they believe a bank's VaR model has deficiencies. This means the capital charge will be the higher of either the previous day's VaR or three times the average of the daily VaR plus a charge for company specific risks (i.e., the SRC).

Banks calculate a 10-day, 99% VaR for SRC. Regulators then apply a multiplicative factor (which must be at least four) similar to m_c to determine the capital requirement. The total capital requirement for banks using the internal model-based approach must be at least 50% of the capital required using the standardized approach.

The bank's total capital charge, according to the 1996 Amendment, is the sum of the capital required according to Basel I, described in LO 55.2, and the capital required based on the 1996 Amendment, described in this LO. For simplicity, the RWAs for market risk capital

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was defined as 12.5 times the value given in the previous equation. The total capital a bank has to keep under the 1996 Amendment is:

total capital = 0.08 × (credit risk RWA + market risk RWA)

where:
market RWA = $12.5 \times (\max(VaR_{t-1}, m_c \times VaR_{avg}) + SRC)$
credit RWA = Σ(RWA on-balance sheet) + Σ(RWA off-balance sheet)

Example: Market risk capital charge

A bank calculates the previous day's market risk VaR as $10 million. The average VaR over the preceding 60 trading days is $8 million. The specific risk charge is $5 million. Assuming a multiplicative factor of three, **calculate** the market risk capital charge.

Answer:

market risk capital charge = 0.08 × {12.5 × [(3 × $8 million) + $5 million]}
= $29 million

Backtesting

The 1996 Amendment requires banks to backtest the one-day, 99% VaR over the previous 250 days. A bank calculates the VaR using its current method for each of the 250 trading days and then compares the calculated VaR to the actual loss. If the actual loss is greater than the estimated loss, an **exception** is recorded. The multiplicative factor (m_c) is set based on the number of exceptions. If, over the previous 250 days, the number of exceptions is:

- Less than 5, m_c is usually set equal to 3.
- 5, 6, 7, 8, or 9, m_c is set equal to 3.4, 3.5, 3.65, 3.75, and 3.85, respectively.
- Greater than 10, m_c is set equal to 4.

The bank supervisor has discretion regarding the multiplier. If the exception is due to changes in the bank's positions during that day, the higher multiplier may or may not be used. If the exception is due to deficiencies in the bank's VaR model, higher multipliers are likely to be applied. There is no guidance to supervisors in terms of higher multipliers if an exception is simply the result of bad luck.

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Credit Risk Capital Requirements

LO 55.5: Describe and contrast the major elements of the three options available for the calculation of credit risk:
- **Standardized Approach**
- **Foundation IRB Approach**
- **Advanced IRB Approach**

LO 55.8: Define in the context of Basel II and calculate where appropriate:
- **Probability of default (PD)**
- **Loss given default (LGD)**
- **Exposure at default (EAD)**
- **Worst-case probability of default**

Basel II specifies three approaches that banks can use to measure credit risk:

1. Standardized approach.
2. Foundation internal ratings based (IRB) approach.
3. Advanced IRB approach.

The Standardized Approach

The **standardized approach** is used by banks with less sophisticated risk management functions. The risk-weighting approach is similar to Basel I, although some risk weights were changed. Significant changes include:

- OECD status is no longer considered important under Basel II.
- The credit ratings of countries, banks, and corporations are relevant under Basel II. For example, sovereign (country) risk weights range from 0% to 150%, and bank and corporate risk weights range from 20% to 150%.
- Bank supervisors may apply lower risk weights when the exposure is to the country in which the bank is incorporated.
- Bank supervisors may choose to base risk weights on the credit ratings of the countries in which a bank is incorporated rather than on the bank's credit rating. For example, if a sovereign rating is AAA to AA–, the risk weight assigned to a bank is 20%. The risk weight increases to 150% if the country is rated below B– and is 100% if the country's bonds are unrated.
- Risk weights are lower for unrated countries, banks, and companies than for poorly rated countries, banks, and companies.
- Bank supervisors who elect to use the risk weights in Figure 3 are allowed to lower the risk weights for claims with maturities less than three months. For example, the risk weights for short-maturity assets may range from 20% if the rating is between AAA to BBB--or unrated, to 150% if the rating is below B–.
- A 75% risk weight is applied to retail loans, compared to 100% under Basel I. A 100% risk weight is applied to commercial real estate loans. The uninsured residential mortgage risk weights are 35% under Basel II, down from 50% under Basel I.

A sample of risk weights under the standardized approach is presented in Figure 3.

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Figure 3: Risk Weights (as a Percent) Under Basel II's Standardized Approach

	AAA to AA–	*A+ to A–*	*BBB+ to BBB–*	*BB+ to BB–*	*B+ to B–*	*Below B–*	*Unrated*
Country	0	20	50	100	100	150	100
Bank	20	50	50	100	100	150	50
Corporation	20	50	100	100	150	150	100

Collateral Adjustments

Banks adjust risk weights for collateral using the **simple approach**, similar to Basel I, or the **comprehensive approach**, used by most banks. Under the simple approach, the risk weight of the collateral replaces the risk weight of the counterparty. The counterparty's risk weight is used for exposure not covered by collateral. Collateral must be revalued at least every six months. A minimum risk weight of 20% is applied to collateral. Using the comprehensive approach, banks adjust the size of the exposure upward and the value of the collateral downward, depending on the volatility of the exposure and of the collateral value.

Example: Adjusting for collateral using the simple approach

Blue Star Bank has a $100 million exposure to Monarch, Inc. The exposure is secured by $80 million of collateral consisting of AAA-rated bonds. Monarch has a credit rating of B. The collateral risk weight is 20% **and** the counterparty risk weight is 150%. Using the simple approach, **calculate** the risk-weighted assets.

Answer:

$(0.2 \times 80) + (1.5 \times 20) = \$46$ million risk-weighted assets

Example: Adjusting exposure and collateral using the comprehensive approach

Blue Star Bank assumes **an** adjustment to the exposure in the previous example of +15% to allow for possible increases in the exposures. The bank also allows for a –20% change in the value of the collateral. **Calculate** the new exposure using the comprehensive approach.

Answer:

$(1.15 \times 100) - (0.8 \times 80) = \$51$ million exposure

Applying a risk weight of 150% to the exposure:

$1.5 \times 51 = \$76.5$ **million risk-weighted** assets

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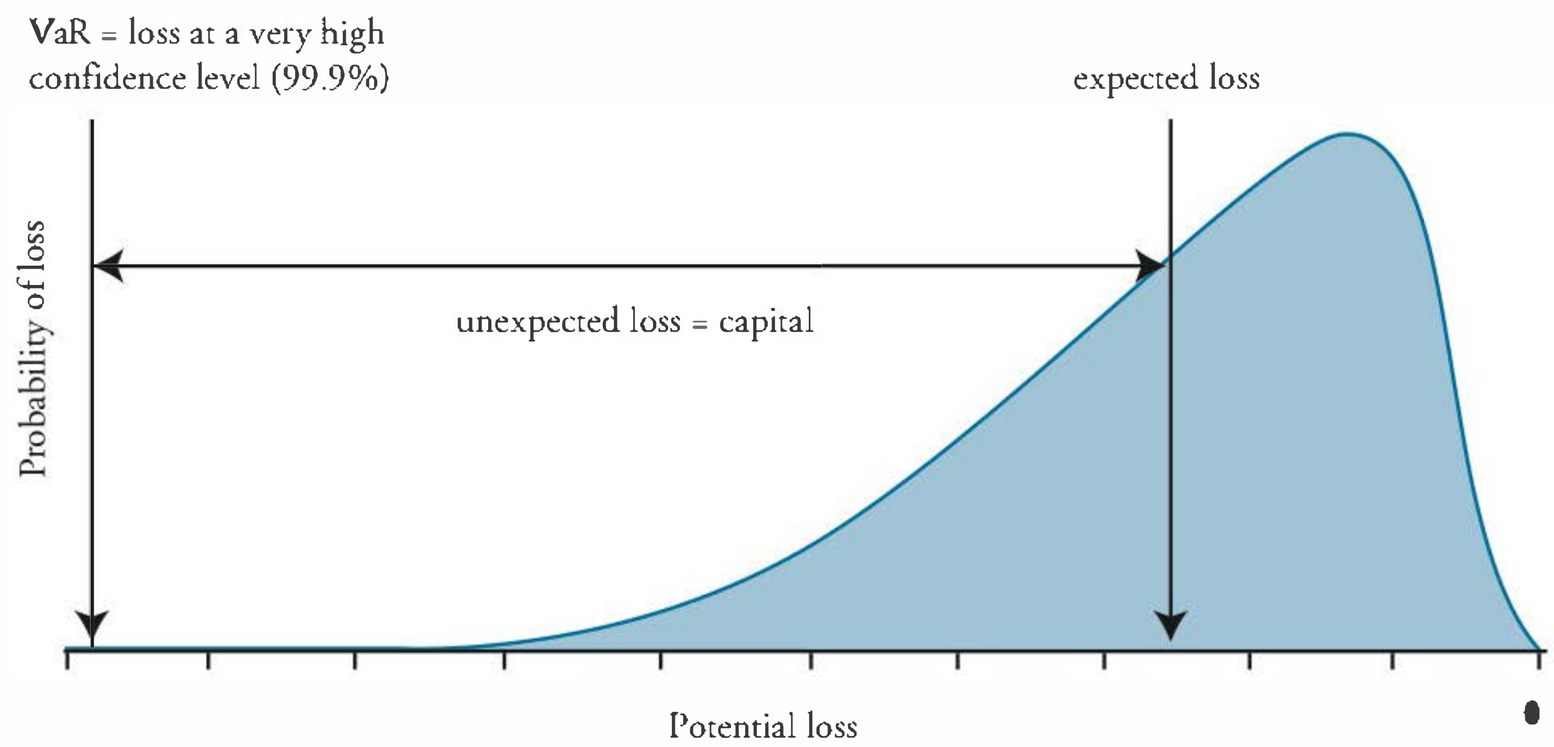
The Internal Ratings Based (IRB) Approach

United States regulators applied Basel II to large banks only. As such, regulatory authorities decided that the **IRB approach** must be used by U.S. banks. Under the IRB approach, the capital requirement is based on a VaR calculated over a one-year time horizon and a 99.9% confidence level. The model underlying this approach is shown in Figure 4.

Figure 4: Capital Requirement



The goal of the IRB approach is to capture unexpected losses (UL). Expected losses (EL) should be covered by the bank's pricing (e.g., charging higher interest rates on riskier loans to cover EL). The capital required by the bank is thus VaR minus the bank's EL. The VaR can be calculated using a Gaussian copula model of time to default. That is:

$$\text{WCDR}_i = N\left[\frac{N^{-1}(\text{PD}_i) + \sqrt{\rho}\,N^{-1}(0.999)}{\sqrt{1-\rho}}\right]$$

In this equation, WCDR_i is the **worst case probability of default**. The bank can be 99.9% certain that the loss from the *i*th counterparty will not exceed this amount in the coming year. PD is the one-year **probability of default** of the ith obligor given a large number of obligors, and ρ is the **copula correlation** between each pair of obligors.

Professor's Note: WCDR is called the worst case probability of default in the assigned reading. It is also called the worst case default rate, hence the acronym WCDR.

Assuming the bank has a large portfolio of instruments such as loans and derivatives with the same correlation, the one-year, 99.9% VaR is approximately:

$$\text{VaR}_{99.9\%,\ 1\text{-year}} \approx \sum_i \text{EAD}_i \times \text{LGD}_i \times \text{WCDR}_i$$

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EAD_i is the **exposure at default** of the ith counterparty or the dollar amount the ith counterparty is expected to owe if it defaults. For example, if the counterparty has a loan outstanding, EAD would likely be the principal amount outstanding on the loan at the time of default. LGD_i is the **loss given default** for the ith counterparty or the proportion of the EAD_i that is expected to be lost in the event of default. For example, if the bank expected to collect (i.e., recover) 40% in the event of default, the LGD_i would be 60% (i.e., 1 – 0.4 = 0.6).

Recall from Book 2 that the expected loss (EL) from default is computed as:

$$EL = \sum_i EAD_i \times LGD_i \times PD_i$$

The capital the bank is required to maintain is the excess of the worst-case loss over the bank's expected loss defined as follows:

$$\text{required capital} = \sum_i EAD_i \times LGD_i \times (WCDR_i - PD_i)$$

Note that WCDR, PD, and LGD are expressed as decimals while EAD is expressed in dollars.

Figure 5 shows the dependence of the one-year WCDR on PD and correlation, ρ.

Figure 5: Dependence of One-Year, 99.9% WCDR on PD and ρ

	PD = 0.1%	*PD = 0.5%*	*PD = 1%*	*PD = 1.5%*	*PD = 2.0%*
ρ = 0.0	0.1%	0.5%	1.0%	1.5%	2.0%
ρ = 0.2	2.8%	9.1%	14.6%	18.9%	22.6%
ρ = 0.4	7.1%	21.1%	31.6%	39.0%	44.9%
ρ = 0.6	13.5%	38.7%	54.2%	63.8%	70.5%
ρ = 0.8	23.3%	66.3%	83.6%	90.8%	94.4%

It is clear from Figure 5 that WCDR increases as the correlation between each pair of obligors increases and as the probability of default increases. If the correlation is 0, then WCDR is equal to PD.

Basel II assumes a relationship between the PD and the correlation based on empirical research. The formula for correlation is:

$$\rho = 0.12 \times (1 + e^{-50 \times PD})$$

Note that there is an inverse relationship between the correlation parameter and the PD. As creditworthiness declines, the PD increases. At the same time, the PD becomes more idiosyncratic and less affected by the overall market, thus the inverse relationship.

The relationship between WCDR and PD, as shown in Figure 6, is obtained by combining the previous equation with the calculation of WCDR. The WCDR increases as the PD

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increases, but not as fast as it would if the correlation were assumed to be independent of PD.

Figure 6: Relationship Between WCDR and PD for Firm, Sovereign, and Bank Exposures

PD	0.1%	0.5%	1.0%	1.5%	2.0%
WCDR	3.4%	9.8%	14.0%	16.9%	19.0%

From a counterparty's perspective, the capital required for the counterparty incorporates a maturity adjustment as follows:

$$\text{required capital} = \text{EAD} \times \text{LGD} \times (\text{WCDR} - \text{PD}) \times \text{MA}$$

where:

MA = maturity adjustment = $(1 + (M - 2.5) \times b)/(1 - 1.5 \times b)$
M = maturity of the exposure
b = $[0.11852 - 0.05478 \times \ln(\text{PD})]^2$

The **maturity adjustment**, MA, allows for the possibility of declining creditworthiness and/or the possible default of the counterparty for longer term exposures (i.e., longer than one year). If M = 1.0, then MA = 1.0 and the maturity adjustment has no impact. The risk-weighted assets are calculated as 12.5 times capital required:

$$\text{RWA} = 12.5 \times [\text{EAD} \times \text{LGD} \times (\text{WCDR} - \text{PD}) \times \text{MA}]$$

The capital required is 8% of RWA. The capital required should be sufficient to cover unexpected losses over a one-year period with 99.9% certainty (i.e., the bank is 99.9% certain the unexpected loss will not be exceeded). Expected losses should be covered by the bank's product pricing. Theoretically, the WCDR is the probability of default that happens once every 1,000 years. If the Basel Committee finds the capital requirements too high or too low, it reserves the right to apply a scaling factor (e.g., 1.06 or 0.98) to increase or decrease the required capital.

Professor's Note: On the exam, if you begin with RWA, multiply by 0.08 to get the capital requirement. If instead you begin with the capital requirement, multiply by 12.5 (or divide by 0.08) to get RWA. In other words, these percentages are simply reciprocals (i.e., 1/0.08 = 12.5).

Foundation IRB Approach vs. Advanced IRB Approach

The **foundation IRB approach** and the **advanced IRB approach** are similar with the exception of who provides the estimates of LGD, EAD, and M. The key differences between the two approaches are outlined by the following.

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Foundation IRB Approach

- The bank supplies the PD estimate. For bank and corporate exposures, there is a 0.03% floor set for PD.
- The LGD, EAD, and M are supervisory values set by the Basel Committee. The Basel Committee set LGD at 45% for senior claims and 75% for subordinated claims. If there is collateral, the LGD is reduced using the comprehensive approach described earlier.
- The EAD is calculated similar to the credit equivalent amount required under Basel I. It includes the impact of netting.
- M is usually set to 2.5.

Advanced IRB Approach

- Banks supply their own estimates of PD, LGD, EAD, and M.
- PD can be reduced by credit mitigants such as credit triggers subject to a floor of 0.03% for bank and corporate exposures.
- LGD is primarily influenced by the collateral and the seniority of the debt.
- With supervisory approval, banks can use their own estimates of credit conversion factors when calculating EAD.

Foundations IRB Approach and Advanced IRB Approach for Retail Exposures

- The two methods are merged for retail exposures. Banks provide their own estimates of PD, EAD, and LGD.
- There is no maturity adjustment (MA) for retail exposures.
- The capital requirement is EAD × LGD × (WCDR – PD).
- Risk-weighted assets are 12.5 × EAD × LGD × (WCDR – PD).
- Correlations are assumed to be much lower for retail exposures than for corporate exposures.

Example: RWA under the IRB approach

Assume Blue Star Bank has a $150 million loan to an A-rated corporation. The PD is 0.1% and the LGD is 50%. Based on Figure 6, the WCDR is 3.4%. The average maturity of the loan is four years. **Calculate** the RWA using the IRB approach and compare it to the RWA under Basel I.

Answer:

$$b = [0.11852 - 0.05478 \times \ln(0.001)]^2 = 0.247$$

$$MA = 1/(1 - (1.5 \times 0.247)) = 1.59$$

$$\text{risk-weighted assets} = 12.5 \times 150 \times 0.5 \times (0.034 - 0.001) \times 1.59 = \$49.19 \text{ million}$$

Under Basel I, the RWA for corporate loans was 100% or $150 million in this case. Thus, the IRB approach lowers the RWA for higher rated corporate loans, in this case from $150 million to $49.19 million.

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Operational Risk Capital Requirements

LO 55.6: Describe and contrast the major elements of the three options available for the calculation of operational risk: basic indicator approach, standardized approach, and the Advanced Measurement Approach.

Basel II requires banks to maintain capital for operational risks. Operational risks include failures of the bank's procedures that result in loss (e.g., fraud, losses due to improper trading activities). External events that result in loss, such as a fire, are also considered operational risks.

Under Basel II, there are three approaches banks may use to calculate capital for operational risk:

1. Basic indicator approach.
2. Standardized approach.
3. Advanced measurement approach.

Basic Indicator Approach (BIA). This is the simplest approach and is used by banks with less sophisticated risk management functions. The required capital for operational risk is equal to the bank's average annual gross income (i.e., net interest income plus non-interest income) over the last three years multiplied by 0.15.

The Standardized Approach (TSA). This method is similar to the basic indicator approach. The primary difference between the two approaches is that a different multiplier is applied to the bank's gross income for different lines of business.

Advanced Measurement Approach (AMA). Like the IRB approach discussed for credit risk, the capital requirement for operational risk under the advanced measurement approach is based on an operational risk loss (i.e., VaR) calculated over a one-year time horizon with a 99.9% confidence level. The approach has an advantage in that it allows banks to consider risk mitigating factors such as insurance contracts (e.g., fire insurance).

Professor's Note: While Basel II generally lowered credit risk capital requirements for most banks, requiring banks to hold capital for operational risks had the effect of raising overall capital requirements back to (approximately) Basel I levels.

Basel II Pillars of Sound Bank Management

LO 55.7: Describe the key elements of the three pillars of Basel II: minimum capital requirements, supervisory review, and market discipline.

While Basel I improved the way capital requirements were determined for banks worldwide, it had some major limitations. First, all corporate loans were treated the same (i.e., a risk

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weight of 100%) regardless of the creditworthiness of the borrower. A firm with an AAA credit rating was treated the same as a borrower with a C rating. Basel I also ignored the benefits of diversification (i.e., there was no model of default correlation). Basel II, proposed in June 1999 and after multiple revisions was published in 2004 and implemented in 2007, corrected a number of the deficiencies in Basel I. The rules applied to "internationally active" banks and thus many small regional banks in the United States were not subject to the requirements but fell under Basel IA, similar to Basel I, instead. All European banks are regulated under Basel II.

There are three pillars under Basel II: (1) minimum capital requirements, (2) supervisory review, and (3) market discipline.

Pillar 1: Minimum Capital Requirements

The key element of Basel II regarding capital requirements is to consider the credit ratings of counterparties. Capital charges for market risk remained unchanged from the 1996 Amendment. Basel II added capital charges for operational risk. Banks must hold total capital equal to 8% of risk-weighted assets under Basel II, as under Basel I. Total capital under Basel II is calculated as:

$$\text{total capital} = 0.08 \times (\text{credit risk RWA} + \text{market risk RWA} + \text{operational risk RWA})$$

Pillar 2: Supervisory Review

Basel II is an international standard, governing internationally active banks across the world. A primary goal of Basel II is to achieve overall consistency in the application of capital requirements. However, Pillar 2 allows regulators from different countries some discretion in how they apply the rules. This allows regulatory authorities to consider local conditions when implementing rules. Supervisors must also encourage banks to develop better risk management functions and must evaluate bank risks that are outside the scope of Pillar 1, working with banks to identify and manage all types of risk.

Pillar 3: Market Discipline

The goal of Pillar 3 is to increase transparency. Banks are required to disclose more information about the risks they take and the capital allocated to these risks. The key idea behind Pillar 3 is that if banks must share more information with shareholders (and potential shareholders), they will make better risk management decisions. Banks have discretion in determining what is relevant and material and thus what should be disclosed. According to Basel II, banks should disclose:

- The entities (banks and other businesses such as securities firms in Europe) to which Basel II rules are applied.
- A description of the characteristics, terms, and conditions of all the capital instruments held by the bank.
- A list of the instruments comprising the bank's Tier 1 capital. The amount of capital provided by each instrument should also be disclosed.
- A list of the instruments comprising the bank's Tier 2 capital.

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- The capital requirements for each type of risk covered under Basel II: credit, market, and operational risks.
- Information about other bank risks.
- Information about the bank's risk management function, how it is structured, and how it operates.

Solvency II Framework

LO 55.9: Differentiate between solvency capital requirements (SCR) and minimum capital requirements (MCR) in the Solvency II framework, and describe the repercussions to an insurance company for breaching the SCR and MCR.

There are no international standards to regulate insurance companies. In Europe, Solvency I establishes capital requirements for the underwriting risks of insurance companies. Solvency II is expected to replace Solvency I and will consider operational and investment risks in addition to underwriting risks. While Solvency II was expected to be implemented in 2013, the date has been postponed. Solvency II has three pillars, analogous to Basel II.

Pillar 1 specifies a **solvency capital requirement** (SCR). The SCR may be calculated using the standardized approach or the internal models approach (discussed in the next LO). Repercussions for breaching the SCR are less severe than if the firm breaches a minimum capital requirement (MCR). If the SCR falls below the required level, the insurance company will likely be required to submit a plan for restoring the capital to the required amount. Specific measures, determined by regulators, may be required.

Pillar 1 also specifies **a minimum capital requirement** (MCR), which is an absolute minimum of capital. There are at least two methods for calculating the MCR under consideration. First, MCR may be set as a percentage of the SCR. A second possibility is to calculate MCR the same way as SCR, but with a lower confidence level. The repercussions for breaching the MCR are severe. If a firm's capital falls below the MCR, regulators will likely prohibit the company from taking new business. Regulators can also force the insurance company into liquidation and transfer the company's insurance policies to another firm.

LO 55.10: Compare the standardized approach and the internal models approach for calculating the SCR in Solvency II.

The two approaches an insurance firm can use to calculate the SCR under Solvency II are:

1. Standardized approach.

2. Internal models approach.

Standardized Approach. Analogous to Basel II, the standardized approach to calculating SCR under Solvency II is intended for less sophisticated insurance firms that cannot or do not want to develop their own firm-specific risk measurement model. It is intended to capture the risk profile of the average firm and is more cost efficient for smaller firms with less fully developed risk management functions.

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Internal Models Approach. This approach is similar to the IRB approach under Pillar 1 of Basel II. A VaR is calculated with a one-year time horizon and a 99.5% confidence level. There is a capital charge for the following three types of risk:

1. *Underwriting risk*: divided into risks arising from life insurance, non-life insurance (such as property and casualty insurance), and health insurance.

2. *Investment risk*: divided into market risk and credit risk.

3. *Operational risk.*

Regulators have implemented quantitative impact studies (QISs) to examine whether capital is sufficient to weather significant market events. For example, QISs have considered large declines (i.e., 32%) in global stock markets, large declines (20%) in real estate prices, large increases (10%) or decreases (25%) in mortality rates, and so on.

Internal models developed by insurance companies must satisfy the following three tests:

1. **Statistical quality test:** This tests the quality of the data and the methodology the firm uses to calculate VaR.

2. **Calibration test:** This tests whether risks are measured in agreement with an industry-wide SCR standard.

3. **Use test:** This test determines if the model is relevant and used by risk managers.

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Key Concepts

LO 55.1

Prior to 1988, bank capital regulations were inconsistent across countries and ignored the riskiness of individual banks. In 1988, the Basel Committee put forth its first guidance to set international risk-based capital adequacy standards known as Basel I.

Basel I was originally developed to cover credit risk capital requirements. It was amended in 1996 to also include market risk capital requirements. Basel II was introduced in 2004 and addressed not only credit and market risk capital but also operational risk capital.

LO 55.2

Under Basel I, banks calculated risk-weighted assets for on- and off-balance sheet items. Capital was required as a percentage of risk-weighted assets. For example, cash and Treasury securities received a 0% risk weight while commercial loans received a 100% risk weight. Off-balance sheet items were expressed as credit equivalent amounts and were "converted" into risk-weighted assets. Capital could be Tier 1 or Tier 2 but at least half of the capital requirement (4%) had to be met with Tier 1 capital (equity and non-cumulative perpetual preferred).

LO 55.3

Banks were required to measure market risk in addition to credit risk under the 1996 Amendment to the 1988 Basel Accord. The 1996 Amendment proposed two methods for calculating market risk including the standardized measurement method and the internal model-based approach. The standardized method assigns a capital charge separately to each of the items in the trading book. This method ignores correlations between the instruments. The internal model-based approach uses a formula specified in the amendment to calculate a value at risk (VaR) measure used to determine the capital requirement. Capital charges are generally lower using this method because it considers correlations between the instruments.

LO 55.4

According to the 1996 Amendment, the market risk VaR is calculated with a 10-trading-day time horizon and a 99% confidence level. The capital requirement for market risk is:

$$\max(VaR_{t-1}, m_c \times VaR_{avg}) + SRC$$

where:
VaR_{t-1} = previous day's VaR
VaR_{avg} = the average VaR over the past 60 days
m_c = multiplicative factor, minimum value of three
SRC = specific risk charge

The 1996 Amendment requires banks to backtest the one-day, 99% VaR over the previous 250 days. If the actual loss is greater than the estimated loss, an exception is recorded. The

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multiplicative factor (m_c) is set based on the number of exceptions. If, over the previous 250 days, the number of exceptions is:

- Less than 5, m_c is usually set equal to three.
- 5, 6, 7, 8, or 9, m_c is set equal to 3.4, 3.5, 3.65, 3.75, and 3.85, respectively.
- Greater than 10, m_c is set equal to four.

The bank supervisor has discretion regarding the multiplier.

LO 55.5

Basel II improves on Basel I in at least two ways. First, counterparty credit ratings are considered in calculating risk-weighted assets. Second, a model of default correlation is included. Basel II specifies three approaches banks can use to measure credit risk, including the standardized approach, the foundation internal ratings based (IRB) approach, and the advanced IRB approach. The standardized approach is the least complicated and the risk-weighting approach is similar to Basel I, although some risk weights were changed. Under the IRB approach, the capital requirement is based on a VaR calculated over a one-year time horizon and a 99.9% confidence level. The foundation IRB approach and the advanced IRB approach are similar. The key difference is who supplies the input variables. Banks supply their own estimates of probability of default (PD), loss given default (LGD), exposure at default (EAD), and the maturity adjustment (M) if using the advanced approach. Under the foundation approach, banks supply PD estimates, while the Basel Committee supplies the estimates of LGD, EAD, and M.

LO 55.6

Basel II requires banks to maintain capital for operational risks. Operational risks include failures of the bank's procedures that result in loss (e.g., fraud, losses due to improper trading activities). External events that result in loss, such as a fire that destroys bank assets or information, are also considered operational risks. Under Basel II, there are three approaches banks may use to calculate capital for operational risk including the basic indicator approach (the simplest), the standardized approach (similar to the basic indicator approach but with different multipliers applied to different lines of business), and the advanced measurement approach (the most complex). The capital requirement for operational risk under the advanced measurement approach is based on an operational risk loss calculated over a one-year time horizon and a 99.9% confidence level (i.e., VaR). The approach has an advantage in that it allows banks to consider risk mitigating factors such as insurance contracts.

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LO 55.7

Basel II is an international standard, governing "internationally active banks." There are three pillars under Basel II as follows:

1. Minimum capital requirements. This pillar involves calculating capital based on the riskiness of the bank, taking into consideration credit risk, market risk, and operational risk.

2. Supervisory review. A primary goal of Basel II is to achieve overall consistency in the application of the capital requirements across countries while, at the same time, giving supervisors discretion to consider market conditions in their own countries.

3. Market discipline. Banks are required to disclose more information about the risks they take and the capital allocated to those risks. According to Basel II, if banks must share more information with shareholders (and potential shareholders), they will make better risk management decisions.

LO 55.8

In the context of Basel II, the worst case probability of default (WCDR) is the amount the bank can be 99.9% certain the loss will not exceed (from a specific counterparty) in the coming year. The one-year probability of default (PD) is the probability that an obligor, given a large number of obligors, will default. The exposure at default (EAD) is the dollar amount a counterparty is expected to owe if it defaults. The loss given default (LGD) is the proportion of the EAD that is expected to be lost in the event the counterparty defaults. For example, if the bank expected to collect 40% in the event of default by a counterparty, the LGD is 60%.

LO 55.9

In Europe, Solvency I establishes capital requirements for the underwriting risks of insurance companies. Solvency II is expected to replace Solvency I and will consider operational and investment risks in addition to underwriting risks. Pillar 1 of Solvency II specifies:

- Minimum capital requirement (MCR). The repercussions for breaching the MCR will likely include a prohibition from taking new business. Regulators may also force the insurance company into liquidation and transfer the company's insurance policies to another firm.
- Solvency capital requirement (SCR). Repercussions for breaching the SCR are less severe than if the firm breaches the MCR. If the SCR falls below the required level, the insurance company will likely be required to submit a plan for restoring the capital to the required amount.

LO 55.10

There are two approaches an insurance firm can use to calculate the SCR under Solvency II. They are the standardized approach and the internal models approach. The standardized approach is least complicated and is meant to capture the risk of the average firm. The internal models approach is similar to the IRB approach under Basel II. It involves calculating a VaR with a one-year time horizon and a 99.5% confidence level.

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Concept Checkers

1. Michigan One Bank and Trust has entered a $200 million interest rate swap with a corporation. The remaining maturity of the swap is six years. The current value of the swap is $3.5 million. Using the table below to find the add-on factor for the interest rate swap, the equivalent risk-weighted assets (RWA) under Basel I is closest to:

Add-on Factors as a Percentage of Principal for Derivatives

Remaining Maturity in Years	*Interest Rate*	*Equity*
< 1 year	0.0	6.0
1 to 5 years	0.5	8.0
> 5 years	1.5	10.0

A. $3,000,000.
B. $3,250,000.
C. $3,500,000.
D. $6,500,000.

2. Saugatuck National Bank uses the internal model-based approach to set market risk capital as prescribed by the 1996 Amendment to the 1988 Basel Accord. The bank has backtested its 99%, one-day VaRs against the actual losses over the last 250 trading days. Based on the results of the backtesting, the bank recorded 11 exceptions. Based on these results, the multiplicative factor (m_c) in the model should be set:
A. less than 3.
B. equal to 3.
C. between 3.1 and 3.9.
D. equal to 4.

3. Bank Macatawa has a $150 million exposure to Holland Metals Co. The exposure is secured by $125 million of collateral consisting of AA+-rated bonds. Holland Metals Co. is unrated. The collateral risk weight is 20%. Bank Macatawa assumes an adjustment to the exposure of +15% to allow for possible increases in the exposure and allows for a –25% change in the value of the collateral. Risk-weighted assets for the exposure are closest to:
A. $78.75 million.
B. $93.75 million.
C. $118.13 million.
D. $172.50 million.

4. Which of the following accords first required banks to hold capital for operational risk?
A. Basel I.
B. The 1996 Amendment to Basel I.
C. Basel II.
D. Solvency II.

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5. Which of the following statements is correct regarding capital requirements for insurance companies?
   A. Basel II includes the regulation of banks and insurance companies in the three pillars.
   B. The minimum capital requirement is likely to be higher than the solvency capital requirement for insurance companies.
   C. The repercussion for violating the solvency capital requirement is likely liquidation and the transfer of company insurance policies to another firm.
   D. The internal models approach to calculating the solvency capital requirement is similar to internal ratings based approach under Basel II in that the firm must calculate a VaR with a one-year time horizon.

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Concept Checker Answers

1. B The add-on factor is 1.5% of the interest rate swap principal for swaps with a maturity greater than five years.

   credit equivalent amount = max(V,0) + a × L

   where:
   V = current value of the derivative to the bank
   A = add-on factor
   L = principal amount

   credit equivalent amount = \$3.5 + (0.015 × \$200) = \$6,500,000

   The risk-weight factor for a corporate counterparty under Basel I is 50% for derivatives and 100% for corporate loans. This means the risk-weighted assets (RWA) are:

   RWA = 0.50 × \$6,500,000 = \$3,250,000

2. D Saugatuck National Bank must compare the VaR calculated using its current method for each of the 250 trading days to the actual loss over the same period to determine the multiplicative factor. If the actual loss is greater than the estimated loss, an exception is recorded. If, over the previous 250 days, the number of exceptions is:
   - Less than 5, m_c is usually set equal to three.
   - 5, 6, 7, 8, or 9, m_c is set equal to 3.4, 3.5, 3.65, 3.75, and 3.85, respectively.
   - Greater than 10, m_c is set equal to four.

   Therefore, with 11 exceptions recorded, m_c should be set equal to four.

3. A Exposure = (1.15 × 150) – (0.75 × 125) = 172.5 – 93.75 = \$78.75

   The risk weight for an unrated corporate counterparty based on Figure 3 in the topic is 100%. Applying the 100% risk weight, risk-weighted assets are:

   risk-weighted assets = 1.0 × 78.75 = \$78.75 million

4. C Basel II requires banks to maintain capital for operational risks. Banks can use three methods to measure operational risk. They are the basic indicator approach, the standardized approach, and the advanced measurement approach.

5. D Solvency II, not Basel II, establishes capital requirements for insurance companies. The minimum capital requirement (MCR) is just that, a true floor and is thus likely to be lower than the solvency capital requirement (SCR). The repercussion for violating the MCR is likely the prohibition of taking new business and possible liquidation. The repercussion for violating the SCR is the requirement of a plan to remedy the situation and bring the capital back to the required level. The internal models approach is similar to the internal ratings based approach under Basel II in that the insurance company must calculate a one-year VaR with a 99.5% confidence level (versus 99.9% confidence for banks under Basel II).

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

Basel II.5, Basel III, and Other Post-Crisis Changes

Topic 56

Exam Focus

Following the 2007–2009 financial crisis, the Basel Committee on Banking Supervision implemented reforms to shore up bank capital. This topic describes the measures taken in Basel II.5 and Basel III to increase capital and tighten the definition of what constitutes capital in normal periods, create buffers to protect banks against loss in stress periods, and encourage banks to better manage liquidity risks by requiring banks to maintain liquidity coverage and net stable funding ratios. It also describes the major reforms in the Dodd-Frank Act that impact banks and bank regulation. For the exam, know the major changes to capital regulation, including the incremental risk charge, the comprehensive risk measure, the stressed VaR, the capital conservation buffer, and the countercyclical buffer. Understand why banks may use less mainstream funding sources, such as contingent convertible bonds, as a result of higher capital requirements. In addition, be able to calculate the leverage ratio, liquidity coverage ratio, and net stable funding ratio given a bank's balance sheet. Finally, be able to recognize and describe major changes imposed on U.S. banks by Dodd-Frank, including the creation of the Financial Stability Oversight Council, the Office of Financial Research, and the Bureau of Financial Protection.

Stressed VaR

LO 56.1: Describe and calculate the stressed value-at-risk measure introduced in Basel 2.5, and calculate the market risk capital charge.

The implementation of Basel II coincided with the financial crisis of 2007–2009. Some people blamed Basel II because banks using the advanced internal ratings based (IRB) approach to calculate credit risk were allowed to use their own estimates of probability of default (PD), loss given default (LGD), and exposure at default (EAD). Some believed Basel II was a move toward self-regulation and allowed banks to underestimate risks. As a result, the Basel Committee on Banking Supervision implemented a series of changes to the calculation of market risk capital. These changes were part of Basel II.5, implemented December 31, 2011. There were three primary changes, including:

1. The calculation of a stressed value-at-risk (SVaR).
2. The implementation of a new incremental risk change (IRC).
3. A comprehensive risk measure (CRM) for instruments sensitive to correlations between default risks of various instruments.

In the past, banks used the historical simulation method to calculate the VaR in order to find the market risk capital charge. The assumption in the historical simulation method

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is that percentage changes in market variables the next day are random samples of the percentage changes over the previous one to four years. Volatilities of most market variables were low in the pre-crisis period (i.e., 2003–2006). As such, market risk VaRs were also low during this period and continuing for a time following the start of the financial crisis. To remedy the problem of low VaRs, Basel II.5 required banks to calculate two VaRs, the usual VaR, using the historical simulation method, and a **stressed VaR**, using a 250-day period of stressed market conditions. Initially, regulators thought the year 2008 would be ideal for stressed market conditions. However, banks are now required to identify a one-year period when their actual portfolios performed poorly. This means the stressed period may be different across banks.

The total market risk capital charge is the sum of the usual bank VaR and the stressed VaR. The formula for the total capital charge is:

$$\max(VaR_{t-1}, m_c \times VaR_{avg}) + \max(SVaR_{t-1}, m_s \times SVaR_{avg})$$

where:

VaR_{t-1} = previous day's VaR, 10-day time horizon, 99% confidence level

VaR_{avg} = the average VaR over the past 60 days, 10-day time horizon, 99% confidence level

m_c = multiplicative factor, determined by supervisor, minimum value of three

$SVaR_{t-1}$ = previous day's stressed VaR, 10-day time horizon, 99% confidence level

$SVaR_{avg}$ = the average stressed VaR over the past 60 days, 10-day time horizon, 99% confidence level

m_s = stressed VaR multiplicative factor, determined by supervisor, minimum of three

Example: Total market risk capital charge

Spartan State Bank has calculated a market risk VaR for the previous day equal to $15.6 million. The average VaR over the last 60 days is $4.8 million. The bank has calculated a stressed VaR for the previous day equal to $17.7 million and an average stressed VaR equal to $18.4 million. Spartan State Bank has an accurate risk measurement model and recorded only two exceptions while backtesting actual losses against the calculated VaR. As such, the multiplicative factors, both m_c and m_s, are set to 3. Calculate the total market risk capital charge.

Answer:

total capital charge = $15.6 million + ($18.4 × 3) = $70.8 million

Professor's Note: Because the stressed VaR will be equal to or, more likely, greater than, VaR, the capital charge for market risk under Basel II.5 will be at least double the capital charge under Basel II.

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Incremental Risk Capital Charge

LO 56.2: Explain the process of calculating the incremental risk capital charge for positions held in a bank's trading book.

Prior to the financial crisis, the capital charge for exposures in the bank's trading book (i.e., bonds, marketable equity securities, commodities, foreign currencies, and most derivatives that are held by the bank for the purpose of trading) was generally lower than the capital charge for exposures in the banking book (i.e., instruments the bank intends to hold for investment purposes including loans and some debt securities). A one-year, 99.9% confidence level VaR was required for calculating capital for the banking book while a multiplier was applied to a 10-day, 99% VaR for capital to back the trading book.

The Basel Committee proposed an **incremental default risk charge** (IDRC) in 2005 to correct the problem. The proposal required a 99.9% confidence level, one-year time horizon VaR for instruments in the trading book that are sensitive to default risk. This change had the affect of requiring roughly the same capital for trading book instruments as banking book instruments. However, because much of the 2007–2009 losses in the financial sector were due not to defaults but instead to downgrades, widening credit spreads, and losses of liquidity, the Basel Committee revised the IDRC to become an **incremental risk charge** (IRC). Instead of instruments sensitive to default, it is now credit-sensitive instruments. Banks must consider ratings change sensitivities in addition to default sensitivity. Banks are expected to rebalance the portfolio through the year to lessen default risk.

As part of the IRC calculation, banks are required to estimate a liquidity horizon for each instrument in the portfolio. For example, assume an AA-rated bond in the portfolio has a liquidity horizon of 6 months. If at the end of 6 months the bond has defaulted or has been downgraded, it is assumed that the bank will replace the bond with an AA-rated bond comparable to the one held at the start of the period. This rebalancing is assumed at the end of each six-month period (or three months, nine months, etc., depending on the estimated liquidity horizon). The Basel Committee set the minimum liquidity horizon at three months.

This assumption of rebalancing to the beginning of the period position is known as the **constant level of risk** assumption. Small losses occur as bonds are downgraded and the portfolio is rebalanced, but the likelihood of default is lessened. Generally this assumption reduces the one-year, 99.9% VaR. As discussed in the previous topic, the specific risk charge (SRC) captures changing credit spreads.

Comprehensive Risk Measure

LO 56.3: Describe the comprehensive risk measure (CRM) for positions which are sensitive to correlations between default risks.

The **comprehensive risk measure** (CRM) is a single capital charge for correlation-dependent instruments that replaces the **specific risk charge** (SRC) and the IRC. The measure accounts for risks in the "correlation book." Instruments that are sensitive to the correlation between the default risks of different assets include asset-backed securities (ABS)

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and collateralized debt obligations (CDOs). In normal periods, there is little risk of loss for highly rated tranches of these instruments. However, in times of stress, as in the 2007–2009 financial crisis, correlations with other instruments increase and even the highest-rated tranches can be vulnerable to loss.

The committee has specified a standardized approach for rated instruments. Due to the experience of the financial crisis, *resecuritizations*, such as CDOs of ABSs, have higher capital requirements than normal securitizations such as mortgage-backed securities.

Figure 1: Standardized Capital Charge for Correlation-Dependent Instruments

Type of Instrument	*AAA to AA–*	*A+ to A–*	*BBB+ to BBB–*	*BB+ to BB–*	*Below BB– or Unrated*
Securitization	1.6%	4%	8%	28%	Deduction
Resecuritization	3.2%	8%	18%	52%	Deduction

For unrated instruments or instruments rated below BB–, the bank must deduct the principal amount of the exposure from capital. This is equivalent to a 100% capital charge; banks must hold dollar-for-dollar capital against the tranche. For unrated tranches banks are allowed, with supervisory approval, to use an internal model to calculate the CRM. If a bank is allowed to use an internal model, it must routinely perform rigorous stress tests. Internal models must be sophisticated and capture the cumulative effects of several factors including:

- Credit spread risk.
- Multiple defaults.
- The volatility of implied correlations.
- The relationship between implied correlations and credit spreads.
- The costs of rebalancing hedges.
- The volatility of recovery rates.

The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank) does not allow ratings to be used in setting capital requirements. As such, the United States is trying to devise its own CRM rules that do not use ratings.

Professor's Note: For unrated and low rated (below BB–) instruments or tranches, the deduction of the principal amount of the exposure from capital is in essence assigning a 1250% risk weight to the asset class. Think about a $100 corporate loan that has a 100% risk weight. The capital charge is $8, or $100 × 100% × 0.08 (the asset value times the risk weight times the capital requirement). If instead you have a $100 unrated ABS CDO, the capital charge is $100. Another way to look at it is $100 × 1250% × 0.08. This lets you see the difference in the way that these low or unrated correlation dependent instruments are treated in terms of capital requirements, compared to traditional assets like loans.

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Basel III Capital Requirements

LO 56.4: Define in the context of Basel III and calculate where appropriate:
- **Tier 1 capital and its components**
- **Tier 2 capital and its components**
- **Required Tier 1 equity capital, total Tier 1 capital, and total capital**

Basel III increased capital for credit risk and tightened the definition of capital in response to the 2007–2009 financial crisis. The proposals were published in December 2010 and will be implemented gradually between 2013 and 2019. Basel III eliminated Tier 3 capital.

Tier 1 capital (or core capital) includes:

- Common equity including retained earnings (called Tier 1 equity capital or Tier 1 common capital).
- Non-cumulative perpetual preferred stock (additional Tier 1 capital, part of total Tier 1 capital).

Tier 1 capital does not include:

- Goodwill.
- Deferred tax assets.
- Changes in retained earnings arising from securitized transactions.
- Changes in retained earnings arising from the bank's credit risk, called debit (debt) value adjustment (DVA).

Tier 1 capital is adjusted downward to reflect defined benefit pension plan deficits (but is not adjusted upward for surpluses). In addition, there are rules governing capital issued by consolidated subsidiaries and also for the inclusion of minority interests.

Tier 2 capital (or supplementary capital) includes:

- Debt subordinated to depositors with an original maturity of five years or more.
- Some preferred stock, such as cumulative perpetual preferred.

Common equity is known as going-concern capital. It absorbs losses when the bank has positive equity (i.e., is a going concern). Tier 2 capital is known as gone-concern capital. When the bank has negative capital and is no longer a going concern, Tier 2 capital absorbs losses. Depositors are ranked above Tier 2 capital in liquidation so theoretically, as long as Tier 2 capital is positive, depositors should be paid in full.

Capital requirements for each tier and for total capital are:

- Tier 1 equity capital must be 4.5% of risk-weighted assets at all times.
- Total Tier 1 capital (i.e., equity capital plus additional Tier 1 capital such as perpetual preferred stock) must be 6% of risk-weighted assets at all times.
- Total capital (Total Tier 1 capital plus Tier 2 capital) must be at least 8% of risk-weighted assets at all times.

By comparison, under Basel I the equity capital requirement was 2% of risk-weighted assets and the total Tier 1 capital requirement was 4% of risk-weighted assets. The new requirements are significantly more rigorous both because the percentages are higher and because the definition of what qualifies as equity capital has been tightened. The 8%

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total capital requirement is the same as under Basel I and Basel II, but again, the stricter definition of equity capital applies under Basel III.

The timeline for implementation for new capital requirements is shown in Figure 2.

Figure 2: Implementation Dates for New Capital Requirements

Regulatory Change	*1/1/13*	*1/1/14*	*1/1/15*	*1/1/18*
Tier 1 Equity Capital	3.5%	4.0%	4.5%	4.5%
Tier 1 Total Capital	4.5%	5.5%	6.0%	6.0%
New Capital Definitions	Phased in	Phased in	Phased in	New definitions fully in place

Capital Conservation Buffer and Countercyclical Buffer

LO 56.5: Describe the motivations for and calculate the capital conservation buffer and the countercyclical buffer introduced in Basel III.

The capital **conservation buffer** is meant to protect banks in times of financial distress. Banks are required to build up a buffer of Tier 1 equity capital equal to 2.5% of risk-weighted assets in normal times, which will then be used to cover losses in stress periods. This means that in normal times a bank should have a minimum 7% Tier 1 equity capital ratio (i.e., 4.5% + 2.5% = 7.0%). Total Tier 1 capital must be 8.5% of risk-weighted assets and Tier 1 plus Tier 2 capital must be 10.5% of risk-weighted assets in normal periods. Banks need an extra cushion against loss during stress periods. The idea behind the buffer is that it is easier for banks to raise equity capital in normal periods than in periods of financial stress. The buffer will be phased in between January 1, 2016, and January 1, 2019.

Dividend payments are constrained when the buffer is wholly or partially used up. For example, if a bank's Tier 1 equity capital ratio is 6%, the bank must retain a minimum of 60% earnings, thus dividends cannot exceed 40% of earnings. See Figure 3 for the restrictions on dividend payments as they relate to the capital conservation buffer.

Figure 3: Dividend Restrictions Resulting from the Capital Conservation Buffer

Tier 1 Equity Capital Ratio	*Minimum Percentage of Retained Earnings*
4.000% to 5.125%	100%
5.125% to 5.750%	80%
5.75% to 6.375%	60%
6.375% to 7.000%	40%
> 7.0%	0%

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Professor's Note: While the buffer requires the ratios to be 7% (Tier 1 equity), 8.5% (Total Tier 1 capital), and 10.5% (total capital) of risk-weighted assets, the ratios are expected to decline in times of market stress due to losses. At that point, the ratio requirements described in LO 56.4 are in force (i.e., 4.5%, 6.0%, and 8.0%, respectively). However, once financial markets stabilize, banks will face pressure to increase the ratios again. Given the higher equity requirements under Basel III, it will likely be difficult for banks to achieve the high returns on equity (ROE) that they enjoyed in the 15 years leading up to the financial crisis (i.e., 1990 – 2006).

While left to the discretion of individual country supervisors, Basel III also recommends that banks have a capital buffer to protect against the cyclicality of bank earnings, called the **countercyclical buffer**. The countercyclical buffer can range from 0% to 2.5% of risk-weighted assets. Like the capital conservation buffer, it must be met with Tier 1 equity capital. The buffer will be phased in between January 1, 2016, and January 1, 2019.

For countries that require the countercyclical buffer, dividend restrictions may apply. See Figure 4 for the restrictions on dividend payments as they relate to the countercyclical buffer (when set to the maximum 2.5% of risk-weighted assets), keeping in mind that the ratios are higher because the capital conservation buffer is also included. In other words, Figure 4 is a revised Figure 3, taking the additional buffer into account.

Figure 4: Dividend Restrictions Resulting from the Capital Conservation Buffer and a 2.5% Countercyclical Buffer

Tier 1 Equity Capital Ratio	*Minimum Percentage of Retained Earnings*
4.50% to 5.75%	100%
5.75% to 7.00%	80%
7.00% to 8.25%	60%
8.25% to 9.50%	40%
> 9.5%	0%

Liquidity Risk Management

LO 56.6: Describe and calculate ratios intended to improve the management of liquidity risk, including the required leverage ratio, the liquidity coverage ratio, and the net stable funding ratio.

In the wake of the 2007–2009 financial crisis, one of the primary goals of Basel III is to improve liquidity risk management in financial institutions. Basel III specifies a minimum **leverage ratio** (capital / total exposure) of 3%. As of the 2010 Basel III publication date, the type of capital required to calculate the ratio was not decided. Total exposure includes all items on the balance sheet, in their entirety (i.e., not risk-weighted). It also includes some off-balance sheet items such as loan commitments.

Banks often finance long-term obligations with short-term funds such as commercial paper or repurchase agreements. This is fine during normal economic periods. However,

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in times of financial stress, this mismatched financing gives rise to liquidity risk. Banks find it difficult to roll over the short-term financing when they have, or are perceived to have, financial problems. During the 2007–2009 financial crisis, liquidity risk, not a lack of capital, was the real problem for many banks (e.g., Lehman Brothers). Basel III requires banks to meet the following two liquidity ratios: (1) liquidity coverage ratio and (2) net stable funding ratio.

Liquidity Coverage Ratio (LCR): The LCR focuses on the bank's ability to weather a 30-day period of reduced/disrupted liquidity. The severe stress considered could be a three-notch downgrade (e.g., AA to A), a loss of deposits, a complete loss of wholesale funding, a devaluation of the value of collateral for funding agreements like repurchase agreements (i.e., increased "haircuts"), and potential drawdowns on lines of credit. The ratio is computed as:

high quality liquid assets / net cash outflows in a 30-day period $\geq$ 100%

Liquid assets need to be at least as great as potential net cash outflows such that the bank can withstand one or more of the pressures described earlier.

Net Stable Funding Ratio (NSFR): The NSFR focuses on the bank's ability to manage liquidity over a period of one year. The ratio is computed as:

amount of available stable funding / amount of required stable funding $\geq$ 100%

To calculate the numerator, each source of funding (such as retail deposits, repurchase agreements, capital, and so on) is multiplied by a factor that reflects the relative stability of the funding source. See Figure 5 for the **available stable funding** (ASF) factors and types of funding available.

Figure 5: ASF Factors in NSFR

ASF Factor	*Category*
100%	Tier 1 and Tier 2 capital, preferred stock, debt with remaining maturity greater than one year.
90%	"Stable" demand and term deposits from individuals and small businesses with maturities less than one year.
80%	"Less stable" demand and term deposits from individuals and small businesses with maturities less than one year.
50%	Wholesale funding (demand and term deposits) from nonfinancial corporations, sovereigns, central banks, multi-lateral development banks, and public sector entities with maturities less than one year.
0%	All other liability and equity categories.

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To calculate the denominator, each required amount of stable funding is multiplied by a factor that reflects the relative permanence of the funding required. See Figure 6 for the **required stable funding** (RSF) factors and the types of assets requiring the funding.

Figure 6: RSF Factors in NSFR

RSF Factor	*Category*
0%	Cash and short-term instruments, securities, and loans to financial entities with residual maturities of less than one year.
5%	Marketable securities with maturities of greater than one year, if claim is on a sovereign with 0% risk weight (e.g., U.S. Treasury securities).
20%	Corporate bonds with rating of AA– or higher and residual maturity greater than one year. Claims on sovereigns or similar bodies with risk-weight of 20%.
50%	Gold, equities, bonds rated A+ to A–.
65%	Residential mortgages.
85%	Loans to small businesses or retail customers with remaining maturities less than one year.
100%	All other assets.

Example: Calculating the NSFR

Bank of the Bluegrass has the following balance sheet:

Cash (coins and banknotes)	10	Retail deposits (less stable)	100
Central bank reserves	10	Wholesale deposits	75
Treasury bonds (> 1 yr)	10	Tier 2 capital	2
Mortgages	30	Tier 1 capital	18
Retail loans (< 1 yr)	30		
Small business loans (< 1 yr)	90		
Fixed assets	15		
Total assets	195	Total liabilities and equity	195

Using the information in Figures 5 and 6 to find the corresponding ASF and RSF factors, **calculate** the bank's net stable funding ratio.

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Answer:

ASF = (100 × 0.8) + (75 × 0.5) + (2 × 1.0) + (18 × 1.0) = $137.50

RSF = (10 × 0) + (10 × 0) + (10 × 0.05) + (30 × 0.65) + (30 × 0.85) + (90 × 0.85) + (15 × 1.0) = $137.00

NSFR = 137.50 / 137.00 = 1.0036 = 100.36%

With an NSFR greater than 100%, Bank of the Bluegrass satisfies the new liquidity requirement.

These new rules represent a significant change for banks and will impact bank balance sheets. The LCR is scheduled to be implemented January 1, 2015, and the NSFR is scheduled to be implemented January 1, 2018.

Contingent Convertible Bonds

LO 56.7: Describe the mechanics of contingent convertible bonds (CoCos) and explain the motivations for banks to issue them.

Contingent convertible bonds (CoCos), unlike traditional convertible bonds, convert to equity automatically when certain conditions are met. These bonds typically convert to equity when the company or bank is experiencing financial strains. The motivation for banks to issue CoCos is that during normal financial periods, the bonds are debt and thus do not drag down return on equity (ROE). However, in periods of financial stress, the bonds convert to equity, providing a cushion against loss, which helps prevent insolvency. The needed capital is provided by private sector bondholders rather than the government, allowing the bank to avoid a bailout.

Potential triggers that activate conversion are:

- The ratio of Tier 1 equity capital to risk-weighted assets. For example, Credit Suisse issued CoCos in 2011. Conversion is triggered if Tier 1 equity capital to risk-weighted assets falls below 7%.
- Supervisors' judgment about the issuing bank's solvency prospects. For example, the Credit Suisse CoCos automatically convert if bank supervisors determine that the bank needs public sector aid (i.e., equity capital) to avoid insolvency.
- A minimum ratio of a bank's market capitalization to its assets. Market value triggers may reduce balance sheet manipulations (as one might see if the ratio of capital to risk-weighted assets is used as a trigger) but might instead introduce stock price manipulation.

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Because of the increased pressure on banks to maintain higher capital levels under Basel III, it is estimated that more than $1 trillion of CoCos will be issued between 2010 and 2020.

Dodd-Frank Wall Street Reform

LO 56.8: Explain the major changes to the U.S. financial market regulations as a result of Dodd-Frank.

The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank) was signed into law in July 2010. The act is intended to protect consumers from abuses and prevent future bailouts and/or collapses of banks and other financial firms. Dodd-Frank has several provisions aimed at regulating banks. Some of the major changes include:

- The establishment of the **Financial Stability Oversight Council** (FSOC). The job of the FSOC is to look out for risks that affect the entire financial system. The body monitors systemic risks.
- The establishment of the **Office of Financial Research** (OFR). The OFR conducts research on the state of the economy and it, along with the FSOC, identifies risks to the financial stability of the United States. The bodies seek to maintain investor confidence and promote market discipline.
- The FSOC and the OFR are charged with identifying **systemically important financial institutions** (SIFIs). SIFIs must establish living wills that map out how the firm can be safely wound down in the event of failure. Banks that are considered too-big-to-fail must be identified and could be broken up under Dodd-Frank if their living wills are judged unacceptable. The FSOC can impose extra capital requirements on SIFIs. In the United States, a bank with more than $50 billion in assets qualifies as a SIFI. The definition is less clear for non-banks.
- The elimination of the Office of Thrift Supervision, a former supervisory body that regulated savings and loan institutions.
- The expansion of the Federal Deposit Insurance Corporation's (FDIC's) powers to liquidate banks. For example, the FDIC is allowed to take over large firms that are failing and sell their assets, even at a loss to shareholders and creditors. The financial industry, not taxpayers, should bear the costs of failures.
- Permanently increasing the FDIC deposit insurance limit from $100,000 to $250,000.
- Greater reporting requirements for large hedge funds and similar firms. These firms must now register with the SEC.
- The establishment of **Federal Insurance Office** that will work with state insurance regulators and monitor the insurance industry.
- The establishment of the **Volker Rule**, intended to curtail proprietary trading by institutions (like banks) that accept insured deposits as a source of funding. One of the problems with this rule is that it can be difficult to distinguish between a bank's speculative trading and hedging activities.
- The requirement that some financial firms spin off high-risk trading operations into separately capitalized subsidiaries.

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- Increased regulation and improved transparency of over-the-counter (OTC) derivatives including requiring standardized OTC derivatives be cleared by exchanges or by central clearing parties (CCPs). To facilitate OTC trading, swap execution facilities (SEFs) were mandated. The Commodity Futures Trading Commission (CFTC) was given responsibility to monitor CCPs and SEFs. A trade repository of all derivatives transactions will be established, improving transparency. A new Legal Entity Identifier (LEI) system will be created to assist with this goal. An LEI is a reference code that identifies a legally distinct entity engaging in a financial transaction.
- The Federal Reserve must set risk management standards for systemically important financial institutions engaged in clearing, settlement, and payment functions.
- The requirement that rating agencies be more transparent in their assumptions and methods used to rate firms. An **Office of Credit Ratings** was created to monitor rating agencies. The potential legal liabilities of rating agencies were also increased under Dodd-Frank.
- The use of external credit ratings in the regulation of banks and other financial institutions was banned. This is in direct conflict with the Basel Committee, which uses external credit ratings to set some capital requirements.
- Individual protections were increased, both for investors and consumers. The **Bureau of Financial Protection** was created within the Federal Reserve to ensure that consumers understand loan applications and terms for things like mortgages and credit cards. The goal is that consumers receive clear and accurate information when they shop for financial products and services.
- Firms are required, with some exceptions, to keep a minimum of 5% of the assets they securitize.
- Changes in compensation. Compensation packages that encourage short-term performance goals that may lead to increased risk taking are discouraged. Shareholders were given a non-binding vote on executive compensation packages. Board compensation committees must be made up of independent directors.
- Banks are required to assess a mortgage borrower's ability to repay. Foreclosures may be disallowed if a bank does not make a good faith effort to determine that the borrower can repay the loan.
- At least one board member should have risk management experience at large, complex organizations.

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Key Concepts

LO 56.1

Basel II.5 requires banks to calculate two market risk VaRs. The first is the usual VaR required in Basel II, using the historical simulation method. The second is a stressed VaR, using a 250-day period of stressed market conditions. To calculate the stressed VaR, banks must identify a one-year period when their portfolios performed poorly. The total market risk capital charge is the sum of the usual bank VaR and the stressed VaR.

LO 56.2

The Basel Committee proposed an incremental default risk charge (IDRC) in 2005 to correct for the fact that the banking book was attracting more capital than the trading book in most banks. For instruments in the trading book that are sensitive to default risk, the IDRC requires the bank to calculate a 99.9% confidence level, one-year time horizon VaR. This was altered to account for ratings change sensitivities in addition to default sensitivities following the 2007–2009 financial crisis and became known as the incremental risk charge (IRC). Banks must estimate a liquidity horizon for each instrument and rebalance the portfolio if credit quality declines.

LO 56.3

The comprehensive risk measure (CRM) accounts for risks in the correlation book. Asset-backed securities (ABS) and collateralized debt obligations (CDOs) are sensitive to the default risk of other assets. For example, they are sensitive to the default risk of the securitized assets that collateralize the instruments. The committee has specified a standardized approach to assign capital charges for rated instruments. Resecuritizations, such as CDOs of ABSs, have higher risk weights than normal securitizations, such as mortgage-backed securities. For unrated instruments or instruments rated below BB–, the bank must deduct the principal amount of the exposure from capital which is equivalent to a 100% capital charge.

LO 56.4

Basel III increased capital requirements for credit risk and tightened the definition of what qualifies as Tier 1 and Tier 2 capital. Basel III eliminated Tier 3 capital. Under Basel III, a bank's total capital consists of Tier 1 equity capital (primarily common stock plus retained earnings), additional Tier 1 capital (primarily non-cumulative perpetual preferred), and Tier 2 capital (primarily debt subordinated to depositors with an original maturity of at least five years). By January 1, 2015, Tier 1 equity capital must be at least 4.5% of risk-weighted assets, total Tier 1 capital must be 6% of risk-weighted assets, and total capital (Tier 1 plus Tier 2) must be at least 8% of risk-weighted assets.

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LO 56.5

The capital conservation buffer protects banks in times of financial distress. Banks are required to build up a buffer of Tier 1 equity capital equal to 2.5% of risk-weighted assets in normal times, which will then be used to cover losses in stress periods. This means that in normal times a bank should have a minimum 7% Tier 1equity capital ratio. Total Tier 1 capital must be 8.5% of risk-weighted assets and Tier 1 plus Tier 2 capital must be 10.5% of risk-weighted assets in normal periods. Dividend restrictions apply when capital ratios fall below required levels.

Basel III also recommends that banks have a capital buffer to protect against the cyclicality of bank earnings, called the countercyclical buffer. This requirement is left to the discretion of individual country supervisors and can range from 0% to 2.5% of risk-weighted assets.

LO 56.6

One of the primary goals of Basel III is to improve liquidity risk management in financial institutions. Basel III requires banks to meet the following three liquidity ratios:

1. A minimum leverage ratio (capital / total exposure) of 3%. Total exposure includes all items on the balance sheet in their entirety (i.e., not risk-weighted) and some off-balance sheet items, such as loan commitments.

2. A minimum liquidity coverage ratio (high quality liquid assets / net cash outflows in a 30-day period) of 100%. The LCR focuses on the bank's ability to weather a 30-day period of reduced/disrupted liquidity.

3. A minimum net stable funding ratio (amount of stable funding / required amount of stable funding) of 100%. The NSFR focuses on the bank's ability to manage liquidity over a period of one year.

LO 56.7

Contingent convertible bonds (CoCos) convert to equity automatically when certain conditions are met, usually when the company or bank is experiencing financial stresses. The motivation for banks to issue CoCos is that during normal financial periods, the bonds are debt and thus do not weigh down return on equity (ROE). However, in periods of financial stress, the bonds convert to equity, providing a cushion against loss and preventing insolvency and potentially allowing the bank to avoid a bailout.

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LO 56.8

Dodd-Frank was signed into law in July 2010. The act is intended to protect consumers from abuses and prevent future bailouts and/or collapses of banks and other financial firms. Dodd-Frank has many provisions aimed at regulating banks. Some of the more important provisions are as follows:

- The establishment of the Financial Stability Oversight Council (FSOC). The job of the FSOC is to look out for risks that affect the entire financial system.
- The establishment of the Office of Financial Research (OFR). The OFR conducts research on the state of the economy and it, along with the FSOC, identifies risks to the financial stability of the United States.
- The FSOC and the OFR are charged with identifying systemically important financial institutions (SIFIs). SIFIs must establish living wills that map out how the firm can be safely wound down in the event of failure. Banks that are considered too-big-to-fail must be identified and could be broken up under Dodd-Frank if their living wills are judged unacceptable. SIFIs may also be required to hold additional capital.
- Permanently increasing the FDIC deposit insurance limit from $100,000 to $250,000.
- The establishment of the Volker Rule, intended to curtail proprietary trading by banks.
- The Bureau of Financial Protection was created within the Federal Reserve to ensure that consumers understand loan applications and terms for things like mortgages and credit cards. The goal is that consumers receive clear and accurate information when they shop for financial products and services.
- Increased regulation and improved transparency for over-the-counter (OTC) derivatives including requiring standardized OTC derivatives be cleared by exchanges or by central clearing parties (CCPs).

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Concept Checkers

1. Which of the following statements about a stressed VaR, required under Basel II.5, is correct?
   A. Basel II.5 has established the year 2008 as the "stress" period. All banks use data from 2008 to calculate the stressed VaR.
   B. The stressed VaR replaces the "normal" VaR for the purpose of calculating capital for credit risks.
   C. Market risk capital under Basel II.5 should be at least double that of market risk capital under Basel II due to the addition of the stressed VaR.
   D. The stressed VaR must be calculated using a 99.9% confidence interval.

2. Banks are required to rebalance their portfolios as the creditworthiness of bonds decline, leading to losses over time but generally not to outright default. This requirement to specify a liquidity horizon for each instrument in the portfolio and rebalance at the end of the liquidity horizon is part of the:
   A. incremental risk charge calculation.
   B. net stable funding charge formula.
   C. countercyclical buffer estimation.
   D. comprehensive risk measure calculation.

3. Which form of capital must be adjusted downward to reflect deficits in defined benefit pension plans under Basel III?
   A. Tier 1 capital.
   B. Tier 2 capital.
   C. Tier 3 capital.
   D. There is no requirement under Basel III to adjust capital downward to reflect deficits in defined benefit pension plans.

4. The capital conservation buffer:
   A. is intended to protect banks from the countercyclical nature of bank earnings.
   B. can be set between 0.0% and 2.5% of risk-weighted assets, and is at the discretion of the regulators in individual countries.
   C. causes the Tier 1 equity capital ratio requirement to increase to 7% of risk-weighted assets in normal economic periods.
   D. requires that total capital to risk-weighted assets must be 10.5% at all times.

5. Highlands Bank has estimated stable funding in the bank to be $100 million. The bank estimates that net cash outflows over the coming 30 days will be $137 million. The bank has capital of $5 million and a total exposure of $140 million. The bank estimates that it has high-quality liquid assets of $125 million. What is the bank's liquidity coverage ratio (LCR)?
   A. 89.3%.
   B. 91.2%.
   C. 73.0%.
   D. 3.6%.

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Concept Checker Answers

1. C Basel II.5 required banks to calculate two VaRs, the usual VaR, using the historical simulation method, and a stressed VaR, using a 99% confidence level, 250-day period of stressed market conditions. The total market risk capital charge is the sum of the usual bank VaR and the stressed VaR. Initially, regulators thought the year 2008 would be ideal for stressed market conditions. However, banks are now required to identify a one-year period when their portfolios performed poorly. This means the stressed period may be different across banks.

2. A As part of the incremental risk charge (IRC) calculation, banks are required to estimate a liquidity horizon for each instrument in the portfolio. For example, assume an AA+-rated bond in the portfolio has a liquidity horizon of three months. If, at the end of three months, the bond has defaulted or has been downgraded, it is assumed that the bank will replace the bond with an AA+-rated bond comparable to the one held at the start of the period. This rebalancing is assumed at the end of each three-month period (or six months, nine months, etc., depending on the estimated liquidity horizon). Rebalancing allows banks to take losses as instruments are downgraded but generally allows the bank to avoid defaults.

3. A Tier 1 includes common equity including retained earnings (called Tier 1 equity capital or Tier 1 common capital) and non-cumulative perpetual preferred stock (additional Tier 1 capital, part of total Tier 1capital). Tier 1 capital does not include goodwill, deferred tax assets, changes in retained earnings arising from securitized transactions, or changes in retained earnings arising from the bank's credit risk. Tier 1 capital is adjusted downward to reflect defined benefit pension plan deficits (but is not adjusted upward for surpluses). Tier 2 or supplementary capital includes debt subordinated to depositors with an original maturity of five years or more. Tier 3 capital was eliminated under Basel III.

4. C The capital conservation buffer is meant to protect banks in times of financial distress. Banks are required to build up a buffer of Tier 1 equity capital equal to 2.5% of risk-weighted assets in normal times, which will then be used to cover losses in stress periods. This means that in normal times, a bank should have a minimum 7% Tier 1equity capital to risk-weighted assets ratio, an 8.5% total Tier 1 capital to risk-weighted assets ratio, and a 10.5% Tier 1 plus Tier 2 capital to risk-weighted assets ratio. The capital conservation buffer is a requirement and is not left to the discretion of individual country regulators. It is not a requirement at all times but is built up to that level in normal economic periods and declines in stress periods.

5. B Basel III requires a minimum liquidity coverage ratio of 100%. The LCR focuses on the bank's ability to weather a 30-day period of reduced/disrupted liquidity. The formula is computed as follows:

   high-quality liquid assets / net cash outflows in a 30-day period

   LCR = $125 million / $137 million = 0.912 or 91.2%.

   In this case, Highlands Bank does not meet the minimum 100% requirement and is in violation of the rule.

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

Fundamental Review of the Trading Book

Topic 57

Exam Focus

The new banking capital requirements, as specified in this topic, will profoundly change the way that capital for market risk is calculated. There are several key innovations that will cause this change. First, banks will be required to forgo using the 99% confidence interval VaR measure in favor of the 97.5% confidence interval expected shortfall measure. This change will better capture the potential dollar loss (i.e., tail risk) that a bank could sustain in a given window of time. Many risk managers have already begun using expected shortfall in practice for internal audits. Second, risk assets will be divided into liquidity horizons that better reflect the volatility in specific asset categories. The third innovation is a rules-based criteria for an asset being categorized as either a trading book asset or a banking book asset. This step will help mitigate the potential for regulatory arbitrage.

Market Risk Capital Calculation

LO 57.1: Describe the proposed changes to the Basel market risk capital calculation and the motivations for these changes, and calculate the market risk capital under this method.

In May 2012, the Basel Committee on Banking Supervision began considering the next round of changes to market risk capital calculations for banks. This process is known as the **Fundamental Review of the Trading Book** (FRTB). After receiving comments on proposals and seeing the results of a formal study, the rules were further refined in December 2014. It is important for risk managers to understand the nature of the proposed changes and the new calculation methodology.

In order to properly understand the changes, it is necessary to first understand the previous market risk requirements. The Basel I calculations for market risk capital involved a 10-day **value at risk** (VaR) calculated with a 99% confidence interval. This process produced a very current result because the 10-day horizon incorporated a recent period of time, which typically ranged from one to four years. The Basel II.5 calculations required banks to add a stressed VaR measure to the current value captured with the 10-day VaR. The stressed VaR measures the behavior of market variables during a 250-day period of stressed market conditions. Banks were required to self-select a 250-day window of time that would have presented unusual difficulty for their current portfolio.

The FRTB researched if the 10-day VaR was really the best measurement for a bank's true risk. The value at risk measure has been criticized for only asking the question: "How bad can things get?" VaR communicates, with a given level of confidence, that the bank's

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losses will not exceed a certain threshold. Consider a bank that uses a 10-day VaR with a 99% confidence interval and finds that losses will only exceed $25 million in 1% of all circumstances. What if the 1% chance involves a $700 million loss? This could be a catastrophic loss for the bank. Therefore, the FRTB has proposed an alternate measure using **expected shortfall** (ES), which is a measure of the impact on the profit and loss statement (P&L) for any given shock of varying lengths. The expected shortfall asks the question: "If things get bad, what is the estimated loss on the bank's P&L?"

Consider the following example that illustrates the difference between value at risk and expected shortfall. A bank has a $950 million bond portfolio with a 2% probability of default. The default schedule appears in Figure 1.

Figure 1: Example Default Schedule for $950 Million Bond Portfolio

Confidence Level	*Default*	*Loss*
95%	No	$0
96%	No	$0
97%	No	$0
98%	No	$0
99%	**Yes**	**$950 million**
99.9%	**Yes**	**$950 million**

At the 95% confidence interval, there is still no expected loss, so the 95% VaR would imply a $0 of loss. However, the expected shortfall measure accounts for the potential dollar loss conditional on the loss exceeding the 95% VaR level. In this case, three out of five times the expected loss is still $0, but two out of five times the expectation is for a total loss of the $950 million bond portfolio's value due to default. This means that 40% of the tail risk would yield a loss, so the expected shortfall is $380 million (i.e., 40% × $950 million). This presents a very different risk perspective than using the VaR measure alone.

Instead of using a 10-day VaR with a 99% confidence interval, the FRTB is proposing the use of expected shortfall with a 97.5% confidence interval. For a normal distribution, with mean of μ and standard deviation of σ, these two measures yield approximately the same result. The 99% VaR formula is $\mu + 2.326\sigma$, and the 97.5% expected shortfall formula is $\mu + 2.338\sigma$. However, if distributions have fatter tails than a normal distribution, then the 97.5% expected shortfall can be considerably different from the 99% VaR.

Under this FRTB proposal, banks would be required to forgo combining a 10-day, 99% VaR with a 250-day stressed VaR, and instead calculate capital based on expected shortfall using a 250-day stressed period exclusively. Just as with the 250-day stressed VaR, banks would be charged with self-selecting a 250-day window of time that would be exceptionally difficult financially for the bank's portfolio.

Professor's Note: There are approximately 250 trading days in a 12-month time period. This is why 250-day time windows are used. Following the same logic, a 120-day window equates to six months, a 60-day window equates to one quarter (three months), a 20-day window equates to one month, and a 10-day window is essentially two weeks.

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Liquidity Horizons

LO 57.2: Compare the various liquidity horizons proposed by the FRTB for different asset classes and explain how a bank can calculate its expected shortfall using the various horizons.

According to the Basel Committee, a **liquidity horizon** (LH) is "the time required to execute transactions that extinguish an exposure to a risk factor, without moving the price of the hedging instruments, in stressed market conditions." The standard 10-day LH was not deemed appropriate given the actual variations in liquidity of the underlying transactions. Five different liquidity horizons are now in use: 10 days, 20 days, 60 days, 120 days, and 250 days. Consider the 60-day horizon, which is essentially three months worth of trading days. The calculation of regulatory capital for a 60-day horizon is intended to shelter a bank from significant risks while waiting three months to recover from underlying price volatility.

Under FRTB proposals, every risk factor is assigned a liquidity horizon for capital calculations. For example, investment grade sovereign credit spreads are assigned a 20-day horizon, while non-investment grade corporate credit spreads are assigned a 120-day horizon and structured products have a 250-day horizon. See Figure 2 for a sample listing of liquidity horizons.

Figure 2: Allocation of Risk Factors to Liquidity Horizons

Risk Factors	*Horizon (in Days)*
Interest rate (EUR, USD, GBP, AUD, JPY, SEK, and CAD)	10
Interest rate (other)	20
Interest rate at-the-money (ATM) volatility	60
Credit spread: sovereign, investment grade	20
Credit spread: sovereign, non-investment grade	60
Credit spread: corporate, investment grade	60
Credit spread: corporate, non-investment grade	120
Credit spread: structured products	250
Equity price: large cap	10
Equity price: small cap	20
Equity price: large cap ATM volatility	20
Equity price: small cap ATM volatility	120
FX rate (liquid currency pairs)	10
FX rate (other currency pairs)	20
FX volatility	60
Energy price	20
Precious metal price	20
Energy price ATM volatility	60
Precious metal ATM volatility	60

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The Basel committee's original idea was to utilize overlapping time periods for stress testing. They initially wanted to find a time period's expected shortfall (ES) by scaling smaller time periods up to longer time periods using a series of trials. Consider a bank that has a 10-day risk asset, like large-cap equity, and a 120-day risk asset, like a non-investment grade corporate credit spread. In the first trial, they would measure the stressed P&L changes from Day 0 to Day 10 for the large-cap equity and also the value change from Day 0 to Day 120 for the non-investment grade corporate credit spread. The next trial would measure the change from Day 1 to Day 11 on the large-cap equity and from Day 1 to Day 121 for the credit spread. The final simulated trial would measure Day 249 to Day 259 for the large-cap equity and Day 249 to Day 369 for the credit spread. The ES used would then be the average loss in the lower 2.5% tail of the distribution of the 250 trials.

After the initial idea was submitted for comments, it was revised in December 2014 to incorporate five categories. The rationale was to reduce implementation costs. The updated categories are as follows:

- Category 1 is for risk factors with 10-day horizons.
- Category 2 is for risk factors with 20-day horizons.
- Category 3 is for risk factors with 60-day horizons.
- Category 4 is for risk factors with 120-day horizons.
- Category 5 is for risk factors with 250-day horizons.

Using this revised, categorical process attempts to account for the fact that risk factor shocks might not be correlated across liquidity horizons.

This proposed new process is formally known as the **internal models-based approach** (IMA). In the internal models-based approach, expected shortfall is measured over a base horizon of 10 days. The expected shortfall is measured through five successive shocks to the categories in a nested pairing scheme using ES_{1-5}. ES_1 is calculated as a 10-day shock with intense volatility in all variables from category 1–5. ES_2 is calculated as a 10-day shock in categories 2–5, holding category 1 constant. ES_3 is calculated as a 10-day shock in categories 3–5, holding category 1 and 2 constant. ES_4 is calculated as a 10-day shock in categories 4–5, holding categories 1–3 constant. The final trial, ES_5, is calculated as a 10-day shock in category 5, holding categories 1-4 constant. The idea is to measure the hit to the bank's P&L for ES_{1-5}. The overall ES is based on a waterfall of the categories, as described above, and is scaled to the square root of the difference in the horizon lengths of the nested risk factors. This relationship is shown in the following formula:

$$ES = \sqrt{ES_1^2 + \sum_{j=2}^{5}\left(ES_j\sqrt{\frac{LH_j - LH_{j-1}}{10}}\right)^2}$$

Until the internal models-based approach has been formally approved, banks must continue to use what is known as the **revised standardized approach.** This process groups risk assets with similar risk characteristics into "buckets," which are essentially just organized around liquidity horizons. The standardized risk measure for each bucket is then calculated using the following formula:

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$$\sum_i w_i^2 v_i^2 + 2\sum_i \sum_{j<i} \rho_{ij} w_i w_j v_i v_j$$

where:
v_i = the value of the ith risk factor
w_i = a weighting factor established by the Basel Committee
ρ_{ij} = the correlation established by the Basel Committee

In order to find the regulatory capital, the standardized risk measures are then combined for each bucket. Regulators may require that capital calculated using the new internal models-based approach be at least some set percentage of the revised standardized approach.

Proposed Modifications to Basel Regulations

LO 57.3: Explain proposed modifications to Basel regulations in the following areas:

- **Classification of positions in the trading book compared to the banking book**
- **Treatment of credit spread and jump-to-default risk, including the incremental default risk charge**

The FRTB also addressed regulatory modifications. One modification is to clarify if a risk asset should be considered part of the trading book or the banking book. Historically, the trading book consisted of risk assets that the bank intended to trade. **Trading book** assets have been periodically marked-to-market. The banking book has consisted of assets that are intended to be held until maturity, and they are held on the books at cost. **Banking book** assets are subject to more stringent credit risk capital rules, while trading book assets are subject to market risk capital rules. Using different rules has enabled a form of regulatory arbitrage where banks will hold credit-dependent assets in the trading book to relax capital requirements.

In an attempt to mitigate this regulatory arbitrage, the FRTB makes a specific distinction between assets held in the trading book and those held in the banking book. To be allocated to the trading book, the bank must prove more than an intent to trade. They must meet dual criteria of: (1) being able to trade the asset, and (2) physically managing the associated risks of the underlying asset on the trading desk. If these two criteria are met, then an asset can be allocated to the trading book, but the day-to-day price fluctuations must also affect the bank's equity position and pose a risk to bank solvency.

Another important distinction was made in terms of reclassification between a banking book asset and a trading book asset. Once an asset has been acquired and initially assigned to either the trading book or the banking book, it cannot be reclassified except for extraordinary circumstances. This roadblock has been established to minimize the act of switching between categories at will, based on how capital requirements are calculated. An example of an extraordinary circumstance is if the bank changes accounting practices that is a firm-wide shift. Another caveat is that any benefit derived from calculating capital requirements under a post-shift category is disallowed. The capital requirement of the original method must be retained.

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Basel II.5 also introduced the **incremental risk charge** (IRC) to further mitigate this regulatory arbitrage. The IRC recognizes two different types of risk created by credit-dependent risk assets: (1) credit spread risk, and (2) jump-to-default risk.

Credit spread risk is the risk that a credit risk asset's credit spread might change and thus cause the mark-to-market value of the asset to change. This risk can be addressed by using the expected shortfall calculation process discussed earlier. The IRC process allows banks to assume a constant level of risk. This means that it is assumed that positions that deteriorate are replaced with other risk assets. For example, if a bank has an A-rated bond with a three-month liquidity horizon that suffers a credit-related loss, then it is assumed that the bank replaces this risk asset with another A-rated bond at the end of the three-month liquidity horizon. This is clearly a simplifying assumption, which is being replaced with incremental marking-to-market without assuming replacement under the FRTB proposals.

Jump-to-default risk is the risk that there will be a default by the issuing company of the risk asset. A default would lead to an immediate and potentially significant loss for the bank that holds the defaulted issuer's risk asset. This risk is subject to an **incremental default risk** (IDR) charge. The IDR calculation applies to all risk assets (including equities) that are subject to default. It is calculated based on a 99.9% VaR with a one-year time horizon.

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Key Concepts

LO 57.1

The Fundamental Review of the Trading Book (FRTB) is changing the historical reliance on 10-day value at risk (VaR) with a 99% confidence interval combined with a 250-day stressed VaR. The new calculation will require the use of expected shortfall with a 97.5% confidence interval. This switch will better capture the value of capital at risk below a certain confidence interval.

LO 57.2

The FRTB is establishing various liquidity horizons, which are the length of time "required to execute transactions that extinguish an exposure to a risk factor, without moving the price of the hedging instruments, in stressed market conditions." The expected shortfall will then be calculated by structuring risk assets into categories and solving for an overall value of expected shortfall for a bank's risk assets.

LO 57.3

Some banks have engaged in regulatory arbitrage by actively switching assets between the trading book and the banking book depending on which category would show their capital requirements in a more favorable light. The FRTB is mitigating this arbitrage opportunity by deploying a rules-based standard for classification into these categories and a roadblock for easily switching between them.

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Concept Checkers

1. Which of the following statements regarding the differences between Basel I, Basel II.5, and the Fundamental Review of the Trading Book (FRTB) for market risk capital calculations is incorrect?
   A. Both Basel I and Basel II.5 require calculation of VaR with a 99% confidence interval.
   B. FRTB requires the calculation of expected shortfall with a 97.5% confidence interval.
   C. FRTB requires adding a stressed VaR measure to complement the expected shortfall calculation.
   D. The 10-day time horizon for market risk capital proposed under Basel I incorporates a recent period of time, which typically ranges from one to four years.

2. What is the difference between using a 95% value at risk (VaR) and a 95% expected shortfall (ES) for a bond portfolio with $825 million in assets and a probability of default of 3%?
   A. Both measures will show the same result.
   B. The VaR shows a loss of $495 million while the expected shortfall shows no loss.
   C. The VaR shows no loss while the expected shortfall shows a $495 million loss.
   D. The VaR shows no loss while the expected shortfall shows a $395 million loss.

3. Which of the following statements best describe how the internal models-based approach (IMA) incorporates various liquidity horizons into the expected shortfall calculation?
   A. A rolling 10-day approach is used over a 250-day window of time.
   B. Smaller time periods are used to extrapolate into larger time periods.
   C. A series of weights are applied to the various liquidity horizons along with a correlation factor determined by the Basel Committee.
   D. The expected shortfall is based on a waterfall of the liquidity horizon categories and is then scaled to the square root of the difference in the horizon lengths of the nested risk factors.

4. Which of the following statements represents a criteria for classifying an asset into the trading book?
   I. The bank must be able to physically trade the asset.
   II. The risk of the asset must be managed by the bank's trading desk.

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

5. Which of the following risks is specifically recognized by the incremental risk charge (IRC)?
   A. Expected shortfall risk, because it is important to understand the amount of loss potential in the tail.
   B. Jump-to-default risk, as measured by 99% VaR, because a default could cause a significant loss for the bank.
   C. Equity price risk, because a change in market prices could materially impact mark-to-market accounting for risk.
   D. Interest rate risk, as measured by 97.5% expected shortfall, because an increase in interest rates could cause a significant loss for the bank.

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Concept Checker Answers

1. **C** Basel I and Basel II.5 use VaR with a 99% confidence interval and the FRTB uses the expected shortfall with a 97.5% confidence interval. Basel I market risk capital requirements produced a very current result because the 10-day horizon incorporated a recent period of time. The FRTB does not require adding a stressed VaR to the expected shortfall calculation. It was Basel II.5 that required the addition of a stressed VaR.

2. **C** The VaR measure would show a $0 loss because the probability of default is less than 5%. Having a 3% probability means that three out of five times, in the tail, the portfolio will experience a total loss. The potential loss is $495 million (= 3/5 × $825 million).

3. **D** The expected shortfall is based on a waterfall of the liquidity horizon categories and is then scaled to the square root of the difference in the horizon lengths of the nested risk factors.

4. **C** The criteria for classification as a trading book asset are: (1) the bank must be able to physically trade the asset, and (2) the bank must manage the associated risks on the trading desk.

5. **B** The two types of risk recognized by the incremental risk charge are: (1) credit spread risk, and (2) jump-to-default risk. Jump-to-default risk is measured by 99% VaR and not 97.5% expected shortfall.

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

Basel II: International Convergence of Capital Measurement and Capital Standards

Topic 58

Exam Focus

This topic presents an overview of the Basel II Accord. It discusses the basic framework of Basel II and how it differs from Basel I. In addition, it provides a detailed review of the major elements and approaches for computing capital requirements for credit risk, market risk, and operational risk. Finally, it addresses the key elements of the three pillars of Basel II.

Professor's Note: For the exam, FRM candidates are expected to understand the general structure of regulatory frameworks and the application of approaches for calculating capital requirements discussed in the previous three Basel readings (Topics 55–57). The last five readings in this book (Topics 58–62) are optional regulatory reference readings. These optional readings are provided for candidates who are interested in understanding regulatory frameworks in greater detail. As such, there is significant overlap between the last five optional topics and the previous three assigned topics.

Banking Regulation

Regulation refers to the oversight provided by an external party with the ability to influence the legal and operating structure of the industry. Implicit in the decision to regulate is the tradeoff between the costs and benefits of regulation. Within the banking industry, the necessity of regulation is subject to debate. While some argue that banks and financial institutions should be treated no differently from firms in other industries (i.e., allowed to fail), most believe that the potential costs of bank failure are so large that regulation is necessary. The scope of regulation can vary significantly from systematic (i.e., ensure global banking stability) to micro-level (i.e., protect consumers and investors).

Four reasons have been advanced to justify the existence of banking regulation:

1. *Protect bank depositor from loss in bankruptcy.* The structure of the banking system is one where the individual depositors are small and anonymous to each other. These characteristics do not provide the incentive to directly monitor bank management or invest in costly monitoring of bank activities. Therefore, individuals need external assurances or guarantees of the recoverability of their deposits in case of bankruptcy.

2. *Provide stability for transactions.* The functioning of a smooth economy depends on the transaction services banks provide in addition to traditional loan origination. It is important that currency availability, payment processing, and settlement functions remain uninterrupted.

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3. *Avoid contagion effects in the banking industry*. The greatest fear of an unregulated banking system is that failure of one institution will lead to the failure of others that, in turn, will lead to the failure of still others. This domino effect is made more likely by the reputation effects of one bank failure on other institutions and by the interconnected nature of transactions with other institutions. Ultimately, the Federal Reserve will intervene if it feels the potential impact of collapse will impact the overall economy.

4. *Maintain stability in the economy*. Banks in distress can severely impact local and regional economies. It is important that other banks fill the void quickly. In the absence of regulation, other banks may refrain from supporting the distressed bank based on differential information regarding the cause of the problem.

Deposit Insurance

Deposit insurance through Federal Deposit Insurance Corporation (FDIC) guarantees the return of deposits (with important limitations) in the extreme case of bank insolvency or failure. While this system reduces the risk of depositors, it also has a negative effect in that it reduces the incentives of those same depositors to monitor the financial strength of the bank. Depositors then have a safety net from deposit insurance and will provide less oversight than they would in the absence of deposit insurance. The bank also faces a **moral hazard** problem, as the deposit insurance system can increase its risk-taking behavior. The bank has an increased incentive to take on more risk than without deposit insurance because the bank does not fully bear the cost (higher required interest on deposits) from its decisions. In short, deposit insurance reduces the incentives of depositors to monitor bank activities since their funds are guaranteed, and banks will increase their risk profiles since losses are effectively subsidized by the FDIC.

The Too-Big-to-Fail Doctrine

Large firms on the brink of insolvency will arguably create a contagion effect if they are allowed to fail. When this threat is large, the government is inclined to prevent the collapse from happening in an effort to reduce the projected contagion risk. This action is based on the **too-big-to-fail policy**. In the event of failure, the government would be forced to pick up the pieces; therefore, offering liquidity to prevent this from occurring is a better option. The intervention by the government creates a moral hazard issue where large businesses have a reduced incentive to monitor behavior. A recent example of a company deemed too big to fail was the American International Group (AIG).

Basel I

The intent of the 1988 Basel Accord (Basel I) was to strengthen and standardize the global banking system. The expectation was that individual countries would implement the basic framework of the Accord and modify appropriately for their respective markets. The primary contribution of the 1988 Accord was the establishment of standardized capital levels built upon a *risk-based* definition of capital (i.e., not all assets have the same risk). Accordingly, assets were sorted into four categories (buckets) based on their risk exposure. Organization for Economic Co-operation and Development (OECD) sovereigns (30

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developed countries) were considered least risky, while corporate obligations carried the greatest risk. The riskier the obligation, the more capital the bank was required to hold. The Accord stipulated that the **Cooke ratio** (capital/risk-weighted assets) must exceed 8%. Basel I was later amended to take account of differences in market risk and to allow the use of internal models to measure market risk. This allowed better measurement of risk and more efficient allocation of capital since banks could hold less capital or lend more based on a given level of capital.

While Basel I, particularly the risk-based capital approach, was a significant improvement in the sophistication and standardization of risk measurement, several important issues were left unaddressed:

- There was no clear rationale for the 8% capital requirement.
- The risk buckets were homogenous. For example, all corporate bonds faced the same capital charge regardless of (important) differences in maturity and seniority.
- The Cooke ratio was too simple to truly evaluate solvency levels.
- Potentially risk-reducing diversification in the loan portfolio was ignored.
- Use of off-balance sheet activities to mitigate risk exposures was not recognized.

Basel II

The Basel II Accord is aimed at large international banks and all subsidiaries, holding companies, and security firms operating under the parent firm. The primary goal of Basel II is to provide more precise classifications of risk levels between banks. Since banks greatly varied in sophistication and credit exposures, the bucket approach of Basel I was deemed both simplistic and ineffective. In addition, the Committee sought a system flexible enough to accommodate the rapid changes and innovations in financial markets as well as risk management practices that were lacking under Basel I. Accordingly, the Committee went to great lengths to secure industry input and to incorporate common practices so that the changes could be reasonably implemented. Ultimately, Basel II established three options for the calculation of credit risk capital requirements.

1. *Standardized approach.* This approach is essentially the same as under the original Basel Accord, but the risk weightings are based on the characteristics of each borrower and provided by external credit rating sources, such as Standard & Poor's Corporation.

2. *Internal ratings-based (IRB) foundation approach.* The IRB foundation approach is a hybrid of internal and external estimates. Typically, the bank uses internal estimates of default probabilities but uses external sources for other model inputs, such as loss given default (LGD). Regulators often provide the latter information.

3. *Internal ratings-based (IRB) advanced approach.* Under this approach, the bank generates all of the estimates used in its models.

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The Three Pillars of the Basel II Accord

Basel II recognizes three pillars of sound bank management that deal with capital requirements, supervisory review by regulators, and market discipline based on better disclosure of risks to the financial community.

The first pillar, Pillar 1, is a highly quantitative assessment of the capital requirements for the bank. Although the main focus of this pillar is credit risk, operational risk (new in Basel II) is also an important factor in determining capital adequacy.

Pillar 2 envisions a formal role for regulators in an effort to identify and stem potential problems. The regulator will provide a credible check for the inputs used in the bank's models and detect risks not covered in Pillar 1. In addition, the frequent monitoring allows for intervention earlier rather than later if corrective action is needed. Also, under Pillar 2, regulators can set the requirement higher than the 8% of Basel I.

Pillar 3 focuses on the capital markets as external monitors of the bank. The institution must submit required disclosures to qualify for regulatory capital treatment. These disclosures also provide the financial community information on the bank's risk exposures and capital adequacy.

Calculating Capital Requirements

While the actual calculations for computing the capital requirements are quite involved under either method (standardized or IRB), the following discussion is qualitative in order to provide a clear understanding of the conceptual differences in methods.

$$\text{basic risk-based capital calculation} = \frac{\text{total capital}}{\text{total risk-weighted assets}}$$

Under Basel I, the risk weightings were based on credit risk only. Under Basel II, assets are risk weighted for credit risk, market risk, and operational risk. This revised ratio is known as the **capital ratio** or **capital adequacy ratio**.

As mentioned, total risk-weighted assets are broken down into credit risk, market risk, and operational risk. According to Basel II, a bank's capital ratio must exceed 8%. This mandated 8% capital requirement is used to determine the capital charge for a given risk. For example, the capital charge for credit risk is computed as 8% of the risk-weighted assets for credit risk.

In order to compute total risk-weighted assets, we start with risk-weighted assets for credit risk. The calculation of risk-weighted assets for credit risk is simply the sum of credit risky assets multiplied by corresponding risk weights. We then add the capital charges for market and operational risk (methods for calculating capital charges are demonstrated shortly). Since we need to determine the risk-weighted assets for market and operational risk we need to divide the capital charge amounts by 8% (or alternatively multiply by 12.5). In other words, if we already know the capital charge for market and/or operational risk, we know that it must be equal to at least 8% of risk-weighted assets for a given risk.

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For example, suppose that the sum of risk-weighted assets for credit risk totals $1,500. Also assume that the market risk capital charge (requirement) is $30 and the operational risk capital charge is $50. Total risk-weighted assets are calculated as follows: $1,500 + [($30 + $50) × 12.5] = $2,500. This means that the bank must hold at least $200 in capital (i.e., $2,500 × 8%) in order to satisfy the minimum capital requirement.

A more detailed discussion of the calculation of credit risk capital requirements and corresponding credit risk-weighted assets is outlined in the following section as well as in LO 58.2.

Standardized Approach

The standardized approach under Basel II assigns a risk weight to each asset based on its credit risk (i.e., probability of default). An asset's assigned risk weight can range from 0% for high quality sovereign debt to 100% or more for corporate debt based on its credit rating. Since 8% is the mandated capital requirement, this serves as the benchmark for calculating the capital contribution for each asset. A simple example will help illustrate this point.

Example: Standardized approach

Suppose First National Bancorp has a $100 million loan portfolio split equally between UK sovereign debt (rated AAA) and corporate debt. **Calculate** the capital requirement for First National Bancorp if the corporate debt is (1) AAA-rated and (2) BBB-rated. Assume the corporate risk weightings are 20% for AAA-rated debt and 100% for BBB-rated debt.

Answer:

Note that the risk weighting of UK sovereign debt is 0% due to its AAA rating.

capital (based on AAA rating) = ($50 million)(0%)(8%)
+ ($50 million)(20%)(8%) = $800,000

capital (based on BBB rating) = ($50 million)(0%)(8%)
+ ($50 million)(100%)(8%) = $4,000,000

An important change in Basel II relative to Basel I is that the previous distinction between OECD and non-OECD sovereign debt is no longer valid. Previously, OECD sovereigns were assigned a risk weighting of 0%. Under Basel II, the credit rating of the debt is determined on a case-by-case basis.

IRB Approach

The IRB approach has the potential to reduce the capital requirement for banks because their own estimates of risk may be lower than those calculated using the "cookie cutter" philosophy of the standardized approach. Some of the benefits of switching from the standard method may be delayed because the capital requirement under IRB cannot be less than 90% of the capital requirement the previous year or less than 80% of the prior requirement after two years.

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Calculation of **risk-weighted assets** (RWA) is based on the potential **exposure at default** (EAD) and **capital requirement** (K) as follows:

risk-weighted assets = capital requirement × 12.5 × exposure at default

Note that collateral is not deducted from EAD under the IRB approach but is deducted under the standardized approach. The calculation of the capital requirement (K) is itself a function of **loss given default** (LGD), **probability of default** (PD), **maturity adjustment** (M), and a **maturity adjustment factor**, related to EAD (b). The exact formulation is:

$$K = LGD \times PD \times f(M,b)$$

Now that we have discussed the basics, each input in the capital requirement is described in a bit more detail. In particular, differences between the foundation IRB and advanced IRB approaches are highlighted. Figure 1 summarizes some of the key properties.

LGD is an important factor in the capital calculation since it is linearly related to *K* (i.e., increases in LGD will increase *K* by the same percentage regardless of the size of the default). Under the foundation IRB approach, LGD increases with the riskiness of the claim. Therefore, (predetermined) senior recovery rates will be higher than subordinated recovery rates. Collateral can be used to reduce LGD and hence the capital charge. Under the advanced IRB approach, banks generate internal estimates of LGD.

The probability of default calculation explicitly incorporates the correlation of the specific asset class. The resulting stressed probability is concave in shape (i.e., diminishing effect of PD on *K*). Asset returns are based on a systematic factor and an idiosyncratic (unsystematic) factor. While the derivation is complex and based on the distributions of the factors, Basel computations are based on a "worse-case" systematic draw at the 99.9% level (approximately three standard deviations from the mean).

The maturity adjustment effect differs between the foundation and advanced IRB approaches. Under the foundation approach, the effective maturity is assumed to be 2.5 years, while the effective maturity is calculated individually based on PD under the advanced IRB approach. Under the latter approach, the maturity adjustment can have the perverse effect of charging higher-quality loans more than lower-quality ones. Hence, the maturity effect can mitigate the gains (i.e., reduce capital requirements) from other areas of the Accord.

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Figure 1: Comparison of Standardized and IRB Approaches

Factor	*Standardized*	*Foundation IRB*	*Advanced IRB*
Collateral deducted from EAD	Yes	No	No
LGD estimates	N/A	Predetermined, decreases with seniority	Internal estimates
PD estimates	External rating agency	Concave PD function	Concave PD function
Maturity adjustment	N/A	Effective maturity is assumed at 2.5 years	Adjusted for effective maturity based on PD

Credit Risk Mitigation and Securitization

Banks that employ the standardized approach can further adjust their capital requirements to reflect the reduced risk in the loan portfolio from the use of collateral, guarantees, hedges, swaps, and other derivatives. The specific rules, as you can imagine, are quite detailed, but the general principles of **credit risk mitigation** (CRM) are straightforward. Highly liquid assets, such as cash, gold, high-grade debt, and equities in indices, can be considered collateral. The bank may also be able to use on-balance-sheet netting if a legal basis exists and accurate netting values can be determined. The criteria for using guarantees and credit derivatives to offset capital requirements are more stringent due to the complexity and specific conditions of the contracts, timing of cash flows, and potential asset-liability mismatches.

Securitization is considered an acceptable method for credit risk mitigation under both the standardized and IRB approaches. However, the committee makes an important distinction between traditional and synthetic securitization. The primary difference is that traditional securitization dictates that the assets in the pool are truly separate from the bank. Synthetics can reduce capital requirements if the underlying credit derivatives meet the previous standard for CRM.

Under the standardized approach, the same weighting scheme described for capital requirement determination is utilized. Institutions employing IRB approaches can compute capital using either a **ratings-based approach** (RBA) or a **supervisory formula approach** delineated by the Basel committee.

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The New Basel II Capital Accord

LO 58.5: Define in the context of Basel II and calculate where appropriate:

- Capital ratio
- Capital charge
- Tier 1 capital and its components
- Tier 2 capital and its components
- Tier 3 capital and its components
- Probability of default (PD)
- Loss given default (LGD)
- Exposure at default (EAD)
- Maturity (M)
- Stress tests
- Concentration risk
- Residual risk

Professor's Note: This learning objective is addressed throughout the topic.

The Bank for International Settlements (BIS) created the first Basel Accord in 1988. Since that time, various changes have taken place in international banking markets that have required an update of the original agreement. The Basel I Accord of 1988 came under criticism within a few years of its issuance. That Accord had fairly stringent guidelines for calculating credit risk, which did not accurately reflect the true risk to capital. The 1988 Accord also failed to address new and innovative risk management vehicles and methods for managing credit risk. Finally, Basel I did not include any consideration of operational risk, and thus failed to capture an important component of most banks' risk profiles.

While the original Accord focused on credit risk and market risk, the new Accord expands the treatment of these risks to include a specific operational risk component in the bank's capital ratio. Although the minimum capital ratio (total capital / total risk-weighted assets) of 8% is the same under the new Accord, these changes may require a different level of capital for some banks than the first Accord. However, the overall objective is to maintain similar overall capital requirements (i.e., capital charges) and to ensure those capital requirements are much more sensitive to the risk profile of the bank's operations.

Besides the general objective of maintaining a sound international financial system, the specific objectives of the Basel II Accord include the following:

- Promote safety and soundness of the financial system.
- Enhance competitive equality.
- Create capital adequacy assessments and approaches that are appropriate to the degree of risk involved in a bank's positions and activities.
- Focus on internationally active banks while allowing the principles to be flexible enough to have application to a wide variety of banking operations.
- Encourage continuous improvement in a bank's internal risk assessment capabilities.
- Ensure that risk is a primary emphasis in supervisory practices.

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The Basel II Accord consists of three pillars:

- **Pillar 1: Minimum capital requirements.** Banks should maintain a minimum level of capital to cover their credit, market, and operational risks.
- **Pillar 2: Supervisory review process.** Banks should assess the adequacy of their capital relative to their risk, and supervisors should review and take corrective action if problems occur.
- **Pillar 3: Market discipline.** Risks should be adequately disclosed in order to allow market participants to assess a bank's risk profile and the adequacy of its capital. Greater disclosure will increase the discipline in the marketplace, leading to greater financial stability.

The BIS believes that these pillars taken together should increase the safety and soundness of the financial system. These pillars represent a package, and according to the BIS, implementation of the New Accord should not be considered complete until all three pillars are in place.

Professor's Note: These three pillars of sound bank management will be discussed in greater detail in LO 58.1 later in this topic.

The Basel II Accord is designed to apply to all internationally active banks. The Accord covers any holding company that may be the parent of other entities involved in banking activities, and it looks at the entire group on a consolidated basis. The idea is to include the risks held at any level of a multilevel banking group and to prevent the double counting of capital.

Bank subsidiaries are viewed as part of the whole banking group. However, the Accord also calls on supervisors to evaluate subsidiaries' individual capital to assure that the depositors of each subsidiary (who may not have access to other parent company assets) are fully protected.

If part of the bank group's or holding company's operations are in related businesses (e.g., insurance, securities), these operations should be consolidated as well, and the capital should be adjusted to appropriately reflect the risk of these entities.

Types of Capital

There are three types of capital available to cover bank risks (credit, operational, and market risks), and they are classified as Tier 1, Tier 2, and Tier 3. The Basel II Accord retains the requirement that banks maintain capital of at least 8% of total risk-weighted assets.

Tier 1 capital, or core capital, is comprised of shareholders' equity and disclosed reserves (i.e., retained earnings). Equity includes common stock outstanding, as well as any outstanding preferred stock that is nonredeemable and noncumulative.

Tier 2 capital, or supplementary capital, is comprised of other assets or equity (e.g., cumulative preferred stock) that may be available to protect depositors, but involve a mandatory charge against future income or have a limited life. Tier 2 capital includes items such as undisclosed reserves, revaluation reserves, general provisions/general loan-loss

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reserves, hybrid debt capital instruments, and subordinated term debt. Obviously, these sources could be used to offset losses, but they are not as certain as Tier 1 capital sources.

Tier 3 capital, or short-term subordinated debt, can *only* be used to meet capital requirements related to market risks. To qualify as Tier 3 capital, short-term subordinated debt must be unsecured, not in arrears, and have been issued with a maturity of two years or more. The debt must also have a covenant limiting interest or principal payments to investors if such payments would impair the bank's minimum capital requirement.

There are no limitations on how Tier 1 capital is used to meet capital requirements. Tier 2 capital is limited to 100% of Tier 1 capital. The Basel II Accord recommends that Tier 2 and Tier 3 capital together be no greater than Tier 1 capital, but leaves this decision up to the regulators in the banks' home country.

Professor's Note: Tier 3 capital will be phased out under the new Basel III capital standards.

Credit Risk Capital Requirements

LO 58.2: Describe and contrast the major elements of the three options available for the calculation of credit risk: Standardized Approach, Foundation IRB Approach and Advanced IRB Approach.

The **Standardized Approach** incorporates risk weights based on external credit rating assessments. The idea is to ensure independent external risk assessments in the calculation of risk weights and give issuers the incentive to seek those externally generated risk assessments. In general, greater risk exposures imply higher risk weightings. For sovereign credits, credit scores of export credit agencies are recommended. Preferential treatment of short-term credit exposures is also recommended. Corporate credit risk weights are substantially expanded. The Committee recommends that bank credits never receive a risk weight less than that applied to the sovereign with which the bank is incorporated. If no external weighting is applied to a certain risk exposure, the Standardized Approach mandates a risk weighting of 100%. This means that the *full* 8% capital requirement applies to that exposure. In addition, loans considered past due are required to be weighted at 150% to reflect their greater risk profile, unless the bank has already set aside provisions for that loan.

Under Basel I, a financial institution's risk categorization depended on whether it was in a country that was an Organization for Economic Co-operation and Development (OECD) member. Non-members had to hold more capital against a credit risky position than members. This created an unfair advantage for OECD banks.

Under the new proposed Basel II regulations, the amount of capital that a bank must hold is specific to the risk of their credit risky assets, the type of institution the claim is written on, and, in the case of claims on banks, the maturity of those assets. These new guidelines are obviously a refinement relative to the original Basel regulations.

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In the case of claims on banks, supervisors have two options to determine the amount of capital that must be held. In option 1, the risk weighting used is one category less favorable than for that of the bank's country (for the higher credit quality assets). The risk weights are the same for assets of lower or unrated quality. In option 2, the bank can pick an external credit rating and use this to determine risk weightings. Note that shorter maturity (three months or less) assets generally receive more favorable treatment (less capital is required to be held).

Given the below risk weights for individual credit-risky assets, the capital requirement under the Standardized Approach is calculated as: asset value × risk weight × 8%.

Figure 2: Minimum Risk Weights for Claims on Sovereigns and Their Central Banks

Credit Evaluation	*AAA to AA–*	*A+ to A–*	*BBB+ to BBB–*	*BB+ to B–*	*Below B–*	*Unrated*
Risk weight	0%	20%	50%	100%	150%	100%

Figure 3: Minimum Risk Weights for Claims on Banks—Options 1 and 2

Credit Evaluation of Sovereign	*AAA to AA–*	*A+ to A–*	*BBB+ to BBB–*	*BB+ to B–*	*Below B–*	*Unrated*
Risk weight (1)	20%	50%	100%	100%	150%	100%

Credit Evaluation of Banks	*AAA to AA–*	*A+ to A–*	*BBB+ to BBB–*	*BB+ to B–*	*Below B–*	*Unrated*
Risk weight (2)	20%	50%	50%	100%	150%	100%
Risk weight for short-term claims (2)	20%	20%	20%	50%	150%	20%

Figure 4: Minimum Risk Weights for Claims on Corporations

Credit Evaluation	*AAA to AA–*	*A+ to A–*	*BBB+ to BB–*	*Below BB–*	*Unrated*
Risk weight	20%	50%	100%	150%	100%

The **internal ratings-based** (IRB) **approaches** (foundation and advanced) for calculating risk weights are an attempt to recognize an individual bank's risk profile in the calculation of capital requirements. The IRB approaches use a bank's own internal estimates of creditworthiness to determine the risk weightings in the capital calculation. The IRB approaches are a significant feature of the Basel II Accord, as they are an attempt to allow more customized (and hopefully more accurate) risk profiles. So far, however, those banks choosing the IRB approach are opting for the lower flexibility of the foundation IRB, rather than the advanced IRB. As was mentioned, the IRB approach can be beneficial for banks since it has the potential to reduce the capital requirement because a bank's own estimates of risk may be lower than those calculated using the standardized approach.

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There are three issues to address in the IRB framework:

1. *Risk components*, which are risk parameter estimates, either developed internally or taken from supervisory estimates.
2. *Risk weight functions*, which take the risk components and translate them into risk-weighted assets.
3. *Minimum requirements*, which are standards that must be met before a bank is eligible to use an IRB approach.

The foundation approach is an IRB method with heavy reliance on supervisory estimates. The only parameter estimated by the bank is **probability of default** (PD). The advanced approach allows banks to estimate not only PD, but also **loss given default** (LGD), **exposure at default** (EAD), and **effective maturity** (M). Under either approach, the bank must use the risk weight functions to derive capital requirements.

As mentioned, under the foundation IRB approach, banks estimate probability of default (PD). The IRB risk weights in turn depend on these default estimates. For example, when considering corporate loans, the foundation IRB approach produces the following risk weights:

PD	*Risk Weight*
0.03%	14.44%
1%	92.32%
5%	149.86%
20%	238.23%

While it is unlikely that you will be tested on these exact risk weightings, you should understand the correlation between default probability and risk weight. As with the Standardized Approach, as probability of default increases, so does the risk weight. Regarding the advanced IRB approach, the capital charge is calculated by multiplying risk weight by EAD and then multiplying that amount by 8%.

Both IRB methods treat corporate, bank, and sovereign risks similarly, but treat retail, project finance, and equity exposures in a different framework.

Corporate, sovereign, and bank **exposures**. The IRB methods of calculating risk-weighted assets rely on four key quantitative inputs:

1. Probability of default (PD).
2. Loss given default (LGD).
3. Exposure at default (EAD).
4. Maturity (M) of the exposure.

The IRB approach allows the bank to use its own internal measures of credit exposure to rate specific borrower default. A PD is generated to represent a long-run average PD for all borrowers in similar risk classes. Unfortunately, PD does not fully incorporate the risk exposure to the bank. Recovery rates also play a role in measuring the bank's exposure and are incorporated into an LGD measure for the credit. The exposure to a particular borrower also plays a role and is incorporated into the EAD estimate.

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LGD and EAD estimates in the foundation IRB approach are set by supervisory rules. However, banks are allowed to set LGD and EAD estimations using the advanced IRB approach if they meet rigorous requirements. These requirements relate to documenting how PDs are generated and justifying their use. Documentation of the process in PD calculations moves the decision making from a purely quantitative process to a more qualitative process.

- **Retail exposures.** The Committee proposes the IRB approach for retail exposures be distinct from those previously mentioned. For retail exposures, there is only one advanced IRB approach and no foundation IRB alternative, meaning that the PD, LGD, and EAD inputs that go into the retail exposure calculation are all determined by the bank. In general, a bank is expected to be more attuned to the risks associated with the retail loans they make that have either a consumer or business focus. Banks are expected to make objective definitions of retail exposures based on borrower and product characteristics, which are segmented along similar risk characteristics. The bank can then make estimates of risk exposure according to pools of similar risks, rather than estimating the exposure for each individual asset.

  Retail exposures are divided into three main categories: (1) exposures secured by residential mortgages; (2) qualifying revolving retail exposures, which include most credit card assets; and (3) other exposures that include loans made to small businesses.

- **Project finance exposures.** These risk weightings are more problematic because repayment depends on performance of the underlying project. The New Accord allows for two potential methods to determine project finance exposures. The first is to simply use the same methodology used for assessing corporate risk exposures as previously described. If the bank cannot estimate all of the relevant data inputs, it can classify the exposure into one of five quality grades where the risk weighting for each grade is predetermined by the Basel Committee.

- **Equity exposures.** Risk weightings for equity exposures are difficult to generate, given their heterogeneous behavior. There are two potential methods that can be used to determine equity risk exposure. The first is based on the PD/LGD corporate exposure methodology, while the second allows banks to model their equity market risk over a quarterly holding period.

Under the IRB framework, banks need to set up a credit risk control function which is responsible for overseeing the selection of internal ratings. This credit risk control function should: (1) test and monitor internal ratings, (2) prepare reports which incorporate historical default probabilities and ratings migrations, (3) ensure that ratings are applied in a consistent fashion, and (4) document any changes to the ratings process.

Expected and Unexpected Loss

In performing their own internal estimates of LGD and EAD, credit institutions must estimate average or expected annual losses based on historical data relating to defaults. **Expected loss** (EL) is a cost component of credit business, and should be covered in the institution's regular course of business, meaning it should be covered by loan loss provisions and write-offs. **Economic capital/regulatory capital** is used for unexpected variations from expected losses called **unexpected losses** (UL). An example of an "unexpected loss" is when there is a general economic downturn, and several borrowers simultaneously default on the same loan type.

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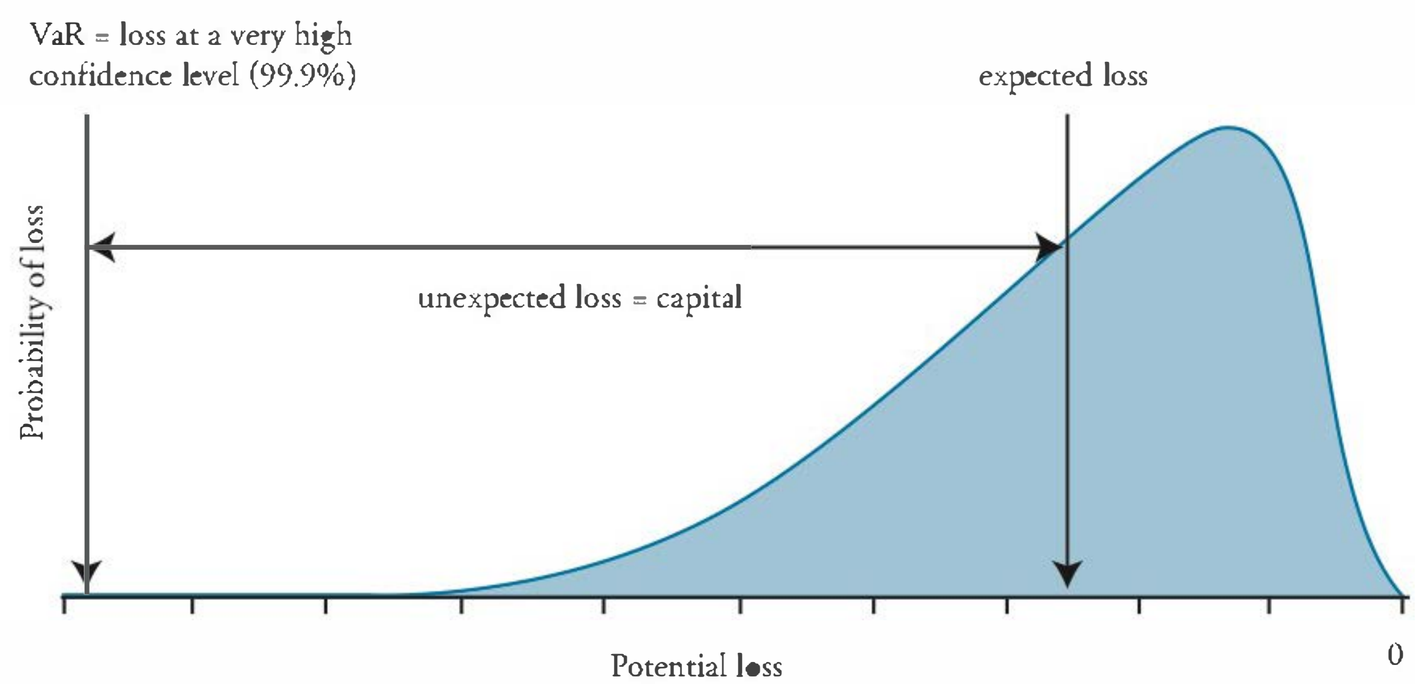
The unexpected loss calibration has two results. First, banks must show they have adequately reserved for EL. Second, banks do not need to maintain reserves for defaulted loans. This second result arises because the Basel risk model employs an LGD, which is a constant—defaulted loans are covered there. To offset this second result, the Committee recommends that LGD estimates rely *not* on historical default rates, but on more conservative estimates assuming economic downturns.

Credit institutions must now estimate **downturn LGD**, which is an estimate of probable losses due to an unexpected economic downturn. This downturn LGD concept is relatively new as it relates to internal risk management. Comparisons will need to be made between average LGD and downturn LGD to determine how far apart the estimates are and what asset classes are most likely affected.

As has been noted, expected loss and unexpected loss are covered with the bank's total economic resources (i.e., capital plus reserves). Under the IRB framework, banks must use a confidence level of 99.9% (over a 1-year time horizon) when calculating value at risk. The confidence level is set very high since it is the percent chance that the bank will remain solvent during the next year. From the loss distribution in Figure 5, you can see that the difference between value at risk and expected loss is the bank's unexpected loss (i.e., required capital). You can also see that the probability of expected loss events is greater than unexpected loss events but the severity of those expected losses is much less.

Figure 5: Value at Risk (VaR)



IRB Risk Weight Function

Risk weight functions are used to assess risk and determine capital adequacy. The following list contains the necessary conditions for the IRB credit risk weight function. The capital requirement model is presented shortly with detailed explanations of the variables.

Conditions for the IRB credit risk weight function:

- Expected losses are covered by provisions or revenue.
- Unexpected losses will be covered by bank capital.
- Unexpected losses will exceed capital at a small pre-determined acceptable probability (i.e., above the chosen confidence level).

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- Risk weights should be **portfolio invariant** (i.e., the calculation of loan risk is independent of the portfolio). Any correlation with other assets in the portfolio is not explicitly included in risk estimation. This simplifies the calculation of capital since each loan is independent of the portfolio that it is being added to. Difficulties including diversification under this assumption are offset by calibrating the risk weight function for a well diversified bank. The supervisory process then adjusts the required capital based on a firm specific assessment of diversification.
- All systematic risks are modeled by a single risk factor; all idiosyncratic (unsystematic) risks tend to cancel out each other.
- Portfolios are composed of numerous diverse exposures.

The capital requirement for credit risk under the IRB framework is computed as follows. This model is known as an asymptotic single risk factor (ASRF) model.

capital requirement (K) = (conditional EL – EL) × (maturity adjustment) =

$$[\text{downturn LGD} \times N\{\sqrt{\frac{1}{1-R}} \times G(PD) + \sqrt{\frac{R}{1-R}} \times G(0.999)\} - \text{LGD} \times PD] \times \frac{[1 + (M-2.5)] \times b(PD)}{1 - 1.5 \times b(PD)}$$

- **Conditional EL – EL**: Conditional EL includes EL and UL, the difference between conditional EL and EL results in the necessary capital for UL only. Regulatory guidelines require EL to be covered by provisions and earnings and therefore, should not be used to estimate capital.
- **Conditional EL** = downturn LGD × conditional PD.
- **LGD**: Estimates should reflect losses incurred during an economic downturn, effectively a "downturn LGD."
- **Conditional PD** = N{…}: Average PDs are transformed into conditional PDs using a regulatory mapping function including a single systematic risk factor and asset correlations. *N* is the normal distribution. The mapping function uses the Merton model[1] to determine a conditional PD.
  - **The conditional default threshold**: The correlation weighted sum of the default threshold G(PD) and the systematic risk factor is used to calculate the conditional PD. *G* is the inverse normal distribution.
  - **R**: Asset correlation to the single systematic risk factor. High correlation is often associated with large corporate loans as corporate returns are closely related to systematic conditions. Asset correlations increase with firm size. Larger firms demonstrate more systematic risk; this applies to corporates, not banks or sovereigns. An example of low correlation assets are retail loans, as they demonstrate high idiosyncratic risk and less association with the general market or other portfolio exposures. Similarly, asset correlations decrease with higher PDs as higher PDs suggest more idiosyncratic risk.
  - **0.999**: Systematic risk factor, identical for all assets. This implies a confidence level (CL) of 99.9% or a default threshold of 0.1%. The CL is set high in case of bank parameter estimation errors.
- **EL** = LGD × PD.
- **PD**: Average probability of default, reflecting expected default rates under normal business conditions.

1. R. C. Merton, "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," *Journal of Finance* 29 (1974): 449–470.

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- **Maturity adjustment**: Long-term credits are riskier than short-term credits and therefore, capital requirements should increase with maturity, *M*. For M = 1, the maturity adjustment equals one and drops out, consistent with the foundation IRB approach. The standard maturity is set at M = 2.5 years.
  - **b(PD)**: Maturity effects are increased with low PDs because, intuitively, low PDs have more opportunity for downgrades than higher PDs.

Credit Risk Mitigation

One intent of the Basel II Accord is to increase supervisory recognition of credit risk mitigation practices. One way to accomplish this is by using collateral to reduce the capital charge.

There are basically two approaches:

1. The **simple approach**, where the risk weight of the collateral is used in lieu of the borrower's risk weight for the secured portion of the exposure.
2. The **comprehensive approach**, where the value of the collateral is adjusted periodically, and that value is deducted from the exposure.

Credit risk mitigation techniques include:

- *Financial and physical collateral*. For example, adjust risk exposure assigned by the value of the collateral. *Haircuts* may be taken periodically to adjust for decline in value of collateral.
- *Receivables*. Capital charge can be reduced by the value of the receivables.
- *Guarantees and credit derivatives*. For example, these are risk weighted by assigning a reduced risk weight of the guarantor to the secured portion of the loan.

Using the foundation IRB Approach, collateral is accounted for through a reduction in LGD. Specifically, the "effective" loss given default is equal to current loss given default times the quantity of exposure after risk mitigation divided by current exposure. As an expression: $LGD_{RM} = LGD \times (E_{RM} / E_C)$.

Asset Securitization

Asset securitization has become a popular method for redistributing risks to other parties. The securitization process essentially requires originators to legally and economically transfer assets or obligations to a third party, termed a **special purpose vehicle** (SPV). The SPV then issues securities that are claims on the pool of transferred assets. To receive the appropriate treatment of capital requirements, the issuing bank must make a "clean break" with the assets transferred and disclose all relevant quantitative and qualitative information associated with the assets.

The Standardized Approach to estimating securitization exposures treats assets rated Baa3 or better similar to other credit risks. Riskier assets have higher risk weights applied, and if an asset has no external rating, then there is a direct deduction to capital (half to core capital and half to additional capital).

The IRB approach to estimating securitization exposures does not allow internal estimates of PD, LGD, or other parameters. Therefore, there is no difference between the foundation

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IRB and advanced IRB as far as securitization risk is concerned. Instead, the IRB approach allows three methods to calculate the capital requirement:

1. **External Ratings-Based Approach** (RBA). This approach must be used by any IRB bank that has an external rating of its risk assessment. The RBA approach treats originators and investors the same. The RBA does allow for a range of risk weights for each rating category.
2. **Supervisory Formula** (SF). The exposure is based on the capital requirement for the underlying assets had they not been securitized. However, the bank is able to adjust this exposure for credit enhancements and a weighted average LGD. The "thickness" of a given exposure is the percentage of the tranched exposure within the entire pool of exposures.
3. **Internal Assessment Approach** (IAA). This is permitted only in limited situations with specific permission of the supervisory authority. The bank calculates its capital requirement by applying its own internal risk assessment to the rating system of a major external rating agency. The bank then uses the RBA to risk weight the exposures. Both the IAA and SF approaches can be used on unrated exposures, and these approaches can reduce the negative effect on required capital arising from unrated securities.

The IRB approach to risk weighted asset securitization is similar to other IRB frameworks. The greater sensitivity to risk exhibited by IRB-generated weights is maintained in the asset securitization application. The risk weights used depend largely on the asset quality of the underlying pool and any credit enhancements that are available to absorb losses. For issuing banks, a key component is the amount of capital the bank would have been required to maintain on the underlying pool of assets if they had not been securitized. The full amount of any first-loss position (losses the bank must absorb before other security holders bear losses) is deducted from regulatory capital.

Market Risk Capital Requirements

LO 58.4: Describe and contrast the major elements—including a description of the risks covered—of the two options available for the calculation of market risk: Standardized Measurement Method and Internal Models Approach.

There are two methods used to calculate market risk capital charges: the standardized method and the internal models approach (IMA).

Standardized Measurement Method

This approach first determines the capital charges associated with various market risk exposures. These market risks include: equity risk, interest rate risk, foreign exchange risk, commodity risk, and option risk. The market risk capital charge for each market risk is computed as 8% of its market-risky assets. The bank's total risk charges can then be found by summing the capital charges of all market risks.

Since the market risk charge from the standardized method is simply a sum of all market risk charges, diversification effects are ignored. The inability to recognize diversification benefits has led many banks to use internal models.

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Internal Models Approach (IMA)

The IMA approach allows a bank to use its own risk management systems to determine its market risk capital charge. Banks are motivated to use the internal models approach since it may produce a lower capital charge than the standardized method. However, in order to use this approach, banks must satisfy certain requirements set forth by regulators. These requirements include: internal oversight, backtesting of output, stress testing, and setting exposure limits.

After these requirements are satisfied, market risk charges can be computed. The market risk charge is set in one of two ways: it is the higher of (1) the previous day's VaR (based on 10 trading days), or (2) the average VaR over the last 60 business days adjusted by a multiplicative factor (subject to a floor of 3). If VaR is continually underestimated, a penalty factor, called a plus factor, is added to this multiplier. The multiplicative factors that include a penalty for exceptions are discussed shortly. The market risk capital charge under this approach is thus average VaR times a multiplicative factor plus a specific risk charge that covers idiosyncratic market risks.

Backtesting VaR

If an institution is using a VaR approach to model its market risk exposure, that model must be backtested. The bank must backtest daily results where the daily change in exposure is compared to the previous day's VaR estimate. If the day's change in value exceeded the VaR estimate of the previous day, an exception has occurred. For a 1-year period, there would be 250 days tested.

The results of the backtest just described are evaluated, and a cumulative total of exceptions is determined for the 250-day testing period. Based on the number of exceptions, the bank's exposure is categorized into one of three following zones and VaR is scaled up by the appropriate multiplier.

- Green zone: 0–4 exceptions, increase in exposure multiplier is 0.
- Yellow zone: 5–9 exceptions, exposure multiplier increases as follows:

Exceptions	*Increase in Multiplier*
5	0.40
6	0.50
7	0.65
8	0.75
9	0.85

- Red zone: Greater than or equal to 10 exceptions, multiplier increases by 1.

These plus factors are added to the multiplicative floor of 3 stated in the IMA approach. So for 250 days, if VaR is exceeded 10 or more times the multiplicative factor for the average VaR amount will be 4 (= 3 + 1). If a bank's model consistently generates a high number of exceptions, the bank should revisit the model and adjust it as needed.

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Professor's Note: You could also find the number of exceptions if you know the confidence level for VaR and the number of days in a testing period. For example, if you are given a 90% confidence level with a 250-day testing period the number of exceptions would be: (1 – 0.90) × 250 = 25 days. In other words, we would expect VaR to be exceeded 25 days in a 250 day period.

Operational Risk Capital Requirements

LO 58.3: Describe and contrast the major elements of the three options available for the calculation of operational risk: Basic Indicator Approach, Standardized Approach and Advanced Measurement Approach.

The Basel Committee decided to incorporate risks other than just credit or market risks in its suggestions for calculating regulatory capital. The specific term for these other risks is operational risk, which the Basel Committee defined explicitly as "the risk of direct or indirect loss resulting from inadequate or failed internal processes, people and systems or from external events." In its broadest terms, any risk that cannot be classified as a market or credit risk can be classified as operational risk. However, it should be noted that under Basel II, reputational risk is not included in the definition of operational risk.

Operational risks are much more difficult to quantify compared to credit or market risks. However, the Basel Committee believes that including operational risk in a bank's capital calculation will encourage the development of methods to assess operational risks and ensure that banks are holding capital that is sufficient to cover those risks. The Committee proposed a continuum of approaches to calculating capital requirements for operational risk. This continuum is defined along the level of sophistication used in quantifying operational risks:

- **Basic Indicator Approach** (BIA). The BIA measures the capital charge on a firmwide basis. Banks will hold capital for operational risk equal to a fixed percentage of the bank's average annual gross income over the prior three years. This fixed percentage is also known as the alpha factor.

  $$\text{operational risk charge (under BIA)} = \text{alpha factor} \times \text{GI}$$

  The Basel Committee has proposed that the alpha factor should be equal to 15%.

- **Standardized Approach** (SA). SA builds on the BIA by allowing banks to divide activities along standardized business lines. Within each business line, gross income will be multiplied by a fixed percentage. The percentage differs across business lines. The capital charge for operational risk is the sum of each business line's charges.

  The Standardized Approach divides bank activities into eight business lines. Each business line's gross income is multiplied by a fixed percentage (known as the beta factor).

  $$\text{operational risk charge (under SA)} = \sum \text{beta factor}_i \times \text{GI}_i$$

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The beta factors for the eight business lines are as follows:

Trading and sales	18%
Corporate finance	18%
Payment, settlement	18%
Commercial banking	15%
Agency services	15%
Retail banking	12%
Retail brokerage	12%
Asset management	12%

- **Advanced Measurement Approach** (AMA). If a bank can meet more rigorous supervisory standards, it may use the AMA for operational risk capital calculations. The AMA is similar to the IRB approach for determining credit risk in that banks use their own methodologies for assessing operational risks. The Basel requirements for the AMA are extremely flexible as long as the approaches are comprehensive in addressing operational risks and systematic in their implementation. The guidelines for implementing the AMA are intentionally broad in hope that banks will develop their own sophisticated methods for measuring operational risk that will evolve over time.

Professor's Note: Under AMA, internal measures must be based on a minimum of five years of data. However, when a bank first moves to the AMA only three years of internal data is needed.

The capital charge for AMA is calculated as the bank's operational value at risk (OpVaR) with a one-year horizon and a 99.9% confidence level. It should be noted that having insurance can reduce this capital charge by as much as 20%. Recall from Topics 43 and 44, that under AMA, firms are encouraged to use the loss distribution approach (LDA). Other methods that could be used to capture "tail events" include scenario analysis and historical loss events.

Pillars of Sound Bank Management

LO 58.1: Describe the key elements of the three pillars of Basel II: minimum capital requirements, supervisory review and market discipline.

Pillar 1: Minimum Capital Requirements

Pillar 1, minimum capital requirements, is mainly concerned with measuring the risk exposures of individual credits in which banks invest. Recall that there are two fundamental approaches to assessing the capital requirements according to the level of risk associated with credit risks. The first approach is the Standardized Approach, which is driven by credit ratings published by external credit rating agencies. The second approach is one that allows banks to use an IRB approach, where the individual lender assesses variables such as creditworthiness, maturity, and concentration associated with default.

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The evolutionary aspect of Pillar 1 relates to the desire of the Committee to see lending institutions move from the Standardized Approach to the IRB approach when assessing risk weightings and measures. Within the IRB approach, the Committee would like to have banks move from the foundation approach to the advanced approach when setting regulatory capital requirements. In this way, it is hoped that individual institutions will formulate more sophisticated risk management procedures that have a greater degree of accuracy in assessing risk exposures. As the international banking industry continues to change faster than the rules and regulations that govern the industry, the hope is that banks, using their own risk management models, will have risk assessment capabilities that will keep up with the changes in the marketplace.

Pillar 2: Supervisory Review Process

The Second Pillar of the New Accord relates to how banking supervisors interact with banking managers and their internal banking management procedures. The main purpose of Pillar 2 is to ensure internal processes appropriately assess capital adequacy. According to the Second Pillar, banking supervisors are responsible for determining how well banks are assessing their risks in relation to the level of capital required. Capital adequacy is not a substitute for sound procedures. The Second Pillar includes not only the assessment of risks (calculation of required capital), but outlines how an institution identifies deficiencies in its operations and what actions will be taken to reduce risk and restore capital on an ongoing basis. There are four key principles to the **Supervisory Review Process** (SRP):[2]

Principle 1: *Banks should have a process for assessing their overall capital in relation to their risk profile and a strategy for maintaining their capital levels.*

The capital adequacy assessment process should include:

- Policies and procedures to ensure relevant risks are identified.
- Procedures for relating bank strategies and the level of capital for risks undertaken.
- Internal controls.
- Reviews and audits to ensure integrity of the overall management system.

The responsibility of this process rests with bank management, who not only need to document their procedures, but must also be mindful of the economic cycle in which business transactions are undertaken. Stress tests to identify events that may adversely affect their capital position should be carried out on an ongoing basis.

Principle 2: *Supervisors should review and evaluate banks' internal capital adequacy assessments and strategies, as well as their ability to monitor and ensure their compliance with regulatory capital ratios. Supervisors should take appropriate supervisory action if they are not satisfied with the results of this process.*

The purpose of this principle is to guide supervisors in carrying out their supervisory roles. Specifically, supervisors should:

- Relate sensitivity analyses and stress tests to the bank's capital.
- Evaluate how management has prepared for expected and unexpected events and their impact on capital.
- Appraise whether target capital levels are properly monitored and reviewed by internal management procedures and senior management officials.

2. International Convergence of Capital Measurement and Capital Standards, Bank for International Settlements (June 2004): 39.

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Principle 3: Supervisors should expect banks to operate above the minimum regulatory capital ratios and should have the ability to require banks to hold capital in excess of the minimum.

Supervisory personnel should have the ability to ensure that banks are operating with adequate levels of capital. Setting triggers or targets for various operational definitions is encouraged. Individual countries and their regulators may want to set ratios higher than those specified as the minimum in the New Accord.

Principle 4: Supervisors should seek to intervene at an early stage to prevent capital from falling below the minimum levels required to support the risk characteristics of a particular bank, and should require rapid remedial action if capital is not maintained or restored.

To ensure minimal capital adequacy, the New Accord suggests that supervisors:

- Increase the frequency and intensity of bank monitoring activities.
- Restrict dividend payments.
- Require the bank to prepare and implement a capital restoration plan.
- Require the bank to raise additional capital immediately.

As a consequence of increasing the validity of banks' internal control procedures, the New Accord treats market risks like interest rate risk as a factor to be analyzed and evaluated under Pillar 2. Specifically, a bank's internal procedures for assessing interest rate risk are incorporated into the overall procedures for risk assessment. Banks must provide results of sensitivity analyses or stress tests to indicate the level of capital that should be maintained in the event of an adverse movement in interest rates (e.g., banks must provide an analysis of the impact of a 200 basis point shock to their capital position).

The supervisors' duties, as a part of the Supervisory Review Process, include the following:

- Check compliance with Pillars 1 and 3, including internal risk management processes, credit risk easing or mitigation, and transparency requirements.
- Assess risks which either are not included or are not properly covered in Pillar 1, including legal risks, documentation risks, liquidity risks, credit concentration risks, and operational risks. Legal risk, documentation risk, and liquidity risk are **residual risks** that may arise when credit risk mitigation (CRM) techniques are applied. For example, the inability to secure collateral would be a residual risk. Recall that CRM techniques are designed to reduce credit risks, however, if collateral is unable to be seized; the risk reduction strategy would prove to be ineffective.
- Assess the internal capital management methods employed by the bank, including their adequacy and whether or not higher capital levels are required.
- Review internal control systems.

Professor's Note: Concentration risk needs to be assessed as part of the Supervisory Review Process since it may not be properly covered under Pillar 1. This risk results from a disproportionately large exposure to a single obligor or a disproportionately large exposure to a common sector.

Pillar 3: Market Discipline

The Third Pillar relates to the disclosure of relevant information so that market discipline can come to bear on capital adequacy regulation and other supervisory activities to ensure safety, soundness, and efficient economic activities in the overall banking system. The

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Committee believes that enhanced transparency benefits all banking and financial system participants. The specific disclosure recommendations are concerned with providing relevant and timely information about banking-related activities.

Procedures mentioned in the New Accord to enhance market discipline and the way it relates to the banking sector include:

- The requirement of general disclosures with specific remedial actions in the case of nondisclosure.
- The introduction of "strong recommendations" if disclosures are not required.
- The provision of guidelines for formal disclosure policy supported by a bank's board of directors. This disclosure policy should include information related to the bank's financial condition and performance, and assessment of the effectiveness of the disclosures.
- The requirement of banks to regularly publish financial statements that fairly reflect their financial condition.
- The specification of remedial guidelines for nondisclosure.
- The recognition of cost-benefit tradeoffs between releasing too much information and not enough information.
- The dissemination of relevant material information between periodic disclosures.
- The recognition of the cost-benefit tradeoffs between releasing proprietary information and creating an undue burden on the industry.
- The alignment of disclosure information with national accounting standards.

Areas of Continuing Research

Basel II is designed to improve the measurement of risk over the original Basel Accord, through improved methodologies and the inclusion of a wider variety of risks. However, the implementation of the new Accord may have several negative externalities, including:

1. Unintended incentives for bad bank behavior in the global banking system.
2. Concerns over a variety of approved methodologies included in Pillar 1.
3. Issues relevant to the implementation of Pillar 2 (Supervision) and Pillar 3 (Market Discipline).

First, Basel II may encourage suboptimal behavior by banks operating or domiciled in emerging markets. The new Accord includes standardized risk variables in the IRB approach. These variables have been very carefully calibrated to accurately assess risk, usually based on a G-7 country. The potential problem arises when these same standardized variables are used for banks operating in emerging markets. The calibration of risk variables will frequently be inaccurate for this specific application. For example, interest rate risk premia are included in the IRB approach when short-term rates exceed a certain volatility. Most emerging markets demonstrate higher levels of volatility more frequently than developed economies, leading to the undesired result of understated risk and required capital. Further, the favorable estimation of risk may discourage banks from migrating to the advanced risk measurement models, which is a stated goal of Basel II.

Second, Basel II may contribute to procyclical behavior by banks. Procyclicality is defined by easy credit in good times and tougher credit in bad times when borrowers may need credit most. The IRB approach models credit risk as a function of debtor's income, which probably moves with the business cycle. Procyclical behavior existed in banks prior to Basel II, but there is concern this behavior will be more dramatic under Basel II.

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Additionally, the implementation of Basel II may affect many aspects of bank decision making across the firm. As Basel models are employed, their use may extend beyond initial applications, providing information for bank wide decision making. Last, the transparency requirement of Pillar 3, in conjunction with risk models, may lead the bank to manage the output of their risk measurement system.

Pillar 2 and Pillar 3 Implementation Issues

Pillar 2 is the key component of the regulatory framework and should bring balance to the model by providing a clear interpretation of the result of the analytical models and clear signals to the market. Supervision, not analytics, will determine the required capital for each bank, including necessary adjustments for institutional differences. Pillar 3 is dependent on clear public information. Numerous studies suggest VaR risk measures provide information useful for valuation; however, it is unclear that VaR is the best risk measure. Currently, accounting standards are non-transparent and foster inconsistent evaluations by bond raters and equity analysts. As accounting standards and risk measurement systems develop more accurate and consistent information, the market mechanism will be more useful.

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Key Concepts

LO 58.1

The Committee desires Pillar 1 to be an evolutionary concept in which banks will move from the standardized approach of risk assessment to the more advanced approaches put forth in the IRB approach.

Pillar 2 moves from a quantitative to a qualitative focus and addresses the Supervisory Review Process. Suggestions are made regarding banking supervisory activities and the relationship with bank management. However, the emphasis on operational processes is much greater than the emphasis on calculating capital adequacy.

Pillar 3 is concerned with efficient and effective bank activity disclosure to enhance market discipline of banking regulation and individual banking business endeavors. The ultimate objective is to allow market discipline to effectively regulate individual banking activity to ensure the safety and soundness of the banking and financial systems.

LO 58.2

Credit risk capital requirements are calculated using either the Standardized Approach or IRB approach. The Standardized Approach is based on external credit ratings to generate risk weightings. The IRB approach proposes either the foundation or advanced approach, where the bank generates its own inputs to determine risk weightings.

As part of the IRB approach, banks should consider loss scenarios based on economic downturns rather than just using historical averages.

Asset securitization has grown in popularity as a way to transfer risk from one party to another. The Basel II Accord allows three methods to reflect securitization in the capital requirement: (1) the external Ratings-Based Approach (RBA), (2) Supervisory Formula (SF), and (3) the Internal Assessment Approach (IAA).

LO 58.3

The Basel II Accord addresses operational risks, in addition to credit and market risks, in calculating capital requirements. Although more difficult to quantify than credit or market risks, operational risk calculations are based on a continuum of calculation sophistication. The basic indicator, standardized, and advanced measurement approaches have been suggested as markers along the sophistication continuum for calculating operational risk impacts on required capital.

LO 58.4

Basel II requires backtesting of VaR approaches, which results in different "zone" classifications depending on the accuracy of the VaR model forecasts in predicting risk.

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LO 58.5

There are three types of capital: Tier 1 is the equity of the institution, Tier 2 is supplementary equity capital, and Tier 3 is short-term debt that can be used to cover market risks.

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Concept Checkers

1. Tier 2 capital would include:
   A. both cumulative preferred stock and loan loss reserves.
   B. cumulative preferred stock, but not loan loss reserves.
   C. unused loan loss reserves, but not cumulative preferred stock.
   D. neither cumulative preferred stock nor loan loss reserves.

2. Credit risk mitigation techniques under the Basel II Accord include which of the following?
   I. Adjusting required capital for changes in the value of collateral.
   II. Using the risk weight of the collateral in lieu of the borrower's risk weight for the secured portion of the exposure.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

3. The Basel II Accord requires a supervisory backtesting framework with all of the following components except:
   A. seven zones with different plus factors.
   B. verifies daily deviations from estimated VaR.
   C. extends over a 1-year period (i.e., 250 trading days).
   D. a multiplier that is subject to a floor of three.

4. The "evolutionary aspect" behind Pillar 1 of the New Accord relates to moving from the:
   A. Standardized Approach, to the advanced internal ratings-based approach (IRB), to the IRB foundation approach.
   B. IRB foundation approach, to the advanced IRB approach, to the Standardized Approach.
   C. Standardized Approach, to the IRB foundation approach, to the advanced IRB approach.
   D. IRB foundation approach, to the Standardized Approach, to the advanced IRB approach.

5. The Supervisory Review Process does not include which of the following elements?
   A. Verifying compliance with Pillar 2.
   B. Reviewing internal control systems.
   C. Assessing operational risks.
   D. Assessing credit concentration risk.

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Concept Checker Answers

1. A Tier 2 capital includes assets that are available to protect depositors, but involves a charge against future income or has a limited life. Cumulative preferred stock involves a charge against future income, and loss reserves have a limited life, so both would be included in Tier 2 capital.

2. C Credit risk mitigation techniques can be either simple or comprehensive. Under the simple approach, the risk weight of the collateral is used in lieu of the borrower's risk weight for the secured portion of the exposure. Under the comprehensive approach, the value of the collateral is adjusted periodically and that value is deducted from the exposure.

3. A The backtesting framework only includes three zones: green, yellow, and red. The plus factor determined from these zones is added to the multiplier floor of three.

4. C The Committee envisions that more sophisticated risk measures will allow banks to move from calculating capital adequacy using the Standardized Approach, to using the IRB foundation approach, to using the advanced IRB approach.

5. A The Supervisory Review Process is Pillar 2 and should include verifying compliance with Pillars 1 and 3.

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

Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems

Topic 59

Exam Focus

This topic addresses changes made by the Basel Committee on Banking Supervision to address risk in the banking industry. The Basel III framework seeks to promote a more resilient banking sector. Changes are broad and encompass increases in both the quantity and quality of bank capital, as well as strengthening the risk coverage of the capital framework. The Committee has included buffers to protect the system in times of significant stress. They will also require a simple, non-risk based leverage standard for banks and will require that banks maintain both short-term and long-term stable funds to protect against liquidity crunches. One of the key problems of the recent financial crisis was how quickly it spread from the financial sector to the real economy. As such, the Committee is providing mechanisms to address systemic risk in financial markets.

Basel III Changes

LO 59.1: Describe reasons for the changes implemented through the Basel III framework.

Representatives of central banks and bank supervisory authorities from across the globe make up the Basel Committee on Banking Supervision. The Committee has instituted a broad range of changes, enacted to strengthen both the capital and liquidity positions of banks worldwide. The stated goal of the Committee is to *promote a more resilient banking sector.*

Professor's Note: In this summary, the word "bank" will be used to represent any financial institution that has regulated capital.

There are several reasons the Committee has acted at this time, many of which are related to the problems that lead to and exacerbated the recent financial crisis. They are as follows:

- Excessive on- and off-balance sheet leverage at banks worldwide.
- A gradual erosion of the amount of capital and the quality of the capital base in banks across the globe.
- Insufficient liquidity at many banks, which made it impossible for the banking system to absorb the shocks and ultimate trading and credit losses.

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- The inability of the banking system to handle the large off-balance sheet exposures that had been created over time but had to be dealt with in a relatively short time frame. The system was not set up to handle major off-balance sheets risks or derivative-related exposures.
- The systemic risk that resulted from the interconnectedness of commercial and investment banks that in the end spread to the real economy.
- Procyclical deleveraging.
- A loss of confidence in the banking system, specifically with respect to the solvency and liquidity of many financial institutions.

These massive problems resulted in a credit crisis, with available credit contracting and the public sector, backed by tax payers, injecting liquidity into financial markets. Governments were also forced to guarantee merger deals between banks, putting tax payer dollars at risk. In addition, U.S. authorities injected equity capital into some banks, giving rise to the concern that U.S. banks were being nationalized.

These problems spread like a virus around the world, causing a nearly unprecedented global contraction of liquidity. The Basel Committee, in an attempt to insulate banks, as well as the broader economy from future shocks, has implemented significant changes. Some have taken effect already; other changes will be phased in over the next several years. The reforms instituted by the Committee focus primarily on strengthening the regulatory capital framework.

Changes, to be discussed in greater detail, will include the following:

- *Raising capital standards*, both in terms of quality and quantity. In addition, the transparency and consistency of bank capital will be improved.
- *Strengthen the risk coverage of the capital framework* by increasing capital requirements for trading books and complex off-balance sheet exposures.
- Requiring a *leverage ratio* to supplement risk-based capital requirements.
- Promoting *countercyclical buffers* to offset the procyclical amplification of financial shocks.
- Instituting policies to address *systemic risk* and the interconnectedness of the financial sector.
- Instituting a *global liquidity standard,* which will include liquidity coverage ratios, net stable funding ratios, and the use of monitoring metrics.

Changes will be made at the bank level (called the microprudential level) to improve the resiliency of individual financial institutions in times of stress. Reforms also target macroprudential, or systemwide, risks that build up across the banking sector.

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LO 59.2: Describe changes to the regulatory capital framework, including changes to:

- **The measurement, treatment, and calculation of Tier 1 and Tier 2 capital**
- **Risk coverage, the use of stress tests, the treatment of counter-party risk with credit valuation adjustments, the use of external ratings, and the use of leverage ratios**

Tier 1 and Tier 2 Capital

Capital Requirements

In simple terms, the purpose of bank capital is to provide a cushion against loss. Banks are heavily leveraged and can sustain relatively small losses before becoming insolvent. There are two categories of bank capital: Tier 1 and Tier 2.

Improving the quantity and quality of the capital base is a key goal of the Basel III reforms. There have been inconsistencies in the definitions of capital across countries. As such, it has been difficult for the market to assess the relative quality of capital across institutions.

To remedy this inconsistency, the Committee will require that Tier 1 capital primarily consist of common stock and retained earnings.

Common Equity Tier 1 capital consists of the sum of the following:

- Common shares issued by the bank.
- Stock surplus (paid-in capital).
- Retained earnings.
- Common shares issued by consolidated subsidiaries of the bank and held by third parties (minority interests).
- Accumulated and other comprehensive income and other disclosed reserves. Note that unrealized gains or losses recognized on the balance sheet are under review, but at this point, no adjustments are being made to remove them from Tier 1 capital.
- Regulatory adjustments applied to the calculation of Common Equity Tier 1 capital.

The Committee has developed strict criteria to describe common shares. To be classified as common shares for regulatory purposes, the criteria is as follows:

- Shares have the most subordinated claim in the case of liquidation.
- Investors have a residual claim to the assets.
- The principal is perpetual and is never repaid outside of a liquidation.
- Investors must not expect a buyback of their stock, even though one might occur.
- Common stockholders take the first and proportionately greatest share of any losses that occur.
- The capital is not recognized as a liability but as equity capital.
- The stock is directly issued and paid-in, with no mechanism for the bank to directly or indirectly provide the funds for the purchase of the stock.

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Additional Tier 1 consists of the sum of the following:

- Instruments issued by the bank that meet the criteria of Additional Tier 1 capital (discussed shortly) but that do not meet the criteria of Common Equity Tier 1 capital.
- Stock surplus from issuing Additional Tier 1 capital shares.
- Instruments issued by consolidated subsidiaries and held by third parties that meet the criteria for inclusion in Additional Tier 1 capital and do not meet the requirement of Common Equity Tier 1 capital.
- Regulatory adjustments applied to the calculation if it is Additional Tier 1 capital.

Instruments that fall under Additional Tier 1 capital must meet the following criteria:

- Instruments must be issued and paid-in.
- Subordinated to depositors and other liabilities of the bank.
- Is neither secured nor guaranteed by the issuer.
- Is perpetual.
- Callable by the issuer only after five years.
- Banks must not create expectations that shares will be redeemed or repurchased.
- Dividends/coupons must be fully at the discretion of the issuing institution and must not trigger a default.
- Dividends/coupons must be paid out of distributable items.
- Dividends/coupons cannot be reset based on the bank's credit standing.
- The instrument cannot contribute to liabilities exceeding assets if a balance sheet insolvency test is performed.
- Instruments classified as liabilities must have principal loss absorption through convertible or write-down features.
- The bank cannot have funded the purchase of the instrument (or purchased the instrument) or have influence over the investor of the instrument.
- The instrument cannot have features that inhibit the recapitalization of the bank.

In sum, Additional Tier 1 capital must be comprised of securities that are subordinated, have fully discretionary, non-cumulative dividends or coupons, and be perpetual with no incentive to redeem. At this point, innovative hybrid capital instruments with an incentive to redeem are limited to 15% of Tier 1 capital but will be phased out under the new guidelines.

Tier 2 capital consists of the sum of the following:

- Instruments issued by the bank that are not included in Tier 1 capital but meet the requirement for Tier 2 capital.
- Stock surplus from the issuance of Tier 2 capital.
- Instruments issued by consolidated subsidiaries of the bank and held by minority interest (third parties) that are not included in Tier 1 capital.
- Loan loss provisions.
- Regulatory adjustments applied in the calculation of Tier 2 capital.

Instruments that fall under Tier 2 capital must meet the following criteria:

- Instruments must be issued and paid-in.
- Subordinated to depositors and other liabilities of the bank.
- Is neither secured nor guaranteed by the issuer.
- Has a minimum maturity of five years with no incentives to redeem.
- Capital in the remaining five years of maturity will be amortized on a straight-line basis.
- Callable by the issuer only after five years.

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- Investors must have no rights to accelerate the repayment of scheduled principal and/or interest payments except in the event of bankruptcy and liquidation.
- Dividends/coupons cannot be reset based on the bank's credit standing.
- The bank cannot have funded the purchase of the instrument (or purchased the instrument) or have influence over the investor of the instrument.

Regulatory adjustments include, but are not limited to the following:

- Deducting goodwill and other intangible assets from Common Equity Tier 1 capital.
- Deferred taxes must be deducted from Common Equity Tier 1 capital if they require that the bank be profitable in the future to be realized. Deferred tax assets must be netted with deferred tax liabilities.
- The amount of cash flow hedge reserves related to items that are not fair-valued on the balance sheet, such as projected cash flows, must be deducted from Common Equity Tier 1 capital if positive, and added back to capital if negative.

Regulatory adjustments may also be made to deal with increases in equity resulting from securitization and unrealized gains and losses (from the change in the fair value of liabilities) due to a change in the following:

- The bank's credit risk.
- Defined benefit pension funds.
- Investments in Treasury stock.
- Reciprocal cross holdings of capital designed to inflate the capital position of banks.
- Investments in the capital of banking.
- Insurance and financial companies outside the scope of regulatory consolidation and where the bank owns more than 10% of the issued common equity.
- Former deductions under Basel II for certain risk exposures (such as securitization).

Given all components of capital, the following **minimum capital standards** apply:

- Common Equity Tier 1 must be at least 4.5% of risk-weighted assets (RWAs) at all times.
- Total Tier 1 capital (Common Equity Tier 1 plus Additional Tier 1) must be at least 6.0% of risk-weighted assets at all times.
- Total Capital (Tier 1 Capital plus Tier 2 Capital) must be at least 8.0% of risk-weighted assets at all times.

Professor's Note: Regulators put in place capital to risk-weighted asset standards several years ago. Prior to that, banks simply had to meet a capital-to-total-assets requirement. Bank regulatory authorities recognized that a common standard for all banks promoted risk-taking. They concluded that there should be different capital standards for banks with different levels of risk. As an extreme example, consider a bank that has only reserves and Treasury securities as assets. This bank is obviously less-risky than a bank that makes only commercial loans and has no Treasury securities on the balance sheet. Risk-weighted capital accounts for these risk differences by tying the capital to risk-adjusted, rather than total, assets. A simple example is a bank that has $100 of total assets: $10 cash, $10 Treasury bills, and $80 commercial loans. Risk-weighted assets = 0% × $10 + 0% × $10 + 100% × $80 = $80. Risk weights are specified by regulators.

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Capital Transparency

To improve transparency, which in turn should improve market discipline, the Committee will require banks to disclose the following:

- A full reconciliation of capital elements back to the balance sheet in the audited financial statements.
- A separate disclosure of regulatory adjustments (as previously described).
- A description of the limits and minimal capital requirements (e.g., Common Equity Tier 1 must be at least 4.5% of risk-weighted assets).
- A description of the main features of the financial instruments issued to meet capital requirements.
- An explanation of the calculation of capital ratios. For example, a complete explanation of the inputs and calculation of the Common Equity Tier 1/risk-weighted assets ratio.
- Web sites must make available the terms and conditions of instruments used to calculate regulatory capital.
- Describe, during the transitional phase, components of capital that benefit from transitional provisions.

Transitional Phase

The Committee does not expect banks to meet the new capital standards immediately. There will be a transitional phase, which should allow banks to meet the new standards through earnings retention and the raising of capital. To support the broader economy, the Committee wants to see banks continue lending.

Implementation will not begin until January 1, 2013. At this point, banks in member countries must meet the following capital requirements relative to risk-weighted assets:

- 3.5% Common Equity Tier 1/RWAs (up from the current 2% requirement).
- 4.5% Tier 1 Capital/RWAs.
- 8.0% total capital/RWAs.

Additional Common Equity Tier 1 and Tier 1 requirements will be phased in between January 1, 2013, and January 1, 2015, as described in Figure 1.

Professor's Note: As of April 2013, implementation of Basel III rules has been delayed for several years.

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Figure 1: Capital Standards During the Transitional Period

	January 1, 2013	*January 1, 2014*	*January 1, 2015*	*January 1, 2015 – January 1, 2018*
Common Equity Tier 1 Capital/ RWAs	Increased from 2% to 3.5%	Increase to 4%	Increase to 4.5%	
Tier 1 Total Capital/ RWAs	Increase to 4.5%	Increase to 5.5%	Increase to 6%	
Total Capital/RWAs	8%	8%	8%	
Other				Many things that count as capital today (e.g., amounts above 15% limit for significant investments in financial institutions, mortgage servicing rights, and deferred taxes) will be deducted from capital measures between 2015 and 2018.

Banks will also be required to build-up **a capital conservation buffer**, which is intended to protect banks and provide an extra "cushion" in times of stress. The capital conservation buffer can be drawn down as losses are incurred, protecting the bank from violating the minimum capital standards set forth in Basel III.

The 2.5% buffer, comprised of Common Equity Tier 1 capital, is established above the minimum capital standards. The capital requirements previously described must be met before a bank can contribute to the capital conservation buffer. In effect, it raises the overall Common Equity Tier 1 capital to risk-weighted assets ratio to 7% (the 4.5% required capital ratio previously discussed plus the additional 2.5% capital conservation buffer).

A bank that meets all of the minimum capital standards but has a 0% capital conservation buffer will be subject to constraints on capital distributions. Banks are restricted from paying dividends, buying back shares of stock and even making discretionary bonus payments to staff.

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Risk Coverage

The Committee not only believes that capital requirements should be increased in banks across the globe, but also believes that the capital framework must capture major on- and off-balance sheet risks. Reforms to the **counterparty credit risk** (CCR) framework become effective January 1, 2013. Reforms are intended to address CCR, **credit value adjustments** (CVA) (i.e., mark-to-market losses on the expected counterparty risk) and wrong-way risk.

Professor's Note: Many guarantor institutions saw their own creditworthiness erode simultaneously with the value of the assets they were guaranteeing. This is known as "wrong-way" risk. An example would be institutions that sold credit default swaps and then saw their own financial positions decline along with the value of the underlying assets.

The goal of these changes is to require banks to hold additional capital if they engage in large derivative sales and trading businesses. Banks incurred losses due to counterparties who defaulted or from CVAs related to mark-to-market losses on non-defaulted counterparties. Over-the-counter (OTC) derivatives trading resulted in significant CCR losses for many financial groups in 2008–2009. The failure of Lehman focused attention on the CCR in trading books at financial institutions.

The bottom line is that banks that have significant businesses in these areas will see their capital requirements increase significantly as they will be required to "risk-weight" these off-balance sheet items four to six times greater than, say a commercial loan, which has a 100% weight.

The Committee's primary objective with respect to counterparty credit risk is to ensure that the capital framework captures the risk. While the changes are complex, there appears to be three overriding goals.

1. Increase the risk weightings of "systemically important" financial intermediaries by increasing the correlation assumptions. The idea is that correlations between financial institutions increase during a crisis and are higher than correlations with non-financial counterparties. The new rules require a 1.25 multiplier be applied to the existing Basel II correlation assumptions. The multiplier applies to the following:
   - All regulated financial institutions with total assets greater than $100 billion.
   - Unregulated financial institutions, regardless of size. Firms are included if their business includes: lending, securitization, managing financial assets, leasing, proprietary trading, and other financial service activities.

2. Increase the CCR risk weightings for banks that use internal models by requiring banks to calculate stressed **effective expected positive exposures** (EPEs). Not all banks will be approved to use internal models (e.g., the internal models method).

3. Add an additional capital charge to cover increased credit value adjustments (CVAs) during one year due to widening counterparty credit spreads.

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Banks must use the greater of the portfolio-level capital charge based on the EPE using current market data and the portfolio-level capital charge based on effective EPE using a stress calibration. The *greater of the two* should be applied on a total portfolio level, and not on a counterparty-by-counterparty basis. The stress calibration should also be applied to the entire portfolio of counterparties.

Banks must add capital to cover default risk due to CCR, as well as add a capital charge to cover the risk of mark-to-market losses (i.e., CVAs). Banks with internal model method approval will use a different formula to calculate the CVA capital charge than those that have not been approved to use an internal model. Those financial institutions without approval use a standardized model described by the Committee. External bond ratings are used in part to calculate the CVA risk capital charge.

Banks will calculate a value at risk (VaR) on CVAs under both normal and stressed scenarios. The additional CVA risk capital charge is tied to credit spread risks, both specific and general. The VaR used to calculate it is the sum of the non-stressed and stressed VaR components. The period of stress should be the most severe one-year stress period contained in the three-year stress period used for the exposure parameters. The stressed VaR calculation will be examined further in Topic 61.

This charge is the standalone market risk charge for all OTC derivatives counterparties. Hedges used expressly to mitigate CVA risk (and managed specifically to offset CVA risk) are eligible to be included in the VaR model. It is important to note that just because a bank has a hedge that could mitigate CVA risk, but the hedge is not being managed specifically to mitigate CVA risk, then the hedge is not eligible to offset the CVA within the standalone VaR calculation of the CVA risk capital charge.

The new framework recognizes that there is a time component to risk that was missing from the Basel II requirements. As such, the new measures have increased the margin periods of risk. For the purpose of modeling **exposure at default** (EAD), a floor of five business days for netting repo-style transactions and ten business days for all other netting sets is imposed.

Stress Tests and Wrong-way Risk

Wrong-way risk results when exposure by a bank to counterparty is adversely correlated with the credit quality of the counterparty. With respect to wrong-way risk, banks use stress tests and scenario analyses designed to identify risk factors that are positively correlated with the creditworthiness of counterparties.

Stress test scenarios must address the possibility of severe shocks occurring when the relationships between risk factors have changed. Banks should identify and monitor and control wrong-way risk from the perspective of industry, region, and product line (i.e., any category that is relevant to the financial institution's business).

Banks must rate each counterparty separately in order to determine exposure to wrong-way risk. In addition, it is determined that banks are exposed to wrong-way risk if future exposure to a counterparty is highly correlated with the counterparty's probability of default.

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Banks must implement a **stress testing program**, which will include the following elements:

- Complete trade capture and exposure aggregation across all types of CCR (not just OTC derivatives) in a time frame that allows the bank to conduct stress tests.
- Exposure stress testing must be performed at least monthly. Tests concerning factors, such as interest rate changes, foreign exchange, credit spreads, equities, and commodity prices, should be performed with the goal of identifying and reducing exposure to specific directional sensitivities.
- Multi-factor scenarios to test non-directional risk should be performed quarterly. These tests might include yield curve exposure, basis risk, and so on. Factors that affect the credit quality of counterparties are of specific concern.
- Joint stress tests of exposure and creditworthiness should be performed at the individual counterparty, group (i.e., industry or region), and bank-wide CCR levels.
- Stress testing should be integrated into the overall risk management plan and reported to senior management. Senior management must take a lead role in the integration of stress testing into the risk management structure and culture of the bank.
- For day-to-day risk management, lesser sensitivities but greater probability events should be considered. Extreme shocks must also be considered.
- Banks should conduct reverse stress tests to identify extreme but plausible scenarios.

In general, a bank must perform extensive CCR risk reviews, not less than once per year, which will include the following:

- Documentation of CCR management.
- The organization of the collateral management unit and the CCR control unit.
- The integration of CCR measures into the overall risk management of the bank.
- The accuracy and completeness of the CCR data.
- Verification of the accuracy and appropriateness of volatility and correlation assumptions.
- Backtesting to verify the accuracy of models used by the bank to measure CCR.

For a bank to qualify to use a models-based approach for CCR management, board members or management must do the following, or the following criteria must be met:

- Conduct regular *backtesting*, comparing model results to realized risk measures.
- The *model must be validated* on an on-going basis, independent of model developers.
- *Board members and senior management* must be actively involved in risk management.
- The bank's model should be *integrated with day-to-day risk management* and should be part of the planning, monitoring, and controlling the bank's CCR.
- Internal trading and exposure limits should be related to the bank's risk management process.
- The risk management process should be *well documented*.
- The internal auditing process should *independently review* the bank's risk management system. The overall risk management process should also be *reviewed at least yearly* and should include the following:
  - Adequacy of the documentation of the risk management system.
  - Organization of the risk control unit.
  - Integration of CCR with daily risk management.
  - Approval process for CCR models.
  - Validation of significant changes in the risk measurement model.
  - Scope of CCRs captured by the risk measurement model.
  - Accuracy of the position data.

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- Verification of the timeliness, consistency, and reliability of data sources used in risk measurement models.
- Accuracy of volatility and correlation assumptions.
- Accuracy of valuation and risk transformation calculations.

Banks must continually document and validate the internal model used to measure CCR. Backtesting is an important part of the validation process. The performance of expected positive exposure models is backtested with the goal of identifying problems with the model's risk measures.

External Ratings

The Committee requires banks to assess the credit risk in its exposures to individual borrowers (issuers of bonds) or counterparties. They must assess the risk whether or not the borrower has an external credit rating. Especially in the case of unrated exposures, the bank must determine if the risk weight is appropriate to the actual risk. If the risk is higher than the risk weight implies (this is particularly important for unrated issues), the bank should consider the higher degree of credit risk when evaluating its overall capital adequacy.

External rating agencies (known as external credit assessment institutions (ECAIs) in the Committee's report) must meet the following criteria:

- Objectivity (unchanged).
- Independence (unchanged).
- Transparency with international access.
- Disclosure should include the following:
  - The nature of compensation.
  - Arrangements with assessed entities.
  - Its assessment methodologies and definition of default.
  - Time horizon.
  - Meaning of each default rating.
  - Actual default rates experienced in each rating category.
  - Transitions of assessments (for example, the likelihood of a AAA-rated bond being downgraded to AA over time).
- Resources (unchanged).
- Credibility (unchanged).

The assessments of ECAIs must be publicly available, along with procedures, methodologies, assumptions, and key elements underlying the assessments.

Banks are not allowed to "cherry pick" the assessments of various ECAIs, or arbitrarily change the use of ECAIs. They must use the same rating agency for risk management and risk-weighting of assets for capital purposes.

Leverage Ratios

As previously noted, a build-up of on- and off-balance sheet leverage contributed significantly to the recent financial crisis. Many banks had strong risk-based capital ratios, while at the same time were experiencing a significant increase in leverage. Since banks had to rapidly deleverage (procyclical deleveraging) at the height of the financial crisis, the downward pressure on asset prices was magnified. This resulted in losses at banks, declines

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in bank capital, a contraction of liquidity that caused losses at banks, declines in capital, and so on.

The Committee has introduced a non-risk based **leverage ratio** that is meant to act as a supplementary measure to risk-based capital standards. The leverage ratio is intended to be simple and transparent. The Committee has the following objectives concerning the leverage ratio:

- The ratio should help constrain the build-up of leverage in financial institutions and the banking sector overall, which in turn should help avoid destabilizing deleveraging as occurred in the recent crisis.
- Provide a simple "backstop" measure of leverage that supplements and reinforces the risk-based capital requirements.

The Committee will test a Tier 1 leverage ratio of 3% during the period January 1, 2013, to January 1, 2017. Again, the ratio is meant to be simple and non-risk based. Banks will begin reporting their leverage ratio as of January 1, 2015, even though the target date for introduction is January 1, 2018.

The numerator will consist of high-quality capital (i.e., the new definition of Tier 1 capital), and the denominator will consist of on- and off-balance sheet (derivatives, stand-by letters of credit, acceptances, and so on) items and/or exposures. In essence, this ratio means that banks will be able to lend 33 times their capital, which is far less than some banks have done in the past. The leverage ratio in effect puts a cap on bank risk, separate from the higher capital standards.

Countercyclical Buffers

LO 59.3: Explain changes designed to dampen the pro-cyclical amplification of financial shocks and to promote countercyclical buffers.

Excessive credit growth followed by a downturn can lead to massive losses in the financial sector. A vicious cycle ensues as losses in the banking sector spread to the real economy and then feeds back to the banking sector again. This cycle is called **procyclical amplification.**

Countercyclical buffers are meant to protect the banking sector by ensuring that capital requirements take into account the macro-environment in which the bank operates.

Banking authorities in individual countries are expected to monitor credit growth. If it seems excessive, and there is an increase in system-wide risk as a result, the buffer must be implemented. However, it appears that this would be an infrequent occurrence. The countercyclical buffer regime includes the following:

- National authorities monitor credit growth.
- Authorities also monitor other factors that could signal an increase in system-wide risk.
- If there is a problem, they will require a countercyclical buffer.
- The buffer is released when the system-wide risk subsides.
- Internationally active banks will be subject to the buffer requirement in multiple jurisdictions.

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- The bank-specific capital buffer for an international bank is the weighted average of the requirements that are being applied in jurisdictions to which the bank has credit risk exposures.
- The buffer will extend the capital conservation buffer previously described, and will result in constraints on capital distributions, if not met.
- The buffer will be between 0% and 2.5% of risk-weighted assets, depending on the local banking authorities' judgment of the risk.
- Banks will be given time, up to 12 months, to meet the new requirement.
- Banks must calculate and publicly disclose the countercyclical buffer in the same frequency as their minimum capital requirements.
- The buffer regime will be phased in between January 1, 2016, and January 1, 2018. It will be fully effective by January 1, 2019. The requirement will be 0.625% of risk-weighted assets on January 1, 2016, and will increase by 0.625% per year to reach the maximum of 2.5% of risk-weighted assets by January 1, 2019.

Improving Systematic Risk Management

LO 59.4: Describe changes intended to improve the handling of systemic risk.

The interconnectedness of many global financial institutions contributed to the financial meltdown. Systemically important financial institutions, as the Committee terms them, should be able to absorb shocks to the system, not transmit them. Policymakers worldwide are considering alternatives for dealing with large, interconnected institutions. The Committee is considering several options for dealing with systemically important institutions, including the following:

- **Capital surcharges.**
- **Contingent capital.** This is a subordinated security, such as a preferred stock or subordinated debenture, that converts to equity under certain circumstances. The conversion feature is contractual; investors understand that under certain conditions, the security will convert to equity. Triggers could be erosions of the bank's capital position or the breach of a capital ratio.
- **Bail-in debt.** Like contingent capital, securities convert to equity under certain conditions. However, with bail-in-debt, the contractual mechanism that triggers the conversion extends to the senior debt securities of the issuing bank, as well.

The approach will be integrated and could include combinations of all of the previously mentioned.

In addition, **changes to capital requirements** will also address the interconnectedness of institutions and systemic risk. These changes include the following:

- Providing incentives for banks to use central counterparties for OTC derivatives.
- Higher capital requirements for banks with large trading and derivatives businesses and complex off-balance sheet exposures.
- Correlations of financial sector firms increase during times of stress. Thus, higher capital requirements for inter-financial sector exposures will be implemented.
- To improve the maturity mismatch of many banks, new liquidity requirements will penalize banks with an excessive reliance on short-term, interbank funding to support longer-term assets.

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Improving Liquidity Risk Management

LO 59.5: Describe changes intended to improve the management of liquidity risk, including liquidity coverage ratios, net stable funding ratios, and the use of monitoring metrics.

The Committee recognizes that increasing/improving capital requirements is not sufficient to protect the financial sector from future shocks. The Committee will also introduce an internationally coordinated **global liquidity standard** intended to improve the management of liquidity in financial institutions across the globe.

The rapid reversal of readily available, low-cost funding to banks exacerbated the recent financial crisis. Liquidity evaporated, not just in the United States, but globally. Markets were illiquid for an extended period of time. Central banks around the world had to intervene, not only at the market level, but in some cases at the individual institution level. As such, the Committee has instituted minimum liquidity standards.

The goals of the liquidity standards are threefold. The committee would like to do the following:

1. Promote short-term resilience of a bank's liquidity profile by ensuring that the bank has access to liquidity during an acute short-term stress event (a 30-day horizon). To that end, the Committee developed the **liquidity coverage ratio** (LCR). The stressed-scenario assumes the following:
   - A downgrade of the bank's credit rating.
   - A loss of deposits.
   - A loss of unsecured wholesale funding.
   - An increase in secured funding haircuts.
   - Increases in derivative collateral calls. This includes significant calls on both contractual and non-contractual off-balance sheet exposures.

   The bank will hold high-quality, liquid assets that can be converted to cash in times of acute stress.

2. Promote resilience over a longer time frame, creating incentives for banks to fund activities with more stable sources of funds. To that end, the Committee developed the **net stable funding ratio** (NSFR).

3. The Committee has developed a set of common metrics to *monitor* global liquidity risks. Factors such as maturity mismatches, wholesale funding concentrations, and the availability of unencumbered assets must be monitored by bank supervisors. This is a macroprudential approach to monitoring liquidity, while the liquidity coverage and net stable funding ratios are bank-specific (i.e., microprudential solutions).

Professor's Note: Unencumbered assets are owned assets that do not have claims against them.

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Key Concepts

LO 59.1

The Basel Committee on Banking Supervision has introduced broad changes to the capital and liquidity standards of financial institutions through the Basel III framework.

The goal of the Committee is to promote a more resilient banking sector in the wake of the recent financial and economic crisis.

Many factors contributed to the recent crisis, including excessive on- and off-balance sheet leverage, an erosion of capital, and insufficient liquidity.

Systemic risk resulted from the interconnectedness of financial institutions. Eventually, market participants lost confidence in the banking system. Liquidity contracted world-wide.

The Basel Committee enacted changes in several areas in an effort to strengthen the global banking system. Changes include the following:

- Raising capital standards, both in terms of quality and quantity.
- Improving the transparency and consistency of bank capital.
- Strengthening the risk coverage of the capital framework.
- Requiring a leverage ratio to supplement risk-based capital requirements.
- Promoting countercyclical buffers to offset the procyclical amplification of financial shocks.
- Instituting policies to address systemic risk and the interconnectedness of the financial sector.
- Instituting a global liquidity standard.

LO 59.2

To remedy the inconsistencies in global capital definitions, the Committee requires that Common Equity Tier 1 capital primarily consist of common stock and retained earnings.

Additional Tier 1 capital will consist of instruments that are subordinated, have fully discretionary, non-cumulative dividends or coupons and are perpetual with no incentive to redeem.

Tier 2 capital will consist of instruments that are subordinated to depositors and other liability holders, are issued and paid-in, and will have minimum maturities of five years with no incentives to redeem.

Regulatory adjustments may be made to any of the capital calculations. For example, goodwill and other intangible assets will be deducted from Common Equity Tier 1 capital.

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Minimum capital standards will be phased in between January 1, 2013, and January 1, 2015. Minimum standards, once fully implemented, will include the following:

- Common Equity Tier 1 must be at least 4.5% of risk-weighted assets (RWAs) at all times.
- Total Tier 1 capital (Common Equity Tier 1 plus Additional Tier 1) must be at least 6.0% of risk-weighted assets at all times.
- Total Capital (Tier 1 Capital plus Tier 2 Capital) must be at least 8.0% of risk-weighted assets at all times.

The transparency of capital will improve as banks are required to disclose a full reconciliation of capital elements back to the balance sheet, as well as describe the securities used to meet capital requirements, and provide an explanation of the calculations of capital ratios.

A capital conservation buffer will be required to provide an extra cushion against loss in times of stress. The buffer will be an additional 2.5% Common Equity Tier 1 capital requirement.

Banks that do not meet the capital conservation buffer or countercyclical buffers will be subject to constraints on capital distributions of dividends, stock repurchases, and discretionary bonuses to staff.

The Committee believes that the capital framework should capture major on- and off-balance sheet risks. As such, reforms to the counterparty credit risk (CCR) framework will become effective January 1, 2013.

The goal of the risk coverage changes imposed by the Committee is to require banks that engage in large derivative sales and trading businesses to hold more capital.

Reforms are intended to address counterparty credit risk, credit value adjustments (CVAs) related to mark-to-market losses, and wrong-way risk.

Risk weightings will increase for "systemically important" financial intermediaries. A 1.25 multiplier will be applied to the existing Basel II correlation assumptions.

Banks must estimate the effective expected positive exposure (EPE) using current market data and a stress calibration. The greater of the two calculations is applied to the capital requirement.

Banks must get approval to use an internal model to estimate credit value adjustments. A standardized model is described by the Committee for those banks that have not been approved to use an internal model.

The margin periods for risk have been increased. For the purpose of modeling exposure at default (EAD), a floor of five business days for netting repo-style transactions, and ten business days for all other netting sets has been imposed.

Banks are required to use stress tests and scenario analysis to identify risk factors that are positively correlated with the creditworthiness of counterparties. This is to protect banks from wrong-way risk.

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Banks that use a models-based approach for counterparty credit risk evaluation must conduct regular backtesting of the model. Banks must perform CCR reviews not less than once per year.

External rating agencies, called external credit assessment institutions (ECAIs) by the Committee, must provide greater transparency and disclosure than is specified in the Basel II framework. Criteria regarding objectivity, independence, resources, and credibility are unchanged.

Banks cannot "cherry pick" their rating agency. They must use the same ECAI for risk management and for risk-weighting of assets for capital purposes.

The Committee has introduced a non-risk based leverage ratio that will act as a supplementary measure to risk-based capital standards. The goals of the leverage ratio are to constrain the build-up of leverage in the banking sector and to provide a simple "back-stop" measure of leverage that supplements and reinforces risk-based capital standards.

The leverage ratio of 3% (Tier 1 capital to on- and off-balance sheet items and exposures) is targeted to take effect January 1, 2018.

LO 59.3

Banks will be subject to a countercyclical buffer if regulatory authorities deem it necessary. The buffer is intended to protect the banking sector by ensuring that capital requirements take into account macro-environment factors.

Procyclical amplification refers to the vicious cycle that ensues when a downturn leads to losses in the financial sector, which spreads to the real economy and then back to the financial sector. Countercyclical buffers are intended to dampen the effect of procyclical amplification and will only be implemented if credit growth is excessive or some other system-wide risk is evident.

LO 59.4

Capital surcharges, contingent capital, and bail-in debt have all been proposed as measures to manage systemic risk. The interconnectedness of financial institutions contributed to the recent financial meltdown. Changes to the capital framework will also be implemented to mitigate systemic risk.

LO 59.5

Increasing/improving capital requirements is not sufficient to protect the financial sector from future shocks. In addition to changes to the capital framework, the Committee will also introduce an internationally coordinated global liquidity standard. The standard is intended to improve the management of liquidity in financial institutions across the globe.

The global liquidity standard will include a liquidity coverage ratio, a net stable funding ratio, and monitoring metrics.

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Concept Checkers

1. Which statement is true regarding Common Equity Tier 1 capital?
   A. Common Equity Tier 1 capital to risk-weighted assets must be 6% beginning January 1, 2015.
   B. Preferred stock will make up the bulk of Common Equity Tier 1 capital because shareholders cannot force the bank into bankruptcy.
   C. Common Equity Tier 1 capital has the least-stringent requirements for what constitutes capital.
   D. To qualify as common shares that may be used for Common Equity Tier 1 capital, investors of the shares must have a residual claim to the assets.

2. The capital conservation buffer:
   A. will provide an extra 2.5% Common Equity Tier 1 capital buffer in times of stress.
   B. will be used exclusively to protect banks from the losses garnered from OTC derivatives trading.
   C. is required only for banks with inadequate liquidity coverage and net stable funding source ratios.
   D. is covered in the increased Common Equity Tier 1 capital to risk-weighted assets ratio that will increase to 4.5% from the current 2% over the next few years.

3. Which of the following statements is false regarding the leverage ratio? The leverage ratio:
   A. acts as a supplementary measure to risk-based capital standards.
   B. is defined as Tier 1 capital to on- and off-balance sheet items and exposures.
   C. allows banks to lend approximately 33 times their capital.
   D. is risk-based.

4. A measure intended to protect the banking sector by taking macro-environment factors into consideration is the:
   A. leverage ratio.
   B. procyclical deleveraging ratio.
   C. countercyclical buffer.
   D. counterparty credit risk adjustor.

5. A subordinated security that contractually converts to equity under certain circumstances is:
   A. a countercyclical buffer.
   B. contingent capital.
   C. Tier 2 convertible capital.
   D. an OTC call option.

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Concept Checker Answers

1. D Common Equity Tier 1 capital to risk-weighted assets must be 4.5% beginning January 1, 2015. Common stock plus retained earnings, not preferred stock, must make up the bulk of Common Equity Tier 1 capital. The requirements for Common Equity Tier 1 capital are the most-stringent, not the least-stringent. Investors of the common shares must have a residual claim to the assets.

2. A The capital conservation buffer is intended to provide an extra cushion against loss in times of stress. It is 2.5% Common Equity Tier 1 capital to risk-weighted assets, which in effect increases the total Common Equity Tier 1 capital ratio to 7%.

3. D The leverage ratio is simple and non-risk based and is meant to act as a "backstop" measure of leverage.

4. C The countercyclical buffer requires that banking authorities monitor credit growth and other system-wide factors. If system-wide risks increase, authorities can require banks to hold additional capital, called the countercyclical buffer.

5. B Both contingent capital and bail-in debt convert to equity under certain conditions. The conversion is contractual and is not the option of the investor. Requiring these forms of additional capital may reduce systemic risk in the banking sector.

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

Basel III: The Liquidity Coverage Ratio and Liquidity Risk Monitoring Tools

Topic 60

Exam Focus

The Basel Committee on Banking Supervision has instituted broad reforms with respect to both capital and liquidity requirements. The Committee has instituted two new liquidity requirements. They have clearly indicated that the requirements are meant to be minimum standards and that banks may choose to maintain higher levels of liquidity. The liquidity coverage ratio is defined as the stock of high-liquidity assets to the total net cash outflows over the next 30 calendar days. Banks must maintain a ratio of 100% or greater; this standard is meant to improve the short-term resilience of banks in times of stress. The net stable funding ratio focuses on longer-term liquidity and is intended to protect banks over a one-year horizon. It is defined as the available amount of stable funding relative to the required amount of stable funding and must be greater than 100%. In addition to these two new standards, the Committee has instituted new global liquidity monitoring tools.

The financial crisis that began in 2007 was exacerbated by a global liquidity crunch. Liquidity evaporated quickly, and illiquidity lasted for an extended period of time during the turmoil. To protect the banking system and the broader economy from liquidity crises in the future, the Basel Committee on Banking Supervision has implemented three specific reforms. These reforms will help banks absorb shocks that arise from economic stresses in the future and will protect the real economy from spill-over effects.

The Committee insists that all banks, as well as regulatory authorities, must participate fully in order for the reforms to work. The Committee also insists that the new requirements are **minimum standards**, and that banks and supervisors may implement more stringent requirements on an individual bank basis, depending on bank-specific liquidity risks. In addition, banks must adhere to **sound practices** as set forth in the 2008 published *Principles for Sound Liquidity Risk Management and Supervision.*

The stated objectives of the liquidity standards are complementary. The two objectives are as follows:

1. To ensure that banks have adequate liquidity to survive a "significant stress scenario" lasting for 30 days.

2. To provide incentives for banks to develop more stable funding sources so they can withstand liquidity shocks that last over longer time horizons.

Professor's Note: In this topic, the word "bank" is used as a general term to describe a financial institution that has regulated capital and liquidity.

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Liquidity Coverage Ratio

LO 60.1: Define and describe the minimum liquidity coverage ratio.

The goal of the **liquidity coverage ratio** (LCR) is to ensure that banks have adequate, high-quality liquid assets to survive a short-term stress scenario. The definition of the standard is as follows:

$$\frac{\text{stock of high-quality liquid assets}}{\text{total net cash outflows over the next 30 calendar days}} \geq 100\%$$

The LCR is a traditional bank "coverage" ratio. It requires that banks have enough high-quality liquid assets to fully cover total net cash outflows over the next month. The goal is to have enough liquid assets that can be converted to cash, either by sale or by secured borrowing, to provide a safeguard against a period of severe liquidity stress. The liquidity of these assets must remain intact even in periods of bank-specific or overall market stress. Both high-quality liquid assets and total net cash outflows are defined in greater detail in the following subsections.

An asset is liquid if it can be *converted easily and immediately to cash with little or no loss of value*. During the crisis, financial institutions were attempting to liquidate assets in a "fire sale" environment. High-quality liquid assets must be unencumbered (i.e., not pledged, implicitly or explicitly, to secure, collateralize, or provide credit-enhancement for any transactions). The assets are meant to act as a source of potential liquidity and must be managed as such.

High-Quality Liquid Assets (HQLA)

LO 60.2: Describe the characteristics of high quality liquid assets (HQLA) and operational requirements for assets to qualify as HQLA.

Fundamental characteristics of high-quality liquid assets include the following:

- *High credit standing of the issuer and low market risk*: Generally, the lower the risk of the asset, the more liquid the asset.
- *Certain valuation*: Assets that are easy to value are generally more liquid. Valuations that rely on strong assumptions weaken the liquidity of an asset. As a result, most exotic or structured products will not classify as HQLA.
- *Low correlation with risky assets*: In this context, wrong-way risk implies that one asset's value will fall because of correlation with another asset. This will in turn affect the liquidity of the asset.
- *Listed on a recognized exchange*: Exchange-traded assets are more transparent than non-exchange traded assets.

Market-related characteristics of high-quality liquid assets include the following:

- *Active and sizeable market*: There should be historical evidence of both market depth and market breadth. Many market participants, as well as high trading volume, increase the liquidity of an asset.

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- *Committed market makers*: Buy/sell quotes should be available for liquid assets.
- *Diverse buyers and sellers*: Low market concentration increases liquidity. The Committee has introduced a monitoring metric that specifically assesses the market concentration of providers of liquidity.
- *Flight-to-quality*: Historically, the market has moved toward HQLA in times of trouble.

Operational Requirements for HQLA

In order for assets to qualify as high-quality liquid assets, several operational requirements must be satisfied. These requirements ensure that a bank can use the HQLA stock as available contingent funds, which allow a bank to convert liquid assets into cash (either through outright sale or repo) when addressing funding gaps between cash outflows and inflows. Banks should periodically monetize a portion of their HQLA stock in order to test market access, determine the availability of assets, and mitigate the risk of sending negative signals to the market when selling assets during a stress period. Operational requirements/restrictions for qualifying assets include the following:

- Assets should be unencumbered (i.e., not carry claims against them).
- If a bank is not able to monetize the asset to address funding gaps, the asset should be excluded from the stock of HQLA.
- The official position or function at the bank responsible for managing liquidity (e.g., treasurer) should oversee the stock of HQLA. This position/function can monetize liquid assets if necessary.
- A bank can hedge any market risk arising from the stock of HQLA.
- The bank should create a policy that monitors the legal entity, currency, account, and/or location where collateral is being held.
- Assets held at the legal entity (or sub-consolidated level) that meet liquidity requirements should only qualify as HQLA at the consolidated level to the degree that relevant risks are also reflected in the consolidated liquidity coverage ratio.
- Due to regulatory, legal, tax, or accounting impediments, assets may not be freely available to the consolidated entity.
- When active repo markets do not exist for a certain asset class, the HQLA stock should be monetized using an outright sale.
- Any assets received through rehypothecation should not be included in the stock of HQLA if the asset can be withdrawn during a stress period by the owner.
- Assets that serve as collateral for derivatives transactions that are not rehypothecated can be included in the stock of HQLA given that the bank accounts for any corresponding risks.
- A bank should manage and monitor its liquidity risks on an intraday basis in order to meet payment and settlement obligations under all conditions, including stress periods.
- A bank should meet all liquidity requirements in each applicable currency and maintain HQLA stock proportional to the liquidity requirements for each currency.
- In the event that a liquid asset becomes ineligible (e.g., through a ratings downgrade), a bank can keep that asset in its HQLA stock for another 30 days to give the bank adequate time to replace the asset.

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Categories of Liquid Assets

LO 60.3: Differentiate between Level 1, Level 2A, and Level 2B assets, and define the respective cap for each asset class as a percentage of total HQLA.

Ideally, liquid assets should be central bank eligible. There are two categories of assets: (1) Level 1 assets, which can be included without limit; and (2) Level 2 assets, which may only comprise 40% of the high-quality liquid asset stock. An additional class of assets (Level 2B assets) may also be recognized. If Level 2B assets are included, they must not comprise more than 15% of total HQLA, and also must be a part of the 40% cap for Level 2 assets. The 40% cap on Level 2 assets and the 15% cap on Level 2B assets are determined after accounting for haircuts, and the unwinding of short-term financing and collateral swap transactions that mature in 30 days and involve the exchange of HQLA.

Level 1 assets include the following:

- Cash.
- Central bank reserves.
- Marketable securities (that are assigned a 0% risk weighting under Basel II) traded in large, deep, active markets with low concentration. These securities must be a proven reliable source of liquidity even in times of stress. They may not be the obligation of a financial institution (due to positive correlation and wrong-way risk).
- Non-0% risk-weighted sovereign or central bank securities.

Level 2A assets include the following:

- A minimum 15% haircut is applied to the current market value of each Level 2A asset.
- Marketable securities assigned a 20% risk-weighting under Basel II. The securities must be traded in large, deep, active markets with low concentration. These securities must be a proven reliable source of liquidity even in times of stress. They may not be the obligation of a financial institution (due to positive correlation and wrong-way risk).
- Corporate debt securities that have at least an AA rating if rated by an external credit assessment institution (ECAI). If not rated, the probability of default must correspond to a credit rating of at least AA.

Level 2B assets include the following:

- A greater haircut than Level 2A assets is applied to the current market value of each Level 2B asset.
- Residential mortgage-backed securities (subject to a haircut of 25%). These securities must have a credit rating of at least AA, and not be issued by the bank itself.
- Corporate debt securities (subject to a haircut of 50%) that either have a rating recognized by an ECAI between A+ and BBB- or are internally rated with a probability of default that corresponds to a rating between A+ and BBB-.
- Common equity securities (subject to a haircut of 50%) that are exchanged traded and have a central clearing party. These shares must also be included in a major stock index and be denominated in the domestic currency.

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Professor's Note: As an example, think about the role that Treasury bills played in the recent financial crisis. Investors sold higher risk assets and bought U.S. Treasury securities in a flight to safety. Treasury bills meet all of the above requirements for high-quality liquid assets.

Net Cash Outflows

LO 60.4: Define how total net cash outflows are calculated for the minimum liquidity coverage ratio.

Net cash outflows are defined as follows:

outflows over the next 30 calendar days – min (inflows; 75% of outflows)

outflows = outstanding balances of various types of liabilities and off-balance sheet commitments × rates at which they are expected to runoff

inflows = outstanding balances of various categories of contractual receivables × rates at which they are expected to flow in

Banks may not double-count items. If an item is included in the numerator of the liquidity coverage ratio (i.e., is counted as a high-quality liquid asset), it cannot again be counted as an inflow. There is a cap on total inflows, as well. The Committee does not want banks to rely solely on expected inflows to cover outflows; they want banks to maintain a stock of high-quality liquid assets. Thus, the amount of inflows that a bank can assume will offset outflows is capped at 75% of expected total outflows. The effect of this cap is to require banks to maintain minimum liquid assets equal to 25% of expected outflows.

Since the timing of bank inflows and outflows is uncertain, banks, as well as bank supervisors, must be aware of any liquidity mismatches that may occur within a one-month period. Bank-specific or market-wide shocks may result in a drain on a bank's liquidity. In general, banks may experience any individual or combination of the following:

- Retail deposit runoffs.
- Losses of unsecured wholesale funding.
- Losses of secured, short-term funding.
- Outflows that result from a downgrading of a bank's public credit rating.
- Risks that impact the quality of collateral or future exposures to derivative positions that require large collateral haircuts or the need for additional collateral.
- Unscheduled or unexpected draws on lines of credit and other unused credit and liquidity facilities by bank customers.
- The need to buy back debt or honor non-contractual obligations to protect the bank's reputation.

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Cash outflows (with runoff rates) include the following:

- **Retail deposit runoff**—retail deposits include demand deposits and term deposits from individuals (natural persons).
  - **Stable deposits**—assume a runoff rate of 5% or higher; these deposits are insured or guaranteed.
  - **Less-stable deposits**—assume a runoff rate of a minimum of 10%. These deposits may not be insured or guaranteed, may be high-value deposits, or the deposits of high net-worth individuals. These deposits can be withdrawn quickly (such as internet deposits) or foreign currency deposits.
- **Unsecured wholesale funding runoff**—liabilities and general obligations raised from non-natural persons (legal entities including sole proprietorships and partnerships). These are not collateralized by specifically designated assets.
  - Provided by small-business customers—assume a runoff rate of 5%, 10%, or higher.
  - Unsecured wholesale funding with operational relationships. Deposit customers are reliant on the bank to perform services, such as clearing, custody, or cash management functions and may be financial or non-financial customers of the bank—assume a runoff rate of 25%.
  - Deposits in institutional networks of cooperative banks—these banks have a common strategic focus—assume a runoff rate of 25%.
  - Unsecured wholesale funding provided by non-financial corporate or sovereigns, central banks, and public sector entities (i.e., non-small business customers)—assume a runoff rate of 75%.
  - Unsecured wholesale funding provided by other legal entities and not held for operational purposes—assume a runoff rate of 100% (notes, bonds, and other debt securities issued by the bank are included in this category).
- **Derivatives payables**—assume a runoff rate of 100%.
- **Liquidity needs that result from downgrade triggers embedded in derivatives/contracts**—assume a runoff rate of 100%. This includes any downgrade up to and including a three-notch downgrade.

Other outflows include those occurring from: valuation changes on posted collateral securing derivative and other transactions (20% of the value of non-Level 1 posted collateral); the loss of funding on asset-backed securities; covered bonds and other structured financing instruments or commercial paper; conduits; and so on (assumes an outflow of 100% of the transaction maturing within 30 days); and draw-downs on committed credit and liquidity facilities (5% draw-downs for retail and small business customers; 10% draw-downs for credit facilities to non-financial corporations and 100% draw-downs for liquidity facilities to non-financial corporations; and 100% draw-downs on committed credit and liquidity facilities to other legal entities). Any lending or funding obligations within a 30-day period should be captured, as well.

Finally, runoff rates of other contingent-funding obligations are at the discretion of bank supervisors of specific jurisdictions. Examples of contingent funding obligations include uncommitted credit and liquidity facilities, letters of credit, guarantees, and non-contractual obligations, such as debt buybacks.

Professor's Note: Runoff rates are defined by the Committee based on an expectation of what funding would "leave the bank" in a liquidity stress event that lasted for 30 days.

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In addition, the liquidity coverage ratio does not cover intraday trading risk. Liquidity needs that occur during the day and disappear by the end of the day are not covered. The Committee is considering whether intraday liquidity risk should be addressed.

In sum, any expected outflow over the 30-day window must be included. Some runoff rates are at the discretion of national bank supervisors, and other runoff rates are specified by the Basel III liquidity framework. Because of the 75% cap on inflows, banks must now maintain liquid assets equal to a minimum of 25% of expected total outflows. The requirement that banks maintain a store of high-quality liquid assets did not exist prior to these reforms.

Liquidity Monitoring Tools

LO 60.5: Describe additional metrics to be used by supervisors as monitoring tools when assessing the liquidity risk of a bank.

Contractual Maturity Mismatch

Banks and supervisors need to more consistently monitor liquidity at both the bank and system-wide levels. The Committee has instituted various metrics that will assist in information gathering and assessment of bank liquidity. In addition, there may be country/jurisdiction-specific liquidity issues, which must be monitored by supervisors in specific jurisdictions.

Gaps between the contractual inflows and outflows of liquidity are known as maturity mismatches. The **contractual maturity mismatch** identifies the amount of liquidity a bank may need to raise in a specific time band, assuming all outflows occur at the earliest possible date.

Definition of contractual maturity mismatch: Contractual and security inflows and outflows from all on- and off-balance sheet items, mapped to defined time bands based on their respective maturities.

Time bands are constructed for overnight; 7 day; 14 day; 1, 2, 3, 6, and 9 months; and 1, 2, 3, 5, and beyond 5-year maturity buckets.

Practical applications of the metric include the following:

- Data collected must be reported to supervisors. Supervisors in turn have a broad view of market outliers with respect to liquidity.
- The model is based on contractual flows with no behavioral assumptions. Supervisors can apply their own behavioral assumptions to the data.
- Banks should also apply behavioral assumptions to inflows and outflows and should consider both normal and stressed conditions. Supervisors must consider whether assumptions regarding inflows and outflows made by banks are reasonable.
- Banks must identify how they plan to address liquidity gaps generated by maturity mismatches. Supervisors must assess the feasibility of a bank's plans with respect to funding liquidity mismatches.

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Concentration of Funding

Banks rely heavily on wholesale funding. As evidenced by the recent financial crisis, removal of that funding can sometimes deliver a fatal blow to a bank. The **concentration of funding** metric attempts to identify those significant sources of wholesale funding which, if withdrawn, could trigger liquidity problems for a bank. In keeping with the Sound Principles, this metric encourages a diverse mix of funding sources. There are three metrics that are used to assess the concentration of funding.

Definitions of concentration of funding ratios:

1. $\dfrac{\text{funding liabilities source from each significant counterparty}}{\text{the bank's balance sheet total}}$
2. $\dfrac{\text{funding liabilities source from each significant product/instrument}}{\text{the bank's balance sheet total}}$
3. List of asset and liability amounts by significant currency.

Funding concentrations are examined based on counterparties, products, and instruments (the numerators for ratios 1 and 2). Both absolute percentages of the funding exposure and significant increases in concentrations are important and should be monitored by banks and supervisors.

What qualifies as a significant counterparty, product, instrument, or currency?

- A single counterparty or group of connected counterparties with an aggregate sum of more than 1% of the bank's balance sheet qualifies as a *significant counterparty*.
- A single product/instrument or group of similar products/instruments with an aggregate sum of more than 1% of the bank's balance sheet qualifies as a *significant product/instrument*.
- A single currency with aggregate liabilities denominated in the currency of 5% or more of the bank's total liabilities qualifies as a *significant currency*.

These metrics are reported separately for times horizons of less than 1 month, 1 to 3 months, 3 to 6 months, 6 to 12 months, and longer than 12 months.

Practical applications of the metric include the following:

- Banks and supervisors must recognize that it is currently impossible to identify the actual funding counterparty for many types of debt. As a result, concentration ratios may be higher than estimated. Also, in periods of market-wide stress, even diversified funding sources may be at risk because the bank and counterparties may experience simultaneous liquidity pressures.
- Two-sided relationships, where the bank also extends funding to the counterparty (or has unused credit lines outstanding to the counterparty) may affect net outflows.
- The currency metric is meant to provide a base for discussion with the bank regarding risk mitigating solutions, such as swaps, forwards, and so on. It is not simply a snapshot of potential risk.

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Available Unencumbered Assets

Data regarding the quantity, key characteristics, and currency denomination and location of a bank's unencumbered assets are provided in the **available unencumbered assets** metric. These assets are potential sources of liquidity in that they can be used as collateral for other secured funding and/or are eligible at central banks.

Definition of available unencumbered assets: Assets that are marketable as collateral in secondary markets, and/or are eligible for central banks' standing facilities.

Banks must report the amount, type, and location of these assets. The assets should also be categorized by significant currency. In addition, banks must estimate haircuts that secondary markets/central banks would require of each asset.

Practical applications of the metric include the following:

- This data should be combined with the maturity mismatch data and other balance sheet data, as it does not compare available unencumbered assets to the amount of outstanding secured funding or other balance sheet scaling factor.
- This data does not capture counterparty haircuts and lending policies that could change given either a system-wide or idiosyncratic event. As such, it may provide a false sense of comfort regarding the value of assets (which might actually be lower than expected in stress conditions).

Liquidity Coverage Ratio by Significant Currency

For internationally active banks, the LCR should be monitored in significant currencies. Currency mismatches, along with liquidity mismatches, are relevant to risk.

Definition of Liquidity coverage ratio by significant currency:

foreign currency liquidity coverage ratio =

$$\frac{\text{stock of high-quality liquid assets in each significant currency}}{\text{total net cash outflows over a 30-day time period in each significant currency}}$$

Note that the amount of total net foreign exchange cash outflows should be net of foreign exchange hedges.

The high-quality foreign exchange assets and net foreign exchange outflows should match those of the liquidity coverage ratio for common currencies. A currency is considered significant if the aggregate liabilities denominated in that currency amount to 5% or more of the bank's total liabilities.

Practical applications of the metric include the following:

- This is a monitoring tool, not a standard, and thus does not have a specified minimum requirement. Supervisors should monitor it, however, and could set their own minimum standards.

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- The key supervisor concerns are related to the banks' abilities to raise funds in a foreign currency and/or their ability to transfer a liquidity surplus in one currency to another currency. If a bank's ability to do either is limited, the ratio requirement should be higher.
- The metric can be used by supervisors and banks to track potential currency mismatches in times of stress.

Market-Related Monitoring Tools

Supervisors and banks can use high-frequency market data with little or no time lag to warn of potential liquidity problems in banks.

Definition of market-related monitoring tools:

1. *Market-wide information*: Supervisors should consider the impact of market movements on the financial sector and on specific banks. Bank funding plans are also dependent on market movements. Information of interest includes the following:
   - Equity prices (indices).
   - Debt markets (money market, medium-term markets, long-term debt, derivatives, government bonds, indices, credit default spreads).
   - Foreign exchange markets.
   - Commodities markets.
   - Specific product indices.

2. *Information on the financial sector*:
   - Financial sector equity market data.
   - Financial sector debt market data.

3. *Bank-specific information:*
   - Equity prices.
   - Credit default spreads.
   - Money market trading prices.
   - Price/yield relationships of the bank's debt.

Practical applications of the metric include the following:

- Information must be interpreted accurately. For example, the same credit default spread may be interpreted differently under different market conditions (such as low market liquidity).
- In addition, supervisors must realize that market participants focus on different types of data and interpret them differently.

All of the monitoring metrics are designed to assist banks and supervisors in their assessment of bank-specific and system-wide liquidity concerns. Banks must be prepared to weather both short-term and long-term liquidity risks in the market. The liquidity coverage ratio and the net stable funding ratio will require banks to maintain more consistent funding, while the monitoring metrics should present early warning signs of future problems to both banks and supervisors.

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Key Concepts

LO 60.1

The Basel Committee on Banking Supervision has instituted two new complementary liquidity requirements meant to improve banks' resilience in periods of stress.

The Committee has made it clear that the new liquidity standards are minimums and can be increased or supplemented by banks or supervisors.

The liquidity coverage ratio is defined as the stock of high-quality liquid assets to the total net cash outflows over the next 30 calendar days. The ratio must be at least 100%.

The liquidity coverage ratio is intended to improve a bank's (or the banking sector's) ability to withstand a liquidity shock that lasts for 30 days.

LO 60.2

In general, characteristics of high-quality liquid assets include the following:

- High credit standing of the issuer and low market risk.
- Certain valuation: Assets that are easy to value are generally more liquid.
- Low correlation with risky assets.
- Listed on a recognized exchange.
- Active and sizeable markets.
- Committed market makers.
- Diverse buyers and sellers.
- Flight-to-quality: The market has traditionally moved toward high-quality liquid assets in times of stress.

LO 60.3

"Level 1" high-quality liquid assets include cash, reserves, 0% risk-weighted marketable securities, and some non-zero risk-weighted securities of sovereign and central banks. "Level 2" assets are of lower quality (i.e., have higher risk weights in the Basel II framework) and may comprise no more than 40% of the overall high-quality stock. An additional class of assets (Level 2B assets) may also be recognized by supervisors.

LO 60.4

Net cash outflows include runoffs of retail deposits; losses of unsecured wholesale funding; losses of secured, short-term funding; outflows that result from downgrades of debt; and so on.

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LO 60.5

The Committee has instituted various metrics that will assist in information-gathering and assessment of bank liquidity so banks and supervisors can more consistently monitor liquidity at both the bank and system-wide levels. The metrics are for monitoring and do not constitute actual standards. There are five metrics, which include the following:

- Contractual maturity mismatch.
- Concentration of funding.
- Available unencumbered assets.
- Liquidity coverage ratio by significant currency.
- Market-related monitoring tools.

The contractual maturity mismatch identifies the amount of liquidity a bank may need to raise in a specific time band assuming all outflows occur at the earliest possible date.

The concentration of funding metric attempts to identify those significant sources of wholesale funding, which, if withdrawn, could trigger liquidity problems for a bank.

The available unencumbered assets metric provides data regarding the quantity, key characteristics and currency denomination and location of a bank's unencumbered assets.

The liquidity coverage ratio by significant currency is calculated as high-quality liquid assets in each significant currency divided by total net cash outflows over the next 30 calendar days.

Supervisors and banks can use high-frequency market data with little or no time lag to warn of potential liquidity problems in banks. They should monitor market-wide information, financial sector information, and bank-specific information.

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Concept Checkers

1. Which of the following assets does not qualify as a Level 1 liquid asset?
   A. Marketable securities (0% risk weight).
   B. Cash.
   C. Central bank reserves.
   D. Securities with a AA-rating by an external credit assessment institution.

2. Fundamental characteristics of high-quality liquid assets include all of the following except:
   A. easy to compute value.
   B. low correlation with risky assets.
   C. listed on a recognized exchange.
   D. high credit standing of the issuer and high market risk.

3. The contractual maturity mismatch monitoring metric:
   A. includes behavioral assumptions for stressed and normal markets.
   B. requires that banks provide detailed plans to bridge liquidity gaps.
   C. should include data on the categories outlined in the liquidity coverage ratio.
   D. assumes that existing liabilities rollover automatically.

4. Given the following information, what is Bank A's liquidity coverage ratio?

• High-quality liquid assets	$100
• Required amount of stable funding	$200
• Cash outflows over the next 30 days	$130
• Net cash outflows over the next 30 days	$90
• Available amount of stable funding	$210
• High-quality liquid assets in each major currency	$75

   A. 83%.
   B. 90%.
   C. 111%.
   D. 130%.

5. Which of the following statements most likely describes the minimum liquidity coverage ratio (LCR)?
   A. The goal of the LCR is to protect banks over a long time horizon of over one year.
   B. LCR requires that banks have enough high-quality liquid assets to fully cover total net cash outflows over the next month.
   C. LCR promotes a sustainable maturity structure for assets and liabilities by creating incentives for banks to use more stable funding sources.
   D. The goal of the LCR is to make banks less resilient to liquidity shocks in the short-run.

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Concept Checker Answers

1. **D** Level 1 liquid assets are of the highest "quality" with respect to liquidity. Level 1 assets include cash, reserves, marketable securities with a 0% risk weight, and non-0% risk weight sovereign and central bank debt.

2. **D** Fundamental characteristics of high-quality liquid assets include: high credit standing of the issuer and low market risk. Generally, the lower the risk of the asset, the more liquid the asset. The other statements are true.

3. **C** The contractual maturity mismatch is a monitoring metric designed to identify liquidity gaps between the contractual inflows and outflows for defined time bands. The metric does not include behavioral assumptions, does not require banks to provide plans of how they will bridge liquidity gaps (although banks should devise plans for handling liquidity gaps), and assumes no rollover of existing liabilities.

4. **C** The 30-day liquidity coverage ratio (LCR) is equal to the stock of high-quality liquid assets divided by the net cash outflow over a 30-day period. Under Basel III, this ratio must equal or exceed 100%. Bank A's liquidity coverage ratio = $100 / $90 = 1.11 = 111%.

5. **B** The LCR is a traditional bank "coverage" ratio. It requires that banks have enough high-quality liquid assets to fully cover total net cash outflows over the next month. The goal of the liquidity coverage ratio is to make banks more resilient to liquidity shocks in the short-run.

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

Revisions to the Basel II Market Risk Framework

Topic 61

Exam Focus

This topic presents an overview of the revisions to the Basel II market risk framework. It briefly expands on the discussion of accounting for securitization under Basel II, which was introduced in previous topics. The calculation of stressed value at risk (SVaR) is examined as well as the calculation of the market risk capital requirement when accounting for SVaR measures.

LO 61.1: Describe the objectives for revising the Basel II market risk framework.

The objective of the current revision to the Basel II market risk framework is to further improve bank models by incorporating additional risk factors, such as migration risk and factors used in pricing securities. In addition, these revisions represent an update to the practice of accounting for trading book positions. The current prudent valuation guidelines indicate that all positions are subject to fair value accounting with focuses on the most recent valuation of a given position to determine adequacy of liquidity.

Capital Charge for Specific and General Risk

LO 61.2: Define the capital charge for specific risk and general market risk.

The capital charge for general market risk uses a 10-day value at risk measure at the 99% confidence level as well as a stressed value at risk (SVaR) measure. The same approach would apply to capital charges for specific risks, given that the bank has approval to model such risks. **Specific risk charges** require the same multiplier as general risk charges, and the bank would still need to cover any incremental capital charge (IRC) if it chooses to model this risk.

There are two approaches for determining capital charges for specific risk under a securitization framework: (1) the standardized approach and (2) the internal ratings-based (IRB) approach, both of which utilize external credit ratings. Provided that the asset securitization is considered a true sale, the bank can utilize updated risk weights based on each tranche's rating, which enables the bank to acknowledge the subdivision of risks. Figure 1 lists capital charges for specific positions under securitization and re-securitization exposures.

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Figure 1: Securitization Risk Weights

External Credit Assessment	*AAA to AA-*	*A+ to A-*	*BBB+ to BBB-*	*BB+ to BB-*	*B+ or below*
Securitization exposures	20%	50%	100%	350%	Deduction
Re-securitization exposures	40%	100%	225%	650%	Deduction

Deductions are required for positions rated B+ and below for long-term ratings. A deduction implies that capital equivalent to the unrated (equity) securitization tranche must be held. Deductions are mandatory for these unrated positions. However, when calculating the capital charge for general market risk, positions that are subject to deductions are excluded.

With regard to capital charges for unrated positions, applications vary depending on whether the bank has approval to use either the IRB approach or an internally developed approach when estimating probability of default and loss given default. In the former case, the bank is required to meet the minimum requirements under the internal ratings-based approach and for the latter, capital charge for incremental risk will apply. In all other cases, under unrated positions with the standardized approach, the capital charge of 8% multiplied by a concentration ratio would apply to the securitized exposure.

While capital charge for specific risk is always higher for a junior rated tranche, positions must be deducted from the capital when banks opt not to apply the previously mentioned specifications or are unable to determine capital charge for specific risk.

Market Risk Factors

LO 61.3: Explain the relationship regulators require between market risk factors used for pricing versus those used for calculating value-at-risk, and the risks captured by the value-at-risk model.

Regulators require specific relationships among the market risk factors used in the pricing process. With respect to pricing based on interest rates, regulators require banks to model yield curves. One method to accomplish this task is to estimate forward rates from zero coupon yields or generate a separate yield curve for different instruments in order to capture interest rate risk and spread risk between bonds and swaps.

There is also a foreign exchange risk factor that a bank should consider if it has significant exposure to a particular foreign currency. This factor needs to be considered since VaR is calculated based on a bank's domestic currency.

In the equity pricing area, market risk factors include market-wide movements in equity prices, price changes in industry sectors, and/or volatility of individual equities to which the bank has exposure.

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For commodity price risk, a single risk factor is sufficient to capture risk in commodity prices with a limited or aggregate position. However, variation in the convenience yield, which reflects the benefits from direct ownership of a physical commodity, should be considered in a more active trading situation between derivatives positions.

With regard to the relationship regulators require between market risk factors for pricing and those used for calculating VaR, any relevant risk factors used for pricing should be included in the calculation of VaR and any omissions should be explained to upper management. In addition to the risk factors used for pricing, correlation risk and basis risk between credit default swaps and bonds as well as nonlinearities for options, such as mortgage-backed securities, should be captured in the VaR model.

Stressed VaR

LO 61.4: Explain and calculate the stressed value-at-risk measure and the frequency which it must be calculated.

The **stressed value at risk** (SVaR) should be calculated on a weekly basis. This measure is calculated by combining current portfolio performance data based on the 10-day, 99% confidence interval with the firm's historical data from a significantly financial stressed period of the same portfolio. Calculation of SVaR is defined as follows:

$$\max\left(SVaR_{t-1}, M \times SVaR_{avg}\right)$$

The formula denotes that the capital requirement for SVaR should be the higher number between its latest available SVaR calculated according to specifications described previously and the average SVaR calculated over the previous 60 business days. The multiplication factor, *M*, is set by individual supervisory authorities on the basis of the assessment of the bank's risk management system quality and subject to an absolute minimum floor of three.

Market Risk Capital Requirement

LO 61.5: Explain and calculate the market risk capital requirement.

The market risk capital requirement can be calculated as follows:

$$MRC = \max\left(VaR_{t-1}, M_{PF} \times VaR_{avg}\right) + \max\left(SVaR_{t-1}, M \times SVaR_{avg}\right)$$

The equation denotes that the market risk capital (MRC) requirement is the summation of both the VaR and SVaR measures. The formula utilizes the maximum value of the previous day's VaR/SVaR value and the average of the daily VaR/SVaR value on each of the preceding 60 business days.

For VaR, the multiplier, *M*, contains a plus factor in addition to the floor multiplication factor. The plus factor is the ex-post performance of the model and ranges from 0 to 1

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based on the outcome of backtesting VaR. Since VaR is used in calculating the plus factor, the multiplication factor is applicable on the VaR portion of the equation only and not on SVaR. Backtesting could be performed on either hypothetical or actual trading outcomes, or both. If the backtesting results are satisfactory (i.e., few exceptions), and the bank meets all of the required qualitative standards, the plus factor could be zero.

Qualitative and Quantitative Disclosures

LO 61.6: Describe the qualitative disclosures for the incremental risk capital charge.

LO 61.7: Describe the quantitative disclosures for trading portfolios under the internal models approach.

Recent credit market turmoil clearly demonstrated the inadequacy of the VaR model to fully capture the default risk of the trading books' positions. The incremental default risk charge (IRC) estimates the default and migration risks, over and above what is captured by VaR, for regulatory capital calculations purposes. As we have seen in previous topics, VaR does not estimate the tail event loss. VaR typically uses a 99% confidence interval and parameters that are estimated using short time series data. Also, VaR does not capture illiquidity risk arising from structured and exotic products in the trading book. Without knowledge of specific methods used by a bank, it is not possible to generate the precise IRC calculations. However, Basel guidelines describe the supervisory parameters for computing the IRC. The guidelines are primarily related to banking and trading book consistency, default and migration risks, constant risk level, liquidity time horizon, risks correlations, risk concentrations, risk exposures estimation, and model validation.

Qualitative disclosures for the incremental risk capital (IRC) charge in the context of internal models should include methodologies and approaches used by the bank to determine liquidity levels and horizons, not only during model validation, but also during the process of assessing capital requirements.

Quantitative disclosures for trading portfolios under the internal models approach (IMA) should include high, mean, and low values of VaR, SVaR, and IRC charges over the reporting period. Analysis of critical outliers found during backtesting and comparisons of VaR estimates with actual gains/losses in the portfolio should also be included.

Valuation of Illiquid Securities

LO 61.8: Describe the regulatory guidance on prudent valuation of illiquid positions.

In addition to meeting requirements for any changes to the value of a position for financial reporting, banks are expected to establish and uphold procedures for computing adjustments to the current value of illiquid securities. A bank's ability to sell or hedge less liquid positions may not be supported by assumptions made about liquidity within the market risk capital charge due to unforeseen market events. As a result, a valuation

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adjustment is needed on a regular basis in order to more precisely determine a position's current illiquidity status. This adjustment is made regardless of whether the position is marked-to-market, marked-to-model, or obtained through third-party valuation.

There are a few factors to consider when determining the accuracy and suitability of the adjustment for illiquid positions. They include, but are not limited to, the market concentrations, the average volatility of the bid-ask spread, the volatility and average trading volumes, the age of the positions, and the amount of time needed to hedge risks from a given position.

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Key Concepts

LO 61.1

The current revision to the Basel II market risk framework seeks to improve risk models by requiring banks to include incremental risk factors and prudent valuation for all trading positions to their fair value.

LO 61.2

Methodologies used to calculate capital charges for general market risk and specific risks are similar.

LO 61.3

Any relevant risk factors used for pricing should be applicable in calculating VaR. Correlation and basis risks should be captured in the VaR model.

LO 61.4

Stressed VaR (SVaR) is the VaR within a time frame that contains significant losses in a portfolio, normally within a 12-month period. It is the higher number between its latest available SVaR and the average of the SVaR numbers over the previous 60 business days multiplied by a factor, which is subject to an absolute minimum of three.

LO 61.5

The market risk capital requirement is the summation of the SVaR measure, described previously, and the higher number between its previous day's VaR_{t-1} number and the average of the daily VaR values on each of the preceding 60 business days, multiplied by a multiplication factor with a plus factor.

LO 61.6

Qualitative disclosure for the incremental risk capital charge should include methodologies used by the bank to determine liquidity levels, in model validation, and to meet criteria in capital assessment.

LO 61.7

Quantitative disclosures for trading portfolios under the internal models approach should include high, mean, and low values of the VaR and SVaR, as well as important outliers and incremental risk capital charges over the reporting period.

LO 61.8

Banks are expected to maintain procedures for computing adjustment to the most current value of less liquid positions regardless of whether the position is marked-to-market, marked-to-model, or obtained through third-party valuation.

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Concept Checkers

1. Approaches used for calculating capital charge for specific risk include which of the following?
   A. Following the exact approach adopted for calculating capital charge for general risk.
   B. The standardized approach.
   C. The basic indicator approach.
   D. Treating rated and unrated positions the same.

2. There are direct links between the market risk factors used for pricing and those used for calculating VaR. Which of the following descriptions is incorrect for establishing these links?
   A. Changes in interest rates will impact the level of a bank's spread risk.
   B. Volatility in equity prices will have no effect on a bank's calculation of VaR.
   C. Fluctuation in a particular foreign exchange rate could affect a bank's net position if it has significant exposure to this foreign currency.
   D. Even with limited positions in commodity-based products, a bank should still track its risk exposure by using one risk factor for each commodity.

3. Which of the following characteristics outlined describe the measurement of stressed value at risk?
   A. The stressed VaR is calculated on a monthly basis.
   B. Historical bank data from the same portfolio is used in measuring SVaR.
   C. The stressed confidence interval is a 95% one-tailed test.
   D. The multiplication factor used in calculating SVaR is the same as that for VaR.

4. In calculating the market risk capital requirement, the following statements are all true except:
   A. both VaR and stressed VaR are considered in calculating capital charge of market risk.
   B. the average value of VaR in the preceding 60 business days is taken into account.
   C. the equation for calculating market risk capital requirement uses a 99% two-tail confidence interval.
   D. only VaR is used when generating backtest results.

5. One of the important revisions to the Basel II market risk framework requires prudent valuation of all trading positions. Which of the following characteristics listed below reflect prudent practice in this area?
   I. Changes to the value of the position for financial reporting do not need to be included.
   II. Positions valued for liquidity level need to be marked-to-market only.

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

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Concept Checker Answers

1. **B** There are two approaches for determining capital charges for specific risk under a securitization framework: (1) the standardized approach and (2) the internal ratings-based (IRB) approach.

2. **B** When pricing based on interest rates, a bank can generate a separate yield curve for different instruments in order to capture interest rate risk and spread risk between bonds and swaps. A bank should also utilize a foreign exchange risk factor if it has significant exposure to that particular foreign currency. For commodity price risk, a single risk factor is sufficient to capture risk in commodity prices with a limited or aggregate position.

3. **B** The stressed value at risk should be calculated on a weekly basis. This measure is calculated by combining current portfolio performance data based on the 10-day, 99% confidence interval with firm's historical data from a significantly financially stressed period of the same portfolio.

4. **C** The equation for calculating market risk capital requirement uses a 99% one-tail confidence interval.

5. **D** There are a few factors to consider when determining the accuracy and suitability of the adjustment for illiquid positions. They include, but are not limited to, the market concentrations, the average volatility of the bid-ask spread, the volatility and average trading volumes, the age of the positions, and the amount of time needed to hedge risks from a given position.

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

Basel III: The Net Stable Funding Ratio

Topic 62

Exam Focus

In order to address liquidity and the stability of funding at internationally active financial institutions, the Basel Committee has developed two minimum standards, the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR). This topic focuses on the goals, application, and calculation of the net stable funding ratio. The goal of the ratio is to ensure that institutions can withstand longer-term liquidity shocks of up to one year by requiring institutions to use longer-term stable sources of funding to finance long-term assets and off-balance sheet exposures. The NSFR is defined as the available amount of stable funding relative to the required amount of stable funding. The ratio must be at least 100%, should be calculated on an ongoing basis, and should be reported at least quarterly.

Net Stable Funding Ratio

LO 62.1: Define and discuss the net stable funding ratio (NSFR).

In the last few decades, banks have increased their reliance on cheap and available sources of **wholesale funding** to fund assets and expand their balance sheets. Wholesale funding is generally defined as funding from private markets. It has historically been used to supplement deposits and provides banks with a great deal of funding flexibility. Wholesale funding is a catch-all phrase that includes, but is not limited to, Federal funds, repurchase agreements, and brokered deposits. These sources of funding tend to be less stable than equity and other core funding sources (e.g., retail and small business demand deposits). As the 2007–2009 financial crisis exposed, some types of funding dry up in periods of financial stress. Many banks met capital requirements during the crisis but still had problems because of poor liquidity management. As such, one of the Basel Committee's reforms to promote a more resilient banking sector addresses the stability of bank funding with the **net stable funding ratio** (NSFR).

The Basel Committee has strengthened the liquidity framework by developing two minimum standards that address liquidity and the stability of funding. First, the liquidity coverage ratio (LCR), described in Topic 60, seeks to ensure that banks have sufficient high-quality liquid assets (HQLA) to survive a short-term stress scenario of up to 30 days. Second, the NSFR requires banks to maintain longer-term, stable sources of funding. While the goal of the liquidity coverage ratio is to make banks more resilient to liquidity shocks in the short-run, the goal of the NSFR is to protect banks over a longer time horizon. The NSFR promotes a sustainable maturity structure for assets and expects banks to do a better job of matching the maturity of liabilities to assets, rather than relying so heavily on very short-term wholesale funding, which can be severely limited in times of stress.

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The NSFR is defined as the available amount of stable funding relative to the required amount of stable funding. The ratio must be at least 100%. The definition of the standard is:

$$\frac{\text{Available Amount of Stable Funding}}{\text{Required Amount of Stable Funding}} \geq 100\%$$

Stable funding sources, by definition, must be reliable over a one-year time horizon under conditions of extended stress. The amount of stable funding required will vary from institution to institution, depending on the liquidity characteristics of the institution's assets and off-balance sheet exposures. Funding stability is calibrated across two dimensions:

1. *Funding tenor.* Longer term liabilities are assumed to be more stable than shorter term liabilities.

2. *Funding type and counterparty.* Short-term deposits (maturities of less than one year) supplied by retail customers (e.g., individual checking and savings accounts) and small business customers, are assumed to be behaviorally more stable than the same maturity funds supplied by capital markets (i.e., wholesale funding sources).

All illiquid assets and securities should be backed by stable funding sources, according to this methodology. In addition, there should be stable funding sources to at least partially support potential calls on liquidity arising from off-balance sheet commitments and contingent funding obligations.

In terms of establishing stable funding requirements, Basel III recognizes that:

- At least some portion of loans must be funded with stable funding sources to ensure the continuity of lending in the economy.
- In the interest of preserving bank/customer relationships, banks will likely roll over a significant portion of maturing loans.
- Some short-term assets require a smaller portion of stable funding because the assets are likely to be allowed to mature rather than be rolled over.
- Unencumbered, high-quality assets that can be readily securitized or sold, and thus can be used as collateral to secure funding, require a smaller portion of stable funding.

Available Stable Funding

LO 62.2: Define and discuss the amount of available stable funding (ASF).

The stability of bank funding sources, and the different propensities of certain providers of funds to withdraw funding, is at issue when defining the sources that qualify as stable funding. The numerator of the NSFR is the bank's **available stable funding** (ASF). To calculate the ASF, first the carry value (i.e., the value of the liability or equity account that is recorded before regulatory deductions or adjustments) of the institution's capital and liabilities are assigned to a category that captures the stability of the source. Liabilities and capital can receive a 100% ASF factor, a 95% factor, a 90% factor, a 50% factor, or a 0% factor. The value is multiplied by the factor and the weighted values are summed.

The goal is for banks to have an ongoing source of funds during stress periods. Stress, in this case, could include customers becoming aware of significant declines in the bank's profitability and/or solvency, downgrades of debt, deposit, or counterparty credit ratings, or a material event that causes the market to reevaluate the bank's reputation or credit quality.

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The Basel Committee does not want banks to rely heavily on central bank funding in times of liquidity stress events, and thus does not include extended borrowing from central bank lending facilities (outside of open market operations) in the calculation of stable funding sources. Note in Figure 1 that central bank funding is given a 50% or 0% weight, depending on the funding's residual maturity.

As noted, capital and liabilities are assigned to one of five available sources of stable funding categories. The amount of funds in each category is multiplied by the ASF factor and then the values are summed to arrive at the total available amount of stable funding (i.e., the numerator of the NSFR). Figure 1 indicates the factors, as well as the funding sources, assigned to each category.

Figure 1: Stable Funding Sources and Their Associated ASF Factors

ASF Factor	*Types of Funding*
100%	The total amount of regulatory capital (before the application of regulatory deductions) as defined by Basel III, excluding Tier 2 instruments with residual maturities of less than one year. In addition, secured and unsecured borrowings, including term deposits, with effective residual maturities of one year or more.
95%	Stable, non-maturity demand or term deposits provided by retail and small business customers (residual maturities of < one year).
90%	Less-stable, non-maturity demand or term deposits provided by retail or small business customers (residual maturities of < one year).
50%	Operational deposits, unsecured wholesale funding provided by non-financial corporations, sovereigns, multilateral development banks or public sector entities (PSEs) (residual maturities of < one year) and other secured and unsecured funding with residual maturities between six months to less than one year, including funding from financial institutions and central banks.
0%	All other liability and equity categories not included above, including funding with residual maturities of less than six months provided by financial institutions and central banks and other liabilities without stated maturities. Also, NSFR derivatives liabilities net of derivatives assets if derivatives liabilities are greater than derivatives assets, and "trade date" payables arising from the purchase of commodities, foreign currencies, and other financial instruments.

Required Stable Funding

LO 62.3: Define and discuss the required stable funding (RSF) for assets and off-balance sheet exposures.

The **required stable funding** (RSF) and the associated RSF factors are described in Figure 2. The RSF is based on the liquidity risk profile of the financial institution's assets and off-balance sheet (OBS) exposures. The goal of the ratio is to fund assets and OBS exposures that do not mature, are rolled over, and/or those that cannot be sold or used as collateral for borrowing over the course of one year. These assets and OBS exposures should be funded with required stable funding.

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Assets and OBS exposures are assigned to the categories described in Figure 2. The values are then multiplied by the factors in each category and the weighted amounts are summed.

Professor's Note: Keep in mind that Figure 1 includes the definitions of funding sources that will be used to cover the required funding in Figure 2, assuming a period of extended (up to one year) liquidity stress. Figure 1 includes funding sources that will satisfy the numerator of the net stable funding ratio, and Figure 2 includes the requirements of that liquidity that is specified in the denominator of the NSFR. Both the numerator and the denominator are weighted sums, based on the respective ASF and RSF factors.

Figure 2: Required Funding and their Associated RSF Factors

RSF Factor	*Types of Funding*
0%	Cash available to meet obligations and not encumbered as collateral or held for a planned use, central bank reserves, claims on central banks with residual maturities of less than six months, and "trade date" receivables arising from the sale of commodities, foreign currencies, and other financial instruments.
5%	Unencumbered Level 1 assets (as defined in LO 60.3) including marketable securities representing claims on or guaranteed by sovereigns, central banks, PSEs, and so on. They are assigned a 0% risk weight in the Basel II framework and are assumed to have an active repo or sales market available.
10%	Unencumbered loans to financial institutions with residual maturities less than six months where the loan is secured against Level 1 assets and the bank can freely rehypothecate the received collateral for the life of the loan.
15%	Unencumbered Level 2A assets (as defined in LO 60.3) including: all other unencumbered loans with residual maturities less than six months not included in the categories above, unencumbered corporate bonds rated AA or higher, unencumbered marketable securities representing claims on or guaranteed by sovereigns, central banks, PSEs, and so on. They are assigned a 20% risk weight in the Basel II standardized approach for credit risk.
50%	Unencumbered Level 2B assets (as defined in LO 60.3) including: high-quality liquid assets (HQLA) encumbered for a period of six months or more and less than one year, loans to financial institutions and central banks with residual maturities between six months and one year, deposits held at other institutions for operational purposes and other assets not included above with residual maturities of less than one year, including loans to non-financial corporate clients, loans to retail customers, loans to small businesses, and loans to sovereigns and PSEs.
65%	Unencumbered residential mortgages that qualify for 35% or lower risk weight + other unencumbered loans with a 35% risk weight (excluding loans to financial institutions).
85%	Cash posted as initial margin for derivatives contracts, unencumbered performing loans with risk weights greater than 35% and residual maturities of one year or more, excluding loans to financial institutions and physical traded commodities including gold.
100%	All other assets not included above including: nonperforming loans and loans to financial institutions with residual maturities of one year or more, assets that are encumbered for one year or more, NSFR derivatives assets net of derivatives liabilities if derivatives assets are greater than derivatives liabilities and 20% of derivatives liabilities.

National supervisors can specify RSF factors for OBS exposures based on specific circumstances.

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NSFR Application

LO 62.4: Explain the application issues for the NSFR.

The NSFR should be calculated on an ongoing basis and should be reported at least quarterly. In addition, the NSFR should be applied to all internationally active banks worldwide. Use of the ratio will ensure greater consistency across banks and will help level the playing field between internationally active banks and domestic banks. However broadly the NSFR is applied, the Basel Committee notes that all financial institutions should actively monitor and control liquidity risk exposures. They indicate that the monitoring and control activities should take place at the individual legal entity, foreign branch, and/or subsidiary levels. They also indicate the firms should be aware of legal, regulatory, and operational limitations on the transferability of liquidity between entities.

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Key Concepts

LO 62.1

The net stable funding ratio (NSFR) focuses on longer-term liquidity and is intended to protect banks over a one-year horizon. The NSFR is defined as the available amount of stable funding relative to the required amount of stable funding. The ratio must be greater than or equal to 100%.

LO 62.2

Available stable funding (ASF) sources include, but are not limited to, the following:

- Capital.
- Preferred stock with a maturity ≥ one year.
- Liabilities with an effective maturity ≥ one year.
- Non-maturity deposits and time deposits that would be expected to stay at the bank in periods of extended stress.

Capital and liabilities are assigned to one of five available sources of stable funding categories (100%, 95%, 90%, 50%, and 0%). The amount of each category of funding is multiplied by the ASF factor and then the values are summed to arrive at the total available stable funding sources.

LO 62.3

Required funding includes anything that must (or may) be funded by the bank in the next year. There are required stable funding (RSF) factors that are applied to each category of assets and off-balance sheet (OBS) exposures, ranging from 0% to 100%. The RSF is based on the liquidity risk profile of the institution's assets and OBS exposures. For example, cash and bank reserves are assigned a 0% weight because they will not have to be funded in the next year while unencumbered residential mortgages are assigned a 65% weight because they may have to be funded in the next year.

LO 62.4

The NSFR should be calculated on an ongoing basis and should be reported at least quarterly. Also, the NSFR should be applied to all internationally active banks.

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Concept Checkers

1. With respect to the net stable funding ratio, Basel III assumes that:
   A. a significant portion of loans will be rolled over at maturity to maintain customer relationships.
   B. funding provided by the capital markets is more behaviorally stable than same maturity deposit funding provided by small businesses.
   C. no assets will be securitized by banks.
   D. some shorter term liabilities are more stable than some longer term liabilities.

2. The point of the net stable funding ratio (NSFR) is to make sure banks and other financial institutions can:
   A. withstand a severe liquidity shock that lasts up to 30 days.
   B. fund capital accounts with reliable common equity financing.
   C. survive liquidity shocks that last for longer periods of time, up to one year.
   D. maintain sufficient deposit sources of funding to finance assets after all wholesale funding and capital are deducted.

3. Demand deposits and deposits from small businesses are most likely considered:
   A. stable and will be assigned to the 100% ASF category.
   B. relatively stable and will be assigned to the 95% or 90% ASF category.
   C. somewhat stable and will be assigned to the 90% or 50% ASF category.
   D. not stable and will be assigned to the 0% ASF category.

4. The required amount of stable funding by Basel III in the net stable funding ratio depends on:
   A. the relative stability of the funding source.
   B. the likelihood that the asset or off-balance sheet exposure will need to be funded for at least one year.
   C. the amount of margin required for an institution's off-balance sheet exposures including all long and short futures positions.
   D. whether the institution is considered well, adequately, or poorly capitalized.

5. The net stable funding ratio should be:
   A. calculated at least annually.
   B. reported at least annually.
   C. calculated at least quarterly.
   D. reported at least quarterly.

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Concept Checker Answers

1. A Basel III assumes: (1) longer term liabilities are more stable than shorter term liabilities, (2) short-term deposits (maturities of less than one year) supplied by retail customers are behaviorally more stable than the same maturity funds supplied by capital markets, (3) at least some portion of loans must be funded with stable funding sources to ensure the continuity of lending in the economy, (4) in the interest of preserving bank/customer relationships, banks will likely roll over a significant portion of maturing loans, (5) some short-term assets require a smaller portion of stable funding because the assets are likely to be allowed to mature rather than be rolled over, and (6) unencumbered, high-quality assets that can be readily securitized or sold, and thus can be used as collateral to secure funding, require a smaller portion of stable funding.

2. C The goal of the liquidity coverage ratio is to make banks more resilient to liquidity shocks in the short-run. The goal of the NSFR is to protect banks over a longer time horizon of up to one year.

3. B Short-term deposits (maturities of less than one year) supplied by retail customers are assumed to be behaviorally more stable than the same maturity funds supplied by capital markets (i.e., wholesale funding). They are assigned to either the 95% or 90% category, depending on their assumed level of stability.

4. B The RSF is based on the liquidity risk profile of the financial institution's assets and off-balance sheet (OBS) exposures. The goal of the ratio is to fund assets that do not mature, are rolled over, and/or those that cannot be sold or used as collateral for borrowing over the course of one year. Therefore, the required amount of stable funding depends on the likelihood that the asset or OBS exposure activity will need to be funded for an extended period of time.

5. D The net stable funding ratio (NSFR) should be calculated on an ongoing basis and should be reported at least quarterly. The NSFR should be applied to all internationally active banks.

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Self-Test: Operational and Integrated Risk Management

10 Questions: 30 Minutes

1. Outsourcing may reduce costs, provide expertise, expand bank offerings, and/or improve bank services. The board of directors and senior management must understand the operational risks that are introduced as a result of outsourcing. Which of the following actions is(are) suggested by the Basel Committee for controlling risks related to outsourcing?

   I. An agreement detailing termination rights and other rights and responsibilities of the two parties involved.
   II. Established policies for restitution in the event of failure on the part of an outside service provider.

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

2. There are five major factors that could lead to a poor or fragmented IT infrastructure at an organization. Which of the following factors is least likely to result in a poor or fragmented IT infrastructure?

   A. Moderate turnover of key IT staff.
   B. Participating in merger and acquisition activities.
   C. Management of a firm that is focused primarily on long-term projects.
   D. Allowing each business line the autonomy to upgrade their IT systems based on the best available resources.

3. Sarah Williams, a risk manager at a mid-size bank in Chicago, has decided that, according to the Basel Committee's guidelines, it would be better to choose a distribution for loss frequency data and another for loss severity data. With respect to severity, Williams should choose a distribution that is most sensitive to:

   A. the tail of the distribution.
   B. the body of the distribution.
   C. the assumptions of the distribution.
   D. the second moment of the distribution.

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4. Given the following data for a project, which of the following statements is most accurate regarding the use of the risk-adjusted return on capital (RAROC)?

- Equity beta: 1.2
- Market return: 13%
- Variance of returns: 5%
- RAROC: 16%
- Risk-free rate: 4%

I. Using the adjusted RAROC, the project should be rejected because the RAROC is less than the market return plus the risk-free rate.
II. Using the adjusted RAROC, the project should be accepted because its adjusted RAROC is higher than the risk-free rate.

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

5. You are holding 100 SkyTrek Company shares with a current price of $30. The daily mean and volatility of the stock return are 2% and 3%, respectively. VaR should be measured relative to initial wealth. The bid-ask spread of the stock varies over time, and the daily mean and volatility of this spread are 0.5% and 1%, respectively. Both the return and spread are normally distributed. What is the daily liquidity-adjusted VaR (LVaR) at a 99% confidence level assuming the confidence parameter of the spread is equal to 3?
A. $103.50.
B. $172.62.
C. $193.15.
D. $202.20.

6. A recently published article on issues with value at risk (VaR) estimates included the following statements.

Statement 1: Differences in the use of confidence intervals and time horizon can cause significant variability in VaR estimates as there is lack of uniformity in practice.
Statement 2: Standardization of confidence interval and time horizon would eliminate most of the variability in VaR estimates.

This article's statements are most likely correct with regard to:
A. Statement 1 only.
B. Statement 2 only.
C. Both statements.
D. Neither statement.

7. Global Transportation, Inc., recently traded at an ask price of $45 and a bid price of $44.50. The sample standard deviation of the bid-ask spread was 0.0001. The 99% spread risk factor for a purchase of Global Transportation is closest to:
A. 0.0057.
B. 0.2541.
C. 25.41.
D. 0.1111.

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8. The Basel Committee has provided guidelines on bank supervision. Which of the following statements is not consistent with their guidelines?
   A. Regulatory capital is used for unexpected, not expected losses.
   B. Banks do not need to maintain reserves for defaulted loans.
   C. Loss given default estimates are calculated using historical default rates.
   D. The term portfolio invariance refers to the fact that risk weights do not incorporate the correlation of the asset with other assets in the portfolio.

9. The standardized model for market risk charges differs from the internal model-based approach in that the standardized model:
   A. sums up market risks across market risk categories, whereas the internal model-based approach uses a multiplicative factor on the average VaR.
   B. sums up market risks across market risk categories, whereas the internal model-based approach focuses solely on specific risk charges.
   C. focuses solely on specific risk charges, whereas the internal model-based approach sums up market risks across market-risk categories.
   D. uses a multiplicative factor on the average VaR, whereas the internal model-based approach sums up market risks across market risk categories.

10. Given the following information, what is Bank X's net stable funding ratio (NSFR)?

• High-quality liquid assets:	$100
• Required amount of stable funding:	$200
• Cash outflows over the next 30 days:	$130
• Net cash outflows over the next 30 days:	$90
• Available amount of stable funding:	$210

A. 65%.
B. 89%.
C. 105%.
D. 125%.

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Self-Test Answers: Operational and Integrated Risk Management

1. A Outsourcing policies should include:
   - Processes and procedures for determining which activities can be outsourced and how the activities will be outsourced.
   - Processes for selecting service providers (e.g., due diligence).
   - Structuring the outsourcing agreement to describe termination rights, ownership of data, and confidentiality requirements.
   - Monitor risks of the arrangement including the financial health of the service provider.
   - Implement a risk control environment and assess the control environment at the service provider.
   - Develop contingency plans.
   - Clearly define responsibilities of the bank and the service provider.

   The Basel Committee does not explicitly suggest establishing policies for restitution in the event of failure on the part of the outside service provider although this could be detailed in the outsourcing agreement.

   (See Topic 38)

2. C Management of a firm that is focused less on short-term financial issues and more on long-term survival is much less likely to encounter problems with poor or fragmented IT infrastructures. Moderate turnover in IT staff, especially key staff, will likely contribute to the problem. Merger and acquisition activity will often result in multiple systems running at the same time so that data aggregation across products and business lines becomes a significant new challenge. Allowing autonomy to each business line will likely result in inconsistency across business lines and could be costly if the systems end up being incompatible due to the inconsistency.

   (See Topic 40)

3. A The choice of distribution related to severity is critical to Advanced Measurement Approach (AMA) models. Medium/heavy-tailed distributions are frequently used. The choice of the frequency distribution is less important to the final outcome than the choice of the severity distribution. Williams's bank should document and be able to verify the choice of a distribution. The bank should undertake exploratory data analysis (EDA) for each ORC in order to understand the statistical profile of the data. This helps the bank choose an appropriate distribution. The bank should also use appropriate techniques and diagnostic tools to evaluate distributions. Preference should be given to distributions that are most sensitive to the tail. Low frequency high impact (LFHI) events, the most severe and costly to the bank, are tail events.

   (See Topic 44)

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4. B The adjusted RAROC (ARAROC) compares the adjusted RAROC to the risk-free rate. So Statement I is incorrect.

The project should be accepted because the ARAROC of 5.2% is greater than the risk-free rate of 4%. So Statement II is correct.

ARAROC = 0.16 – 1.2(0.13 – 0.04) = 0.052.

(See Topic 46)

5. D At the 99% confidence level, you would use an alpha statistic of 2.33 since VaR is a one-tailed test. The liquidity-adjusted VaR = normal VaR + adjustment for liquidity.

Normal VaR = portfolio value × (mean – 2.33 × standard deviation)

Normal VaR = 100 × $30 × (2% – 2.33 × 3%)

Normal VaR = $149.70 (Note that a negative sign is implied here since we are dealing with the value at risk.)

Liquidity adjustment = 0.5 × portfolio value (spread mean + 3 × spread volatility)

Liquidity adjustment = 0.5 × $3,000 × (0.5% + 3 × 1%) = $52.5

LVaR = $149.70 + $52.5 = $202.20

(See Topic 50)

6. A Statement 1 is correct as variability in risk measures, including lack of uniformity in the use of confidence intervals and time horizons, can lead to variability in VaR estimates. Statement 2 is incorrect as other factors can also cause variability, including length of the time series under analysis, ways of estimating moments, mapping techniques, decay factors, and number of simulations.

(See Topic 51)

7. A The formula for the expected transactions cost confidence interval is:

$+/- P \times \frac{1}{2}(s + 2.33\sigma_s)$

where:

P = an estimate of the next day asset midprice, usually set to *P*, the most recent price observation.

s = expected or typical bid-ask spread calculated as (ask price – bid price) / midprice

σ_s = sample standard deviation of the spread

The $\frac{1}{2}(s + 2.33\sigma_s)$ component of the confidence interval is referred to as the 99% spread risk factor.

Midprice = (45 + 44.50) / 2 = 44.75

s = (45 – 44.5) / 44.75 = 0.0112

spread risk factor = ½[0.0112 + 2.33(0.0001)] = 0.0057

(See Topic 52)

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8. C Regulatory capital is used for unexpected losses. Expected losses should be covered by a bank's normal course of business (i.e., loan loss provisions and write-offs). Banks do not need to maintain reserves for defaulted loans because they are covered by the loss given default. Loss given default estimates cannot be calculated using historical default rates. They should be estimated conservatively, assuming economic downturns. Portfolio invariance refers to the fact that risk weights do not explicitly incorporate the correlation of the asset with other assets in the portfolio.

(See Topic 55)

9. A The standardized model approach simply sums the market risks across the market-risk categories. The internal model-based approach applies a multiplicative factor to the average VaR.

(See Topic 55)

10. C The longer-term funding ratio is equal to the available amount of stable funding divided by the required amount of stable funding. Under Basel III, this ratio must equal or exceed 100%. Bank A's net stable funding ratio = $210 / $200 = 105%.

(See Topic 56)

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Formulas

Topic 43

basic indicator approach:

$$K_{BIA} = \frac{\left(\sum_{i=1}^{n} GI_i \times \alpha\right)}{n}$$

where:
GI = annual (positive) gross income over the previous three years
n = number of years in which gross income was positive
α = 15% (set by Basel Committee)

the standardized approach:

$$K_{TSA} = \frac{\left\{\sum_{3\ \text{Years}} \max\left[\sum(GI_{1-8} \times \beta_{1-8}), 0\right]\right\}}{3}$$

where:
GI_{1-8} = annual gross income in a given year for each of the eight business lines
β_{1-8} = beta factors (fixed percentages for each business line)

Topic 46

economic capital:

economic capital = risk capital + strategic risk capital

RAROC:

$$\text{RAROC} = \frac{\text{after-ta expected risk-adjusted net income}}{\text{economic capital}}$$

$$\text{RAROC} = \frac{\left(\begin{array}{l}\text{expected revenues} - \text{costs} - \text{e pected losses} \\ - \text{ta es} + \text{return on economic capital} \pm \text{transfers}\end{array}\right)}{\text{economic capital}}$$

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hurdle rate:

$$h_{AT} = \frac{[(CE \times R_{CE}) + (PE \times R_{PE})]}{(CE + PE)}$$

where:
CE = market value of common equity
PE = market value of preferred equity
R_{CE} = cost of common equity [could be derived from the capital asset pricing model (CAPM)]
R_{PE} = cost of preferred equity (yield on preferred shares)

adjusted RAROC:

$$\text{Adjusted RAROC} = \text{RAROC} - \beta_E (R_M - R_F)$$

Topic 50

$$\text{spread} = \frac{(\text{ask price} - \text{bid price})}{(\text{ask price} + \text{bid price}) / 2}$$

liquidity-adjusted VaR (constant spread):

$$\text{LVaR} = (V \times z_\alpha \times \sigma) + [0.5 \times V \times \text{spread}]$$

$$\text{LVaR} = \text{VaR} + \text{LC}$$

where:
V = asset (or portfolio) value
z_α = confidence parameter
σ = standard deviation of returns

lognormal VaR: $\text{VaR} = [1 - \exp(\mu - \sigma \times z_\alpha)] \times V$

$$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{\text{spread}}{2 \times [1 - \exp(-\sigma \times z_\alpha)]}$$

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elasticity: $E = \frac{\Delta P/P}{\Delta N/N}$

where:
$\Delta N/N$ = size of the trade relative to the entire market

$$LVaR = VaR \times \left(1 - \frac{\Delta P}{P}\right) = VaR \times \left(1 - E \times \frac{\Delta N}{N}\right)$$

$$\left.\frac{LVaR}{VaR}\right|_{combined} = \left.\frac{LVaR}{VaR}\right|_{exogenous} \times \left.\frac{LVaR}{VaR}\right|_{endogenous}$$

Topic 52

leverage ratio: $L = \frac{A}{E} = \frac{(E+D)}{E} = 1 + \frac{D}{E}$

leverage effect: ROE = (leverage ratio × ROA) – [(leverage ratio – 1) × cost of debt]

transactions cost confidence interval: +/– $P \times \frac{1}{2}(s + 2.33\sigma_s)$

where:
P = an estimate of the next day asset midprice, usually set to *P*, the most recent price observation
s = expected or typical bid-ask spread
σ_s = sample standard deviation of the spread

spread risk factor: $\frac{1}{2}(s + 2.33\sigma_s)$

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Topic 55

credit equivalent amount:

$$\max(V, 0) + a \times L$$

where:
V = current value of the derivative to the bank
a = add-on factor
L = principal amount

market risk capital requirement:

$$\max(VaR_{t-1}, m_c \times VaR_{avg}) + SRC$$

where:
VaR_{t-1} = previous day's VaR
VaR_{avg} = the average VaR over the past 60 trading days
m_c = multiplicative factor
SRC = specific risk charge

expected loss:

$$EL = \sum_i EAD_i \times LGD_i \times PD_i$$

required capital = EAD × LGD × (WCDR – PD) × MA

where:
MA = maturity adjustment = $(1 + (M - 2.5) \times b)/(1 - 1.5 \times b)$
M = maturity of the exposure
b = $[0.11852 - 0.05478 \times \ln(PD)]^2$

total capital = 0.08 × (credit risk RWA + market risk RWA + operational risk RWA)

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Topic 56

stressed VaR:

$$\max(VaR_{t-1}, m_c \times VaR_{avg}) + \max(SVaR_{t-1}, m_s \times SVaR_{avg})$$

where:

VaR_{t-1} = previous day's VaR, 10-day time horizon, 99% confidence level

VaR_{avg} = the average VaR over the past 60 days, 10-day time horizon, 99% confidence level

m_c = multiplicative factor, determined by supervisor, minimum value of three

$SVaR_{t-1}$ = previous day's stressed VaR, 10-day time horizon, 99% confidence level

$SVaR_{avg}$ = the average stressed VaR over the past 60 days, 10-day time horizon, 99% confidence level

m_s = stressed VaR multiplicative factor, determined by supervisor, minimum of three

liquidity coverage ratio:

high quality liquid assets / net cash outflows in a 30-day period $\geq$ 100%

net stable funding ratio:

amount of available stable funding / amount of required stable funding $\geq$ 100%

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