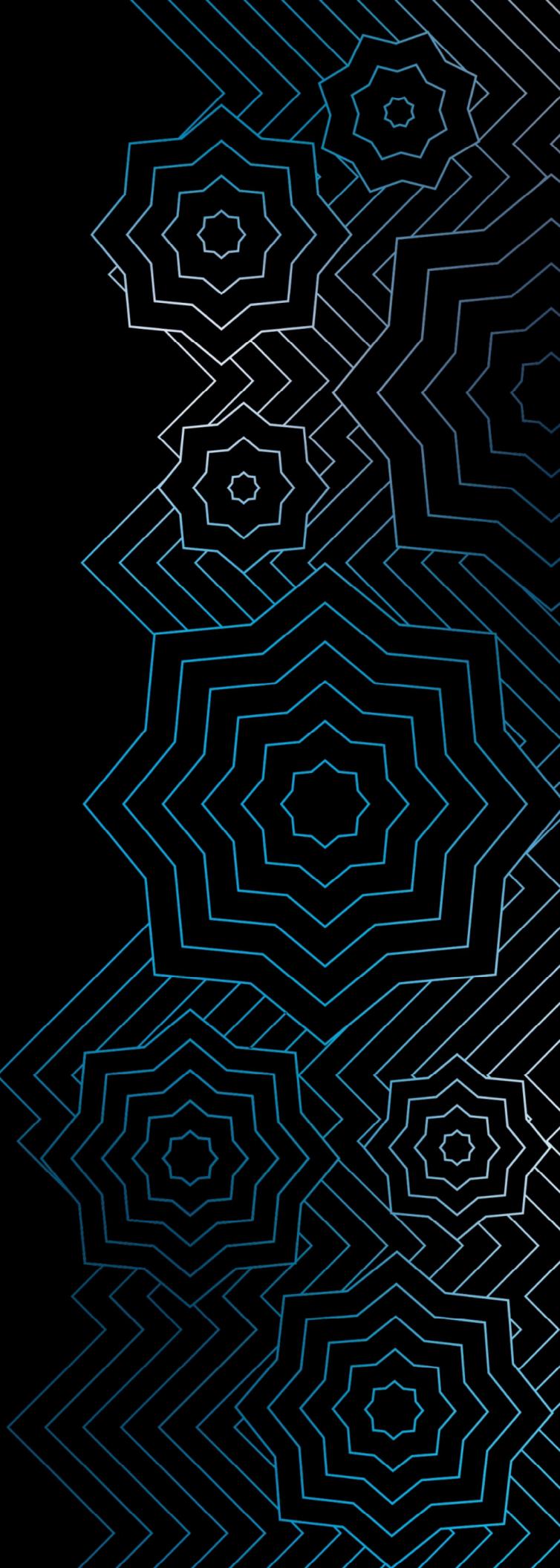


2024

**FRM®**

EXAM PART I

*Foundations of  
Risk Management*



FRM® | Financial Risk Manager



2024

**FRM<sup>®</sup>**

EXAM PART I

*Foundations of  
Risk Management*





# Contents



---

## Chapter 1    The Building Blocks of Risk Management 1

---

<b>1.1 Typology of Risks and Risk Interactions</b>	<b>2</b>
Market Risk	4
Credit Risk	5
Liquidity Risk	5
Operational Risk	6
Business and Strategic Risk	6
Reputation Risk	7
<b>1.2 The Risk Management Process</b>	<b>7</b>
<b>1.3 Identifying Risk: Knowns and Unknowns</b>	<b>8</b>
<b>1.4 Quantitative Risk Metrics</b>	<b>10</b>
Expect the Unexpected	10
From Unexpected to Extreme	10
Risky Relationships	10
Value-at-Risk	11
Expected Shortfall	11
<b>1.5 Risk Factor Breakdown and Interactions Between Factors</b>	<b>11</b>

<b>1.6 Structural Change: From Tail Risk to Systemic Crisis</b>	<b>12</b>
<b>1.7 Human Agency and Conflicts of Interest</b>	<b>12</b>
<b>1.8 Risk Aggregation</b>	<b>13</b>
<b>1.9 Balancing Risk and Reward</b>	<b>14</b>
<b>1.10 Enterprise Risk Management (ERM): More Than Adding Up Risk?</b>	<b>15</b>
<b>Questions</b>	<b>17</b>
<b>Answers</b>	<b>19</b>

---

## Chapter 2    How Do Firms Manage Financial Risk? **21**

---

<b>2.1 Background: The Modern Imperative to Manage Risk</b>	<b>22</b>
Risks from Using Risk Management Instruments	23
Hedging Philosophy	23

<b>2.2 Risk Appetite—What Is It?</b>	<b>24</b>	The Evolving Role of a Risk Advisory Director	50
<b>2.3 Risk Mapping</b>	<b>26</b>	The Special Role of the Board Risk Management Committee	50
<b>2.4 Strategy Selection: Accept, Avoid, Mitigate, Transfer</b>	<b>26</b>	<b>3.5 Risk Appetite and Business Strategy: The Role of Incentives</b>	<b>50</b>
<b>2.5 Rightsizing Risk Management</b>	<b>27</b>	The Role of the CRO	50
<b>2.6 Risk Transfer Toolbox</b>	<b>28</b>	Limits Policies	51
Beer and Metal	29	Monitoring Risk	52
Airline Risk Management: Turbulence Ahead	30	<b>3.6 Incentives and Risk-Taking</b>	<b>52</b>
Interest Rate Risk and Foreign Exchange Risk Management	31	<b>3.7 The Interdependence of Organizational Units in Risk Governance</b>	<b>53</b>
<b>2.7 What Can Go Wrong in Corporate Hedging?</b>	<b>32</b>	<b>3.8 Assessing the Bank's Audit Function</b>	<b>54</b>
<b>Summary</b>	<b>33</b>	<b>Questions</b>	<b>56</b>
<b>Questions</b>	<b>34</b>	<b>Answers</b>	<b>58</b>
<b>Answers</b>	<b>36</b>		

---

## Chapter 3 The Governance of Risk Management **39**

---

<b>3.1 The Post-Crisis Regulatory Response</b>	<b>42</b>
After the Crisis: Industry Restructuring and the Dodd-Frank Act	44
The European Regulatory Response to the GFC: SREP and EBA Stress Tests	45
<b>3.2 Infrastructure of Risk Governance</b>	<b>45</b>
The Board and Corporate Governance	45
From Corporate Governance to Best-Practice Risk Management	46
<b>3.3 Risk Appetite Statement</b>	<b>47</b>
<b>3.4 Implementing Board-Level Risk Governance</b>	<b>49</b>
The Board Audit Committee	49

---

## Chapter 4 Credit Risk Transfer Mechanisms **61**

---

<b>4.1 Overview of Credit Risk Transfer Mechanisms</b>	<b>62</b>
<b>4.2 How Credit Risk Transfer Can Be Useful</b>	<b>63</b>
<b>4.3 The Mechanics of Securitization</b>	<b>65</b>
<b>4.4 From Buy-and-Hold to Originate-to-Distribute</b>	<b>66</b>
<b>Questions</b>	<b>70</b>
<b>Answers</b>	<b>71</b>

---

<b>Chapter 5</b>	<b>Modern Portfolio Theory and Capital Asset Pricing Model</b>	<b>73</b>
5.1 Modern Portfolio Theory	74	
5.2 The Capital Asset Pricing Model	76	
5.3 The Capital Market Line and the Security Market Line	78	
5.4 Estimating Beta	79	
5.5 Performance Measures	80	
Sharpe Performance Index	80	
Treynor Performance Index	80	
Jensen's Performance Index	80	
Link Between the Treynor and Jensen's Performance Measures	81	
Sortino Ratio	81	
Information Ratio	81	
Questions	82	
Answers	83	
<b>Chapter 6</b>	<b>The Arbitrage Pricing Theory and Multifactor Models of Risk and Return</b>	<b>85</b>
6.1 The Arbitrage Pricing Theory	86	
6.2 Different Types of Factor Models	86	
Macroeconomic Factor Models	87	
Fundamental Factor Models	87	
Statistical Factor Models	89	
6.3 Factor Analysis in Hedging Exposure	89	
Questions	90	
Answers	91	
<b>Chapter 7</b>	<b>Principles for Effective Data Aggregation and Risk Reporting</b>	<b>93</b>
7.1 Introduction	94	
7.2 Benefits of Effective Risk Data Aggregation and Reporting	95	
7.3 Key Governance Principles	95	
7.4 Data Architecture and IT Infrastructure	96	
7.5 Characteristics of a Strong Risk Data Aggregation Capability	97	
7.6 Characteristics of Effective Risk Reporting Practices	98	
Conclusion	99	
Appendix	100	
Compliance Levels of 30 Banks	100	
Questions	101	
Answers	102	
<b>Chapter 8</b>	<b>Enterprise Risk Management and Future Trends</b>	<b>103</b>
8.1 ERM: What Is It and Why Do Firms Need It?	104	
8.2 ERM—A Brief History	105	
8.3 ERM: From Vision to Action	106	
8.4 Why Might Enterprise Risk Demand ERM: Four Key Reasons	107	
Top to Bottom—Vertical Vision	107	
Are There Potentially Dangerous Concentrations of Risk within the Firm?	108	

---

Thinking Beyond Silos	108	<b>9.4 Model Risk</b>	<b>128</b>
Risk Retention Decisions: Self-Insurance and Captive Insurance	108	Wrong Assumptions—The Niederhoffer Put Options	129
<b>8.5 The Critical Importance of Risk Culture</b>	<b>109</b>	Long Term Capital Management and Model Risk: When “Normal” Relationships Breakdown	129
Discussion—Five Culture Clashes	112	Trading Models	130
<b>8.6 Scenario Analysis: ERM’s Sharpest Blade?</b>	<b>113</b>	Risk Measurement Models and Stress Testing	130
Scenario Analysis Before the Global Financial Crisis	114	Model Risk and Governance—The London Whale	131
Post-Crisis Trends in Scenario Building	114	Setting the Scene	131
Stress Testing in Europe: Future Directions	116	The Risk Exposure Grows	131
<b>8.7 ERM and Strategic Decisions</b>	<b>116</b>	Operational Risk	131
<b>8.8 Conclusion: Risk Management and the Future</b>	<b>117</b>	Corporate Governance: Poor Risk Culture	132
Questions	120	Model Risk: Fudging VaR Models	132
Answers	121	<b>9.5 Rogue Trading and Misleading Reporting</b>	<b>132</b>
		Barings, 1995	132
<b>Chapter 9 Learning from Financial Disasters</b>	<b>123</b>	<b>9.6 Financial Engineering</b>	<b>134</b>
<b>9.1 Interest Rate Risk</b>	<b>124</b>	The Risks of Complex Derivatives	134
The Savings and Loan Crisis	124	The Case of Excess Leverage and Complex Financial Instruments: Orange County	134
<b>9.2 Funding Liquidity Risk</b>	<b>124</b>	The Case of Investing in AAA Tranches of Subprime CDOs: Sachsen	135
Liquidity Crisis at Lehman Brothers	125	<b>9.7 Reputation Risk</b>	<b>135</b>
Liquidity Crisis at Continental Illinois	125	Volkswagen Emission Cheating Scandal	135
Northern Rock—Liquidity and Business Models	126	<b>9.8 Corporate Governance</b>	<b>135</b>
Lessons Learned	126	Enron	136
<b>9.3 Constructing and Implementing a Hedging Strategy</b>	<b>127</b>	Aftermath	137
Metallgesellschaft—How a Dynamic Hedging Strategy Can Go Wrong	127	<b>9.9 Cyber Risk</b>	<b>137</b>
Hedging Considerations	128	The SWIFT Case	137
		Conclusion	137
		Questions	138
		Answers	139

<b>Chapter 10</b>	<b>Anatomy of the Great Financial Crisis of 2007–2009</b>	<b>141</b>		
			<b>Questions</b>	<b>150</b>
			<b>Answers</b>	<b>152</b>
			<hr/>	
	<b>Chapter 11</b>	<b>GARP Code of Conduct</b>	<b>153</b>	
			<b>I. Introductory Statement</b>	<b>154</b>
			<b>II. Code of Conduct</b>	<b>154</b>
			1. Principles	154
			2. Professional Standards	154
			<b>III. Rules of Conduct</b>	<b>155</b>
			1. Professional Integrity and Ethical Conduct	155
			2. Conflict of Interest	155
			3. Confidentiality	155
			4. Fundamental Responsibilities	155
			5. General Accepted Practices	155
			<b>IV. Applicability and Enforcement</b>	<b>156</b>
		<b>Index</b>		<b>157</b>



# PREFACE

8331

I want to thank you on behalf of GARP's Board of Trustees and our professional certification program staff for your support of the Financial Risk Manager (FRM®) program.

It's gratifying to see that in the 26 years since the first FRM examination, the FRM program has become the global standard for educating and credentialing financial risk management professionals. Its worldwide effects in furthering the understanding and acceptance of financial risk management have been highly positive and, in many ways, transformative.

COVID is thankfully in the rearview mirror. We now can be much more flexible in expanding—and in certain instances re-focusing and updating—the FRM program to address the many new challenges encountered by financial institutions globally.

Our FRM program advisory committee, consisting of senior risk professionals from around the world, that meets regularly to debate and settle the FRM program's subject coverage, has found no shortage of subjects for inclusion in the FRM curriculum.

One of the advisory committee's more-material challenges is to understand and assess where the global financial services industry is headed, and then identify issues and subjects most important for risk management professionals.

The FRM advisory committee also recommends how the FRM program covers subject matter. Its objective is to ensure that candidates who complete the FRM program successfully can be confident that their skills have been assessed objectively, and that they possess the requisite knowledge to succeed as a risk management professional anywhere in the world.

The FRM program's coverage is dynamic. The advisory committee reacts to and tries to anticipate market changes, global economic trends, technological advances, and regulatory adjustments; and assesses how these will affect the necessary knowledge and skill sets of a risk management professional.

The biggest change to the program's coverage for 2024 revolves around credit risk measurement and management. About two-thirds of the subject readings in *Credit Risk Measurement and Management* were updated for 2024.

Notably in 2023, GARP expanded the FRM program's coverage of operational resilience, an issue of rapidly growing importance around the world. Materials deal with structural vulnerabilities and areas of the financial system that may be under stress. The transmission of shocks to the financial system, and the assessment, modeling, and measurement of potential points of failure are other important covered concepts.

Also notable in 2023, GARP added two chapters on machine learning (ML) in the FRM Part I *Quantitative Analysis* book. These chapters not only introduce the ML methods risk managers need to understand, but also address key issues associated with artificial intelligence (AI) and ML, including transparency, interpretability, and explainability; data considerations; and risks that arise from the use of AI/ML, including the potential for bias, discrimination, and unethical behavior.

Throughout the FRM curriculum, GARP aims, wherever possible, to present lessons learned from noteworthy current events to contextualize program content and give FRM candidates critical insight.

As you will see from reviewing the program's coverage and readings, it keeps up with a world that is becoming more interconnected and complex by the day.

GARP is committed to offering a program that is dynamic, sophisticated, and responsive to the needs of financial institutions and risk professionals around the world.

We wish you the very best as you study for the FRM exams. And much success in your career as a risk-management professional.

Yours truly,



Richard Apostolik  
President & CEO



# FRM® COMMITTEE

## Chairperson

### **Nick Strange, FCA (Chair)**

Senior Technical Advisor, Operational Risk & Resilience,  
Prudential Regulation Authority, Bank of England

## Members

### **Richard Apostolik**

President and CEO, GARP

### **Richard Brandt**

MD, Operational Risk Management, Citigroup

### **Julian Chen, FRM**

SVP, FRM Program Manager, GARP

### **Chris Donohue, PhD**

MD, GARP Benchmarking Initiative, GARP

### **Donald Edgar, FRM**

MD, Risk & Quantitative Analysis, BlackRock

### **Hervé Geny**

Former Group Head of Internal Audit, London Stock Exchange Group

### **Aparna Gupta**

Professor of Quantitative Finance

Associate Dean, Academic Affairs

A.W. Lawrence Professional Excellence Fellow

Co-Director and Site Director, NSF IUCRC CRAFT

Lally School of Management

Rensselaer Polytechnic Institute

### **John Hull**

Senior Advisor

Maple Financial Professor of Derivatives and Risk Management,

Joseph L. Rotman School of Management, University of Toronto

### **Keith Isaac, FRM**

VP, Capital Markets Risk Management, TD Bank Group

### **William May**

SVP, Global Head of Certifications and Educational Programs,  
GARP

### **Attilio Meucci, PhD, CFA**

Founder, ARPM

### **Victor Ng, PhD**

Chairman, Audit and Risk Committee

Former MD, Head of Risk Architecture, Goldman Sachs

### **Matthew Pritsker, PhD**

Senior Financial Economist and Policy Advisor/Supervision,  
Regulation, and Credit, Federal Reserve Bank of Boston

### **Samantha C. Roberts, PhD, FRM, SCR**

Instructor and Consultant, Risk Modeling and Analytics

### **Til Schuermann, PhD**

Partner, Oliver Wyman

### **Evan Sekeris, PhD**

Head of Non-Financial Risk, MUFG

### **Sverrir Þorvaldsson, PhD, FRM**

Senior Quant, SEB

# ATTRIBUTIONS



## Contributors

**Frank J. Fabozzi**, PhD, Professor of Finance at EDHEC Business School

**Michel Crouhy**, PhD, Head of Research and Development, NATIXIS Corporate and Investment Bank

**Robert Mark**, PhD, Managing Partner, Black Diamond Risk Enterprises

**Dan Galai**, PhD, Abe Gray Professor of Finance and Business Administration at the Hebrew University

## Reviewers

**Bernadette Minton**, PhD, Arthur E. Shepard Endowed Professorship in Insurance and Chair, Department of Finance, The Ohio State University

**David W. Wiley**, MBA, CFA, President, WHW Investments, LLC

**Luca Blasi**, FRM, ACMA, Head of the Valuation and Trading Control Unit, Prudential Regulatory Authority—Bank of England

**Patrick Steiner**, FRM, Large Institution Supervision Coordinating Committee, Federal Reserve Bank of New York

**Dan Pugh**, FRM, Chief Legal and Risk Officer, Corporate Secretary, and Global Risk Manager, GSE Systems

**Jesus Gonzalez**, FRM, Vice President, Director of Market Risk Analytics, BB&T





# 1

# The Building Blocks of Risk Management

## ■ Learning Objectives

After completing this reading, you should be able to:

- Explain the concept of risk and compare risk management with risk taking.
- Evaluate, compare, and apply tools and procedures used to measure and manage risk, including quantitative measures, qualitative risk assessment techniques, and enterprise risk management.
- Distinguish between expected loss and unexpected loss and provide examples of each.
- Interpret the relationship between risk and reward and explain how conflicts of interest can impact risk management.
- Describe and differentiate between the key classes of risks, explain how each type of risk can arise, and assess the potential impact of each type of risk on an organization.
- Explain how risk factors can interact with each other and describe challenges in aggregating risk exposures.

Risk, in the most basic sense, is the possibility that bad things might happen. Humans evolved to manage risks such as wild animals and starvation. However, our risk awareness is not always suited to the modern world (as anyone who has taught a child to cross the road knows). Behavioral science shows that we rely too much on instinct and personal experience, as biases skew our thought processes. Furthermore, even the way we frame risk decisions irrationally influences our willingness to take risk.

Even so, surprisingly sophisticated examples of risk management can be seen in early history. In ancient times, merchants and their lenders shared risk by tying loan repayments to the safe arrival of shipments using maritime loans (i.e., combining loans with a type of insurance). The insurance contract separated from the loan contract as early as the fourteenth century in northern Italy, creating the first standalone financial risk transfer instrument. From the seventeenth century onward, a more methodical approach to the mathematics of risk can be traced. This was followed by the development of exchange-based risk transfer in the form of agricultural futures contracts in the eighteenth and nineteenth centuries (Figure 1.2).

That methodical approach continued to evolve in the twentieth century and beyond, with major advances in financial theory in the 1950s; an explosion in risk management markets from the 1970s onwards; and the emergence of new instruments, such as cyber risk insurance, in the early twenty-first century. Risk management is an old craft but a young science—and an even younger profession.

How we think about risk is the biggest determinant of whether we recognize risks, assess them properly, measure them using appropriate risk metrics, and succeed in managing them.

This introductory chapter looks at the definitions of risk, the classic risk management process, the principal types of risk, and the tools used to track risk and make decisions. We isolate 10 risk management building blocks along the way (Figure 1.1).<sup>1</sup>

Most risk management disasters are caused by the failure to properly recognize and/or deal with one or more of these fundamental building blocks, rather than the failure of some sophisticated risk management technique. Centuries-old financial institutions have been bankrupted because their risk management procedures ignored a certain type of risk,

1. The risk management process
2. Identifying risk: knowns and unknowns
3. Expected loss, unexpected loss, and tail loss
4. Risk factor breakdown
5. Structural change: from tail risk to systemic crisis
6. Human agency and conflicts of interest
7. Typology of risks and risk interactions
8. Risk aggregation
9. Balancing risk and reward
10. Enterprise risk management (ERM)

**Figure 1.1** Ten risk management building blocks.

misunderstood connections between risks, or did not follow the classic steps in the risk management process.

## 1.1 TYPOLOGY OF RISKS AND RISK INTERACTIONS

Risk is a wild animal, circling the campfire in the dead of night. But what kind of animal is it?

Figure 1.3 sets out a typology of risks in the financial industry.<sup>2</sup> Given the variety of business models that firms pursue, corporate risks take many forms. However, most firms face risks that can be categorized within the risk typology discussed in this chapter.

This kind of typology has many uses. It can help organizations drill down into the risk-specific factors within each risk type, map risk management processes to avoid gaps, and hold staff accountable for specific risk domains.

Indeed, Figure 1.3 relates quite closely to how risk functions are organized at many banks and large corporations, where there are often particular functions for market risk, credit risk, etc. Many of these risk functions worked quite independently of one another until an effort to build a more unified risk management approach began in the mid-1990s.

Each key risk type demands a specific set of skills and its own philosophical approach. For example, most banks treat market and credit risks as a natural part of their business. They recognize that risk scales alongside reward and actively pursue risky assets

<sup>1</sup> Not every risk practitioner will agree with our choice. The building blocks are not discussed in order of importance, and not every firm needs to develop a sophisticated approach to each building block, but we would argue that an awareness of each of our 10 building blocks is a good place to start thinking about risk management.

<sup>2</sup> For a more detailed description of financial risks see M. Crouhy, D. Galai, and R. Mark, *The Essentials of Risk Management*, 2<sup>nd</sup> ed. (Ch. 1, App.), McGraw Hill, 2014.

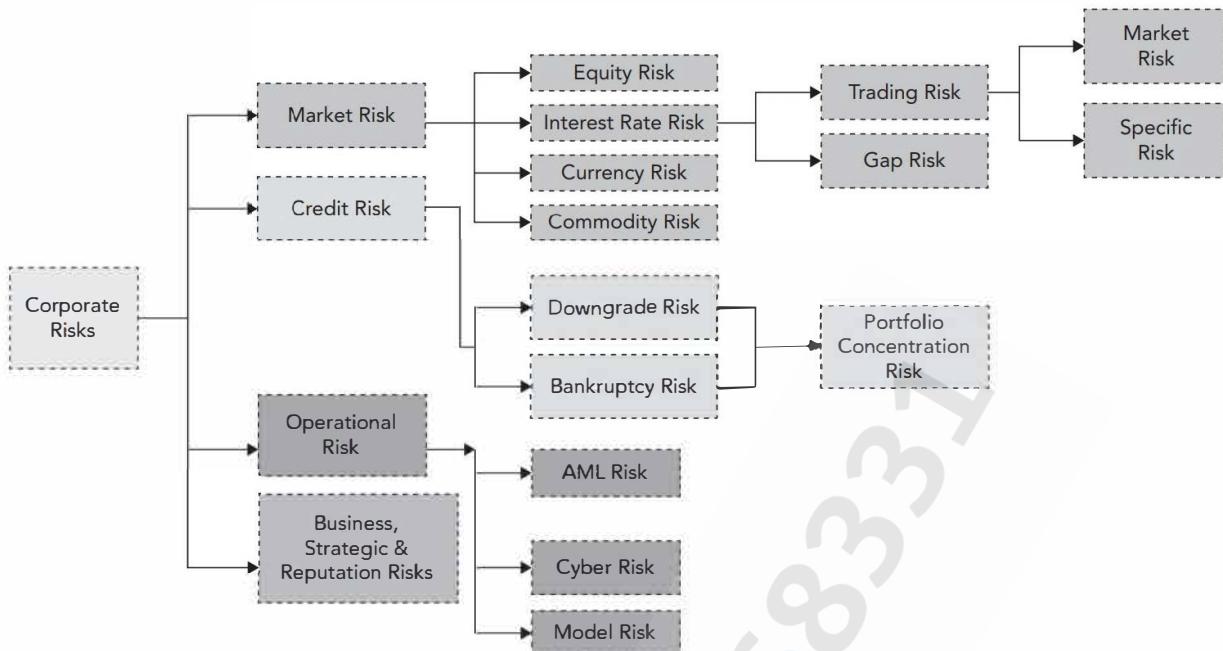
c.1750 BC—Code of Hammurabi records Babylonian maritime loan insurance.	1972 —CME currency futures contracts
Roman era—Burial societies cover funerary expenses with regular premiums.	1973—Chicago Board of Trade (CBOT) options on stocks; Chicago Board Options Exchange (CBOE) created
Early medieval period—Early guilds support members who suffer financial loss.	1973—Black-Scholes option pricing formula
1300s—Shipping insurance matures in Genoa.	Mid 1970s—Treasury bill and bond futures
1583—First recorded life insurance policy in London	1979–1980—OTC currency options and swaps
1650s—Blaise Pascal and Pierre de Fermat lay foundation of probability theory.	Early 1980s—Growth of early OTC markets; first interest rate swaps
1666—Great Fire of London inspires early fire insurance companies.	1983—Interest rate caps and floors
1688—Lloyds (of London) coffee house first mentioned	1987—Commodity swaps; average options; and other path-dependent options
1690s–early 1700s—Development of mortality tables in London	1988—Basel Accord (Basel I) banking reform, focused on credit risk
Late 1600s—early 1700s—Jakob Bernoulli describes law of large numbers/statistical inference.	1990—Collateralized loan obligations
1730—Japanese rice futures traded in Osaka (world's first futures).	Early 1990s—Credit derivatives develop, for example, credit default swaps
1730—Normal distribution and standard deviation described by Abraham de Moivre.	1993—CBOE volatility index (VIX)
1762—First life insurer to calculate premiums in scientific manner (forerunner of Equitable Life)	1994—J.P. Morgan publishes value-at-risk (VaR) methodology (RiskMetrics)
1764—Publication of Thomas Bayes' 1750s work (Bayesian statistics)	1994–1995—Classic cases of derivative misuse, for example, Orange County, Barings Bank
1846—Cologne Re: first dedicated reinsurance company	1996—Market Risk Amendment for Basel I
1864—Chicago Board of Trade lists first US standardized futures contracts (corn).	1998—Russia financial crisis, LTCM near collapse
1875—Francis Galton, British statistician, describes regression to the mean.	1998–1999—Synthetic CDOs (collateralized debt obligations); CDOs of CDOs (CDO squared)
1900—Louis Bachelier models Brownian motion to investigate financial assets.	2001—Terrorist attacks on World Trade Center (9/11); Enron collapse, corporate scandals
Early 1900s—Lloyds underwriters collect catastrophe risk data for pricing, for example, hurricane records.	2002—Sarbanes-Oxley Act (SOX) to prevent fraudulent accounting
1921—Frank Knight explores 'Risk, Uncertainty and Profit'.	2004—Basel II (including operational risk capital)
1950s–1960s—Large corporations self-insure; "risk manager" used for widened insurance purchaser role.	2004–2006—VIX futures, options
1952—Diversification and modern portfolio management: Harry Markowitz	2007–2009—Global Financial Crisis
1961–1966—Capital Asset Pricing Model: William Sharpe and John Lintner	2009—Contingent convertible bonds (CoCos)
1970s—Decade of market liberalization and price and interest rate volatility	2010—Basel III ongoing (including liquidity risk)
	2010—Dodd-Frank Act
	2011 onwards—Fast development of cyber risk transfer market
	2016—Solvency II reform in effect for insurance industry
	2017—Finalized Basel III reforms released

**Figure 1.2 Risk management timeline.**

Note: The dates in this timeline are sometimes an approximation; in particular, the development date of various OTC risk transfer instruments can be open to debate.

(e.g., particular credit segments). An increase in operational risks, on the other hand, does not lead to greater reward, so banks avoid these risks when they can. Below we look at the key risk types in turn, but first a word of warning. Risk typologies must be

flexible because new risks are always emerging. A banking industry risk typology made in the early 1990s may have not considered rogue trading risk or even the entire operational risk class. As of 2020, "new" forms of operational risk are again climbing



**Figure 1.3** A typology of risks for the banking industry.

up the risk manager's watch list: cyber risk (particularly the risk of hackers stealing and destroying data and compromising systems) and data privacy risk.<sup>3</sup>

Furthermore, the risk types interact with one another so that risk flows. During a severe crisis, for example, risk can flow from credit risk to liquidity risk to market risk, (which was the case during the global financial crisis of 2007–2009). The same can occur within an individual firm: the “fat finger” of an unlucky trader (operational risk) creates a dangerous market position (market risk) and potentially ruins the standing of the firm (reputational risk). That is why a sophisticated understanding of risk types and their interactions is an essential building block of risk management.

## Market Risk

Market prices and rates continually change, driving the value of securities and other assets up and down. These movements create the potential for loss, as price volatility is the engine of market risk.

Market risk takes many forms depending on the underlying asset. From a financial institution's perspective, the key forms are equity risk, interest rate risk, currency risk, and commodity price risk.

Each of these markets has its own risk management tools and methodologies, and we give examples of corporate applications and strategies in Chapter 2. However, across all these markets, market risk is driven by the following.

- **General market risk:** This is the risk that an asset class will fall in value, leading to a fall in the value of an individual asset or portfolio.
- **Specific market risk:** This is the risk that an individual asset will fall in value more than the general asset class.

Market risk can be managed through the relationships between positions. The diversification benefits of a large equity portfolio, for example, form the bedrock of investment risk management.

However, market risk also arises from these relationships. For example, an equity portfolio designed to track the performance of an equity market benchmark might fail to track it perfectly—a special form of market risk. Likewise, a position intended to balance out, or hedge, another position or market price behavior might do so imperfectly—a form of market risk known as basis risk.

For risk managers, this mismatching of price movements is often a bigger problem than any single market risk exposure. For example, a commodity risk manager might decide to use crude oil futures to hedge the price of jet fuel based on the historical relationship between crude oil price movements and jet fuel price movements. However, the hedge may fail due to an adverse change in the historical relationship between the price movement of these two commodities that renders the hedge ineffective, or worse, results in a greater loss than if no hedge was placed.

<sup>3</sup> New risks tend to be born out of a fundamental change in market and industry practice. Bank rogue trading risk rose out of the growth of the derivatives industry and a rise in proprietary trading; bank liquidity risk during the global financial crisis arose out of insidious changes in bank funding strategies and leverage; legal risk in the period since the crisis has been exacerbated by a new wave of class action lawsuits and claims for compensation (not to forget some poor bank behavior); and cyber risk is a product of the digital revolution.

## Credit Risk

Credit risk arises from the failure of one party to fulfill its financial obligations to another party. Some examples of credit risk include

- A debtor fails to pay interest or principal on a loan (bankruptcy risk or default risk);
- An obligor or counterparty is downgraded (downgrade risk), indicating an increase in risk that may lead to an immediate loss in value of a credit-linked security; and
- A counterparty to a market trade fails to perform (counterparty risk), including settlement or Herstatt risk.<sup>4</sup>

Credit risk is driven by the probability of default of the obligor or counterparty, the exposure amount at the time of default, and the amount that can be recovered in the event of a default. These levers can all be altered by a firm's approach to risk management through factors such as the quality of its borrowers, the structure of the credit instrument, and controls on exposure. The structure of the credit instrument involves whether the credit instrument is collateralized or not, the type of collateral if it is collateralized, the priority of the creditor in the case of bankruptcy, and inclusion of protective covenants in the loan agreement that impose restrictions on the borrower so as to protect the lender.

The exposure amount is clear with most loans but can be volatile with other kinds of transactions. For example, a derivative transaction may have zero credit risk at the outset because it has no immediate value in the market. However, it can quickly become a major counterparty credit exposure as markets change and the position of one counterparty gains at the expense of the other counterparty.

Traditionally, the probability of default of an obligor is assessed through identifying and evaluating a selection of key risk factors. For example, corporate credit risk analysis looks at key financial ratios, industry sectors, etc. Meanwhile, the risk in whole portfolios of credit risk exposures is driven by obligor concentration (i.e., the exposure to each obligor relative to the portfolio's value) as well as the relationship between risk factors. The portfolio will be a lot riskier if:

- It has a small number of large loans rather than many smaller loans;
- The returns or default probabilities of the loans are positively correlated (e.g., borrowers are in the same industry or region);

- The exposure amount, probability of default, and loss given default amounts are positively correlated (e.g., when defaults rise, recovery amounts fall).<sup>5</sup>

Risk managers use sophisticated credit portfolio models to uncover risk arising from these combinations of risk factors.

## Liquidity Risk

Liquidity risk is used to describe two quite separate kinds of risk: funding liquidity risk and market liquidity risk.

*Funding liquidity risk* is the risk that covers the risk that a firm cannot access enough liquid cash and assets to meet its obligations. Funding liquidity risk threatens all kinds of firms. For example, many small and fast-growing firms find it difficult to pay their bills quickly enough while still having sufficient funds to invest for the future.

Banks have a special form of funding liquidity risk because their business involves creating maturity and funding mismatches. One example of a mismatch is that banks aim to take in short-term deposits and lend the money out for the longer term at a higher rate of interest. Sound asset/liability management (ALM), therefore, lies at the heartening of the banking business to help reduce the risk. There are various techniques involved in ALM, including gap and duration analyses.<sup>6</sup>

Of course, banks sometimes get it wrong, with disastrous consequences. Many of the banks that failed during the 2007–2009 global financial crisis had built up large maturity mismatches and were vulnerable to the wholesale funding market's perception of their creditworthiness.

*Market liquidity risk*, sometimes known as trading liquidity risk, is the risk of a loss in asset value when markets temporarily seize up. If market participants cannot, or will not, take part in the market, this may force a seller to accept an abnormally low price, or take away the seller's ability to turn an asset into cash and funding at any price. Market liquidity risk can translate into funding liquidity risk overnight in the case of banking institutions too dependent on raising funds in fragile wholesale markets.

It can be very difficult to measure market liquidity risk. Measures of market liquidity in a normal market, for example, might look at the number or volume of transactions and at the spread between the bid-ask price. However, these are not necessarily good indicators that a market will remain liquid during a time of crisis.

<sup>4</sup> Named after the failure of Herstatt bank in Germany. The bank, a participant in the foreign exchange markets, was closed by regulators in 1974. The timing of the closure caused a settlement failure because Herstatt's counterparties had already paid their leg of foreign currency transactions (in Deutsche Marks) only to find the defunct Herstatt unable to pay its leg (in US dollars).

<sup>5</sup> These concepts will be explored later in this book.

<sup>6</sup> See M. Crouhy, D. Galai, and R. Mark, *The Essentials of Risk Management*, 2<sup>nd</sup> ed. (Ch. 8), McGraw Hill, 2014.

## BOX 1.1 BANK OPERATIONAL RISK: MEASURE OR MANAGE?

No one doubts the importance of operational risk, but its measurement remains challenging. The banking industry embarked on the project in the late 1990s, mainly because it seemed logical to set capital aside for operational risk alongside that set aside for credit and market risks. The industry built extensive loss databases along with a set of risk measurement tools including statistical analysis, scorecard systems, sets of key risk indicators, and scenario analysis approaches.

However, many banking regulators remained skeptical about whether these tools could support accurate risk capital allocation. The Basel Committee signaled a change of direction in 2016.<sup>7</sup> It would continue to encourage banks to

understand their operational risk using a variety of tools, but capital allocation would be based on a simpler standardized approach using weighted bank size with a multiplier based on a bank's record of larger operational risk losses.

However, this will not dampen bank efforts to manage operational risk. Operational risk includes the massive legal threats and claims for compensation that have plagued banks since the 2007–2009 global financial crisis. It includes the growing threat of cyber risk and the threat of penalties and lawsuits over data privacy infringements. In all its guises, operational risk remains one of the biggest threats to banks and other large corporations, even if it is impossible to properly measure its true cost.

## Operational Risk

Operational risk can be defined as the "risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events."<sup>8</sup> It includes legal risk, but excludes business, strategic, and reputational risk.

That is a deliberately broad definition, and it includes everything from anti-money laundering risk and cyber risk to risks of terrorist attacks and rogue trading. The outbreaks of rogue trading in the 1990s helped persuade regulators to include operational risk in bank capital calculations.

Looking beyond the banking industry, we might include many corporate disasters under the operational risk umbrella. These include physical operational mishaps and corporate governance scandals, such as the crisis at energy giant Enron in 2001. The management of operational risk is the primary day-to-day concern for many risk managers outside the financial industry, often through insurance strategies.

The definition and measurement of operational risk continues to be problematic, however, especially in the financial industry (Box 1.1).

## Business and Strategic Risk

Business risks lie at the heart of any business and includes all the usual worries of firms, such as customer demand, pricing decisions, supplier negotiations, competition, and managing product innovation.

Strategic risk is distinct from business risk. Strategic risk involves making large, long-term decisions about the firm's direction,

often accompanied by major investments of capital, human resources, and management reputation.

Business and strategic risks consume much of the attention of management in non-financial firms, and they are clearly also a key concern in financial firms. However, it is not obvious how they relate to the other risks that we discuss or fit within each firm's risk management framework. For example, today banks and other financial institutions are facing competition from so-called financial technology [FinTech] companies. Bank management must decide whether to develop those same services internally, acquire those companies, or partner with FinTech companies.

A sudden fall in customer demand, the failure to launch the right kind of new product, or a misplaced major capital investment can threaten a firm's survival. Responsibility for these risks lies with the firm's general management. So what is the role of the risk manager?

The answer lies in three observations.

1. First, the firm's management needs to define its appetite for risk in a holistic manner that embraces the risk of significant business and strategic decisions. Firms can be very conservative with respect to credit risk, yet very entrepreneurial with respect to business risk. However, the logic for that divergence needs to be articulated by management.
2. Second, the chief risk officer and supporting team may have specific skills they can bring to bear in terms of quantifying aspects of business and strategic risk. Credit experts, for example, often become involved in managing supply chain risk. As we discuss in a later chapter, new techniques such as macroeconomic scenario analysis can be adopted to improve business and strategic decisions.
3. Third, business decisions generate large exposures in other risk management areas, such as credit risk and commodity price risk. As a result, financial risk managers must be involved at the start of business planning. For example, it may be impossible to fund

<sup>7</sup> Basel Committee, Standardised Measurement Approach for Operational Risk, March 2016: <https://www.bis.org/bcbs/publ/d355.pdf>. The move built on earlier proposals in 2014.

<sup>8</sup> Basel Committee on Banking Supervision, Principles for the Sound Management of Operational Risk, June 2011, <https://www.bis.org/publ/bcbs195.pdf>, page 3, footnote 5.

the construction of a power station without having some form of energy price risk management strategy in place. Meanwhile in the financial industry, expanding a credit business will increase credit exposures and may necessitate the deliberate lowering of credit standards. Banks that fail to coordinate business, strategic, and risk management goals do not survive for long.

## Reputation Risk

Reputation risk is the danger that a firm will suffer a sudden fall in its market standing or brand with economic consequences (e.g., through losing customers or counterparties).

Reputation risk usually comes about through a failure in another area of risk management that damages confidence in the firm's financial soundness or its reputation for fair dealing. For example, a large failure in credit risk management can lead to rumors about a bank's financial soundness. Rumors can be fatal in themselves. Investors and depositors may begin to withdraw support in the expectation that others will also withdraw support. Banks need to have plans in place for how they can reassure markets and shore up their reputations.

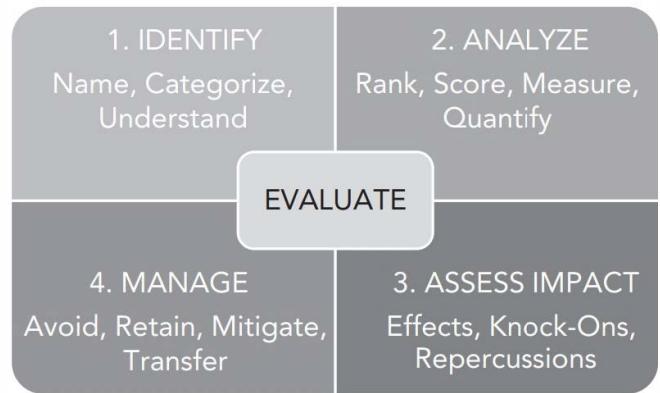
A reputation for fair dealing is also critical. Large firms are expected to behave in certain ways. If a firm misrepresents a product's risks, it can lose important customers.

Reputation with regulators is particularly important to financial institutions. Regulators wield considerable informal as well as formal power. A bank that loses the trust of a regulator may become the subject of extensive examinations and/or its activities may be criticized or curtailed.

## BOX 1.2 BRAINSTORMING AND TRIAGING RISKS

The first steps toward risk identification and triage take some classic forms.

- **Brainstorming:** This could include discussions with representatives from different business divisions to discuss the risk exposures they face and scenarios that could negatively impact their divisions. The most obvious approach is to put the key professionals (e.g., business leaders, audit professionals, etc.) in a room and talk to them. What is your personal professional nightmare? What else could go wrong, why would it go wrong, and how badly could it go wrong? What are the root causes and what are the consequences (e.g., in terms of triggering further risks)? Who is accountable?
- **Structured interviews, questionnaires, and surveys:** These are an attempt to push that initial inquiry out to a wider group of professionals within the company or throughout the industry. They should include open-ended questions.
- **Industry resources:** Unless the activity is unique, there will be industry resources available in the form of checklists, professional and regulatory standards, industry surveys, and expert opinions. These resources should be used to enrich the brainstorming process.



**Figure 1.4** The risk management process.

## 1.2 THE RISK MANAGEMENT PROCESS

We take risks in pursuit of reward, whether that reward is food, shelter, or digital currencies. But the key questions are twofold: (1) is the risk commensurate with the reward, and (2) could we lower the risk and still get the reward? Our attempt to address these questions gives rise to our first building block: the classic risk management process (Figure 1.4).

During this process, the risk manager attempts to: identify the risk (e.g., Box 1.2), analyze and measure the risk, assess the effects of any risk event, and finally manage the risk.

- **Loss data analysis:** Brainstorming often identifies many potential risks. The analyst will next want to look at how the wider industry categorizes each risk and at any internal and external loss records available, to gauge the frequency and severity of loss events and how they relate to specific risk factors.
- **Basic risk triage:** Not every risk is quantifiable in an exact way, but risk managers should be able to determine a given risk's frequency and severity.
- **Hypothetical what-if analysis:** Initial research may suggest worst-case scenarios that the brainstorming team can be asked to consider.
- **Front line observation:** There is no substitute for going to the business line or function and looking at how things are done. Have front-line staff been included in the risk information gathering process?
- **Following the trail:** How are key processes conducted and what are the risks associated with them? Can we see weaknesses or gaps in the process? Can we track our worst nightmares backwards through the process?

Identifying the risk can be just as important as its size in determining the appropriate risk management strategy. Across the corporate world, some risks are regarded as natural to a business and others as quite foreign. Manufacturers, for example, often accept and manage the operational risks of complex factory processes but try to avoid or transfer large market or credit risks. Investors often react badly to mishaps concerning risk types they believe are unnatural to a firm (e.g., a loss from a speculative derivatives position held by a non-financial corporation).

The risk management process culminates in a series of choices that both manage risk and help to define the identity and purpose of the firm.

- **Avoid Risk:** There are risks that can be sidestepped by discontinuing the business or pursuing it using a different strategy. For example, selling into certain markets, or off-shoring production, might be avoided to minimize political or foreign exchange risks.
- **Retain Risk:** There are risks that can be retained within the firm's risk appetite. Large risks can be retained through mechanisms such as risk capital allocation, self-insurance, and captive insurance.
- **Mitigate Risk:** There are risks that can be mitigated by reducing exposure, frequency, and severity (e.g., improved operational infrastructure can mitigate the frequency of some kinds of operational risk, hedging unwanted foreign currency exposure can mitigate market risk, and receiving collateral against a credit exposure can mitigate the severity of a potential default).
- **Transfer Risk:** There are risks that can be transferred to a third party using derivative products, structured products, or by paying a premium (e.g., to an insurer or derivatives provider).

As the risk taker improves its risk management strategy, it will begin to avoid or mitigate non-essential or value-destroying risk exposures, which in turn will allow it to assume more risk in areas where it can pursue more value-creating opportunities for its stakeholders. Investment in risk management thus allows farmers to grow more food, metals producers to produce more metal, and banks to lend more money. Risk management allows firms to excel.

In modern economies, risk management is therefore not only about corporate survival. It is critically important to the broader processes of specialization, scaling, efficiency, and wealth creation.

This explains why risk never really goes away. Risk management success is a platform for greater endeavors. The risk manager is constantly identifying, evaluating, and managing risks to achieve the right balance between creating value and exposing the firm to undue risk. However, identifying and analyzing risk in a fast-changing world remains a major challenge.



**Figure 1.5** Risk managers face the unknown and unexpected.

## 1.3 IDENTIFYING RISK: KNOWNS AND UNKNOWNs

One of the easiest mistakes to make is to focus on risks that are known and measurable while ignoring those that are unknown or sets out.

Figure 1.5, our second building block, sets out a fundamental classification of known versus unknown risk that considers a classic paper on risk by economist Frank Knight,<sup>9</sup> and the much-quoted words of Donald Rumsfeld, former United States Secretary of Defense:

"There are things we know that we know. There are known unknowns . . . But there are also unknown unknowns."<sup>10</sup>

Rumsfeld said this when trying to encapsulate the danger of terrorists using weapons of mass destruction. His point was that humans tend to focus on the risks for which they have data and ignore potentially larger risks that are unknown or poorly understood. Yet those risks exist and must be managed.

Some of the distinctions in Figure 1.5 are much older than Rumsfeld's quote. In his famous 1921 paper, Knight distinguished between variability that cannot be quantified at all, which he called uncertainty, and "true" risk that can be quantified in terms of statistical science. (Box 1.3)

<sup>9</sup> F. Knight, *Risk, Uncertainty, and Profit* (New York: Houghton Mifflin, 1921).

<sup>10</sup> Donald Rumsfeld, US Secretary of Defence, press conference, NATO HQ, Brussels, 6 June 2002, responding to a question regarding terrorism and weapons of mass destruction and the possible inadequacy of intelligence information: <https://www.nato.int/docu/speech/2002/s020606g.htm>

### BOX 1.3 RISK VERSUS UNCERTAINTY

Economists have argued about the distinction between risk and uncertainty since the early 1920s. The distinction was first made in 1921 by two economists, Frank Knight<sup>a</sup> and John Maynard Keynes.<sup>b</sup> Knight explained the distinction between risk and uncertainty as follows which he referred to as "measurable risk" or "risk proper." Risk, according to Knight, applies to decision making when the outcome of the decision is unknown, but the decision maker can fairly accurately quantify the probability associated with each outcome that may arise from that decision. Knight viewed uncertainty, which he referred to as "unmeasurable uncertainty" or "true uncertainty," as applicable to decisions when the decision maker cannot know all the information needed in order to obtain all the probabilities associated with the

outcomes. Today we refer to this as Knightian uncertainty. A similar distinction between risk and uncertainty was made by Keynes in 1921. He argued that there is risk that can be calculated and another sort of risk he labeled "irreducible uncertainty." He understood that for some decisions, the risks cannot be calculated because attempting to do so would necessitate the reliance on assumptions about the future that have no basis in probability theory.

<sup>a</sup> Frank Knight, *Risk, Uncertainty, and Profit* (New York: Houghton Mifflin, 1921).

<sup>b</sup> John Maynard Keynes, *Treatise on Probability* (New York: Macmillan, 1921)

### BOX 1.4 METEORS AND MOONWALKING, ICEBERGS AND ELEPHANTS

When is a risk truly unknown? Perhaps when it arrives out of the blue like a meteor. But many risks are more unseen than unknown. In a 2018 speech, the Bank of England's Alex Brazier separated these risks into "moonwalking bears" and "underwater icebergs."

Moonwalking bears are named after a viral video that shows how people avidly watching a basketball game failed to see a bear impersonator on the screen. This kind of risk can be seen during periods of compressed yields in the debt market: the evidence that risk is being bought too cheaply is plain to see on every financial screen, but investors keep on buying.

The underwater icebergs are more difficult to spot and include the growth in leverage in some financial firms in the run up to the 2007–2009 global financial crisis. After the risk event, these risks also seem obvious because they are usually concerned with some fundamental weakness.

To this ensemble, we might add the age-old elephant in the room. This is the risk that is easy to see, that everyone has indeed spotted, but that it would be impolite to publicly acknowledge.

Source: Alex Brazier, Executive Director for Financial Stability Strategy and Risk, Bank of England, "Moonwalking Bears and Underwater Icebergs," 26 April 2018.

Incalculable Knightian uncertainties can be very large and important. Nuclear war is a major threat to the world, but its chances of happening are impossible to estimate.

Even so, Knightian uncertainties can be managed through avoidance and other forms of risk management. Multilateral nuclear disarmament, whether wise or not, would remove the risk of nuclear war. For difficult actions to be taken, however, there has to be agreement that the Knightian uncertainty is plausible and extremely threatening in terms of its severity (if unquantifiable in terms of frequency).

The boundary between Knightian uncertainty and measurable, statistical risk can be fluid. Before 1950, the size of the health threat from smoking was uncertain and cigarette producers regularly advertised their brand as the one that doctors chose to smoke. By the mid-1970s, dedicated researchers had turned this uncertainty into a quantified statistical health risk or

"known known": one in two long-term smokers die from the habit.<sup>11</sup>

Do the distinctions between the risk classes in Figure 1.5 matter to financial risk managers? Yes. Risk managers take responsibility for all sorts of risk, not just those that can be measured. They must continuously search for Rumsfeld's "unknown unknowns," including risks that are hiding in plain sight (Box 1.4). They cannot simply ignore Knightian uncertainties. In fact, they sometimes need to make sure their firms avoid or transfer them.

<sup>11</sup> This may be a conservative estimate, with the most recent research suggesting that smoking eventually kills around two in three smokers. See M. Roberts, "Tobacco Kills Two in Three Smokers," BBC News online, 24 February 2015: <http://www.bbc.co.uk/news/health-31600118>

Where they can, risk managers move poorly understood risks from the periphery of Figure 1.5 to a position nearer to the center. As cigarettes have demonstrated, Knightian uncertainties can be more severe and prevalent than we initially suspect.

However, risk managers must never treat risks that cannot be measured as if they are a known quantity. Uncertainty and ambiguity must be acknowledged because they exist in much greater amounts for some risky activities than for others. Our confidence in a risk measure shapes how the result should be applied in decision-making.<sup>12</sup>

## 1.4 QUANTITATIVE RISK METRICS

Figure 1.5 makes an important distinction between expected and unexpected loss. This distinction is our third building block.

Expected loss (EL) is the average loss a position taker might expect to incur from a position or portfolio. In theory, some portfolios realize losses that rarely depart far from this average. The losses from this kind of portfolio may be amenable to statistical measurement over a relatively short period of time with a fair degree of confidence. They might vary, for example, from year to year, but not by too much.

The EL of a portfolio can be calculated by identifying and estimating values for the key underlying risk factors. In general, EL is a function of (1) the probability of the risk event occurring; (2) the firm's exposure to the risk event; and (3) the severity of the loss if the risk event occurs. In the case of the credit risk of a loan, these become the borrower's probability of default (PD); the bank's exposure at default (EAD); and the severity of loss given default (LGD). Thus, EL is simply:

$$EL = EAD \times LGD \times PD$$

Where EL can be calculated with confidence, it can be treated like a variable cost or predictable expense rather than a risk or uncertainty. The bank can make a profit simply by adding a price margin that covers the cost of the EL.<sup>13</sup> Here, the risk manager's role is primarily to measure the amount of EL and to make sure the portfolio does not lose its predictable quality.

<sup>12</sup> For further discussion of the role of uncertainty in economics, see A. Lo and M. Mueller, "Warning: Physics Envy May Be Hazardous to Your Wealth!" March 19, 2010: [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1563882](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1563882)

<sup>13</sup> Theoretically, therefore, banks should not need to set aside provisions for expected losses where these are accurately priced into a product, though they will need to allocate risk capital for unexpected loss levels. For a discussion about why banks should, in the real world, provision for expected losses as well see B. Cohen and G. Edwards, "The New Era of Expected Credit Loss Provisioning," *BIS Quarterly Review*, March 2017: [https://www.bis.org/publ/qtrpdf/r\\_qt1703f.htm](https://www.bis.org/publ/qtrpdf/r_qt1703f.htm)

## Expect the Unexpected

That said, well-behaved portfolios inevitably offer surprises. EL is created from good and bad days. On a bad day, losses can range above the expected level (e.g., the result of an announcement of fraud in a credit card business or simply an unlucky sequence of losses). The extent to which losses depart from the average is called the unexpected loss level.

In a credit portfolio, the potential for unexpected loss might be driven by something quite simple, such as the number and size of the loans. When a portfolio is composed of a large proportion of small loans, there is little chance of one very important loan defaulting. In addition, if the portfolio is well diversified, there is little chance of multiple losses occurring together to generate unexpected loss levels.

Also, consider that the amount of EL (and unexpected loss) in a credit portfolio is changing continuously. These fluctuations are driven by factors such as changes in the macroeconomic environment and size and constitution of the portfolio (e.g., its credit quality or correlations). Estimating expected losses for even a well-behaved portfolio involves a fair amount of art as well as science—and some big assumptions.

## From Unexpected to Extreme

Some credit portfolios, however, exhibit a much more extreme variance in their losses over intervals of time (e.g., a decade). Here, the expected losses over time are constructed from both long runs of good years (when losses are much lower than average) and short runs of bad years (when losses are much higher than average). In the bad years, losses reach unexpected and even extreme levels.

These portfolios can be very deceptive from a risk management point of view. It is easy to be lulled into a complacent view of risk exposure and then experience a sudden shock. For this kind of risky position or portfolio, banks need to allocate large amounts of risk capital to protect against large unexpected losses that can trigger insolvency and default. This allocation of risk capital is done in addition to pricing EL into the product directly.

## Risky Relationships

A classic example of this loss level variability can be seen in the regular cycles of boom and bust in commercial real estate (CRE) markets around the world.<sup>14</sup>

<sup>14</sup> This classic cycle is well documented in the literature, for example, European Systemic Risk Board, *Report on Commercial Real Estate and Financial Stability in the EU*, December 2015, available at: [https://www.esrb.europa.eu/pub/pdf/other/2015-12-28\\_ESRB\\_report\\_on\\_commercial\\_real\\_estate\\_and\\_financial\\_stability.pdf](https://www.esrb.europa.eu/pub/pdf/other/2015-12-28_ESRB_report_on_commercial_real_estate_and_financial_stability.pdf)

First, demand for commercial property strengthens, often in line with general economic upswings. But CRE supply is inelastic<sup>15</sup>: it takes time to construct a property. Prices rise, attracting investors, banks, and other lenders, who may begin to relax loan-to-value ratios and other safeguards to gain market share.

Eventually, prices begin to weaken through a combination of cyclical oversupply of property and deteriorating economic conditions. Banks begin to withdraw credit from investors and developers in the market, exacerbating the fall. Overextended property developers experience cash flow problems. Property loses value as collateral. The financial condition of CRE lenders deteriorates and lending dries up. One fire sale later—and the market has entered a devastating cycle of feedback.

The result for lenders is that the probability of default by property developers rises at the same time collateral values fall—a bad combination referred to as *wrong way risk*. The global CRE markets are one of the clearest examples of how risk factors act together to produce waves of extreme loss.

There are many other examples in the financial markets of risk factors that can act together to generate risk. For example, in derivative markets, the value of a contract with a counterparty may tend to rise simultaneously with the default risk of the counterparty (another example of *wrong way risk*).

## Value-at-Risk

In January 1990, Dennis Weatherstone, newly appointed CEO of J.P. Morgan, called for a report on the total risk of his bank to be delivered to his desk every day at 4:15 p.m. The request helped to drive the development of a new global risk metric: Value-at-Risk (VaR).<sup>16</sup>

Jorion defines the VaR measure as the “worst expected loss over a given horizon under normal market conditions at a given level of confidence.”<sup>17</sup> For example, suppose that a bank’s trading portfolio has a weekly VaR at the 95% confidence level of \$10 million. This means that under normal market conditions, there is a 5% probability that the bank’s trading portfolio will lose more than \$10 million over the next week. As another example, suppose that a fund’s monthly VaR at the 99% confidence level is a loss of 3%. This means that under normal market

<sup>15</sup> An inelastic supply refers to a market situation wherein a change in the price of a product (in this case CRE) does not result in a corresponding change in supply of that product.

<sup>16</sup> Other firms such as Bankers Trust, a US merchant bank, had been working to build global risk reports in the period, and many of the concepts underlying VaR appeared prior to the 1990s. J.P. Morgan published the methodology behind its VaR model in 1993/4.

<sup>17</sup> P. Jorion, *Value at Risk: The New Benchmark for Managing Financial Risk*. New York, NY: McGraw-Hill, 2001

conditions, there is a 1% probability that the fund will have a loss that is greater than 3%.

VaR uses the loss distribution associated with a position or portfolio to estimate losses at a given level of likelihood (or confidence). However, an important point is that for any given loss distribution, the VaR number would tend to fall if we eased the confidence level to 95%. The number would also rise or fall if the shape of the loss distribution changed. For example, a loss distribution with a much fatter tail incurs more unexpected loss and a larger VaR number.

## Expected Shortfall

While VaR is a useful measure, it fails to quantify how much risk there is in the tails. A measure that overcomes that drawback is expected shortfall (ES), also referred to as conditional value-at-risk (CVaR). For a given tail probability, ES is defined as the average of the VaR numbers that exceed the VaR at that tail probability. That is, ES focuses on the losses in the tail that are larger than the corresponding VaR level.

## 1.5 RISK FACTOR BREAKDOWN AND INTERACTIONS BETWEEN FACTORS

The example of the CRE cycle demonstrates how important it is for risk analysts to break risk down into discrete risk factors—in this case, PD, LGD, and EAD—and understand how these risk factors might interact over time and under stress to generate losses.<sup>18</sup>

In turn, each primary risk factor is driven by a more fundamental set of risk factors. For example, the probability of default by a firm may be driven by its strength or weakness in terms of key financial indicators, industry sector, management quality, etc.

Breaking risk down into its key risk factors and understanding their importance as loss drivers—and their relationships with each other and the wider business environment—is a key activity for risk managers and is our fourth building block.

A key question concerns how granular each risk factor analysis should be. Ideally, risk managers would like to understand every significant risk factor and analyze each factor’s importance and dynamics through the data available.

To score the risk factor, the risk manager may want to look at its sub-factors. For example, what is it that drives the credit risk variable of management quality: management’s years of

<sup>18</sup> Understanding the dynamics of a loss record greatly increases its predictive power. To prepare for a key banking reform, Basel II, some years ago, banks had to spend millions of dollars re-engineering their credit rating systems when the regulators asked them to improve their risk modeling by recording probability of default, loss given default, and credit exposure as separate risk factors.

## BOX 1.5 WILL DATA SCIENCE REVOLUTIONIZE RISK ANALYSIS?

Data science includes big data, artificial intelligence, and machine learning. Data science is helping risk managers approach the identification of risk variables in a new way. This should allow risk managers to isolate innumerable risk factors and understand their relationships at a greater level of complexity.

In the insurance world, for example, analysts are bringing together public databases, social data, crediting rating data, and unstructured data to understand risk at the

individual level—the “segment of one,” as the industry calls it.

Across the risk industries, massive computing power can now help risk managers spot patterns and relationships in data more quickly. Unsupervised machine learning can help the risk manager identify the “unknown unknowns” through identifying clusters and correlations without specifying the area of interest in advance. Risk managers are about to enter an age of plenty in terms of data volume and risk factor analysis.

experience? Or what drives a firm’s vulnerability to cyber risk: systems, processes, or people?

Finding the answers to such questions is important, but practicalities often impose their own limits. Analytical resources may not be available. The loss data that can be used to isolate and statistically examine the power of each risk variable may be limited in quantity, quality, or descriptive detail.

That being said, new streams of data offering an undreamt level of granularity, analyzed by means of machine learning and massive cloud-based computational power, may prove revolutionary in the identification of discrete risk factors (Box 1.5).

When the structure underlying a system changes, risk increases. Large loss events may suddenly increase in frequency or size. Risk factors might suddenly move in lockstep. Entirely new sources of loss, in terms of risk type, may appear. In this case, more historical data will not help and “once-in-100-year” events might pop up once a decade until the structural problem is fixed, or proper risk management processes are adopted.

A change in events does not only affect tail risk—the amounts of EL and unexpected loss might change as well. Risk managers are continuously trying to assess the risk in systems that are changing in ways that might, or might not, matter.

While this is a problem for all risk managers, there is a special twist for those working in the financial markets. Unlike most mechanical and natural systems, human systems (such as financial markets) are subject to constant structural change from levers such as social behavior, industry trends, regulatory reforms, and product innovations.

An important recent example was the growth in subprime mortgage lending by US banks and other financial institutions starting in the early 2000s and its role in the creation of the 2007–2009 global financial crisis. Unusual types of mortgages, such as interest-only mortgages and below market initial loan rates, rose quickly from comprising a small fraction of total loans originated to a substantial share of all new mortgages. At the same time, the proportion of loans that were subprime (i.e., mortgages to borrowers with blemished credit histories) also increased. Structural change—looking out for it and modeling its future effects—is our fifth building block of risk management.

## 1.7 HUMAN AGENCY AND CONFLICTS OF INTEREST

Structural change is not the only wild card in financial systems. Unlike natural systems, human systems are run by intelligent participants that can react to change in a self-reflective or even a calculating manner.

<sup>19</sup> For accessible reviews of the literature, see A. Pazarbasi, “Tail Risk Literature Review,” *Alternative Investment Analyst Review*; D. Levine, “Modelling Tail Behavior with Extreme Value Theory,” *Risk Management*, September 2009, Issue 17.

For example, consider a trader who carefully attempts to predict the effects of a market reform. The trader's peers can try to second guess his or her predictions. Perhaps a regulator that helped draft the reform joins a financial consulting firm and advises the industry on how to circumvent the safeguard.

This type of behavior is true inside the firm as well. Those who understand how risk is generated and managed are in the best position to game it. They also often have the least incentive to make the risk transparent: Why would they broadcast the potential for unexpected loss levels or tail risks? This is one reason many financial firms employ three lines of defense:

1. First line: Business line that generates, owns, and manages risk;
2. Second line: Risk managers that specialize in risk management and day-to-day oversight; and
3. Third line: Periodic independent oversight and assurance, such as an internal audit.

The safeguards do not always work. Risk management systems always have loopholes and become obsolete quickly in the face of industry innovations. For example, in a worrying number of rogue trading cases in the banking industry, the trader had first worked in the middle or back office and thus understood the loopholes in the risk management infrastructure. Sometimes traders and business leaders deliberately undermine the credibility of risk management systems. Understanding the role of human agency, self-interest, and conflict of interest, is the sixth building block of risk management.

## 1.8 RISK AGGREGATION

Given the many different types of risk and risk metrics, a key problem in risk management is the challenge of seeing the bigger picture. How can senior managers identify the riskiest businesses on their watch and tell when the firm's aggregate risk is approaching intolerable levels?

Market risk tends to be the most amenable risk type to quantification and aggregation but controlling this risk factor is challenging. Until recent decades, market risk exposures were largely compared in terms of the notional amount held in each asset (e.g., USD 10 million of a large capitalization stock) rather than both the notional amount held in each asset and their volatilities.

This was never satisfactory. Some stocks and industry sectors were historically more volatile in price than others. Making matters worse, it made no sense to use notional amounts to compare the risks taken by, for example, the US Treasury trading desk and a desk dealing in a volatile commodity.

The advent of the derivatives markets in the 1970s made it imperative to improve market risk measures. Derivatives can be highly volatile and are an easy way to build up large risk exposures. Their value and their risk are driven by factors only tangentially related to the notional value of the instrument.

Portfolios of derivatives are often designed so that the individual instruments offset each other's market risk. It therefore makes no sense to treat the aggregate notional amounts in the portfolio as an indicator of portfolio risk.

Options trading specialists developed their own measures of risk, including delta (i.e., sensitivity of option value to a change in the value of the underlying) and theta (i.e., the change in option value as the option expiration date approaches). These measures, commonly referred to as the "Greeks," were—and still are—invaluable risk measures on the options trading desk.

The Greeks are of limited help at an enterprise level, however, because they cannot be added together; nor do they imply the same level of risk across markets (e.g., delta in foreign exchange versus commodity markets). Large financial institutions needed a risk measure that was much more comprehensive.

VaR was a popular risk aggregation measure in the years leading up to the crisis. However, it was not calculated using a set methodology, and there were at least three principal methodologies (and many ways to implement them). In fact, the concept of VaR also involves many simplifying assumptions.

The concept proved almost too useful. It was quickly applied to manage risk across much longer time horizons, across many institutions and whole industries, and across many different risk types.

The shortcomings of VaR as a risk measure were understood well before the global financial crisis of 2007–2009, but the crisis brought these weaknesses to the forefront and led to a reaction against over-dependence on this risk metric. VaR does, however, remain an important tool for risk managers.

Bank regulators have tried to improve the way VaR is calculated, make its calculation across the industry more consistent and reliable, and strengthen the role of supplementary risk measures such as ES and worst-case scenario analysis (Box 1.6).

The inherent drawbacks of VaR have encouraged risk managers to adopt a broader approach to risk metrics. Aggregate risk measures are useful in their place, but they inevitably fail to capture key dimensions of risk and must be supplemented with other approaches. Understanding risk aggregation and its strengths and weaknesses is our eighth risk management building block.

## BOX 1.6 TAKING ACCOUNT OF TAIL RISK

VaR only looks at the largest loss at a given likelihood threshold; it does not examine the size of losses beyond this threshold. For that reason, it is often said to ignore tail risk (i.e., the effect of very severe but rare events). After the global financial crisis of 2007–2009, various remedies for this were put forward. One of these was expected shortfall (ES), which is a statistical measure designed to quantify the mean risk in the tail of the distribution beyond the cut-off of the VaR measure.

Banks and their regulators also turned to scenario stress testing and reverse stress testing. Scenario analysis and stress testing ignore the problem of measuring the frequency or probability of a rare event. Instead, they focus analytical resources on imagining a reasonably plausible worst-case scenario that may develop in stages over an extended period.

The risk manager develops the scenario—or is handed it by a regulator—and then analyzes the impact of the event on the institution given its risk exposures and reactive capabilities. Scenario analysis and stress testing can be highly quantitative and involve complex modeling, but the numbers are all focused on assessing severity rather than frequency.

Reverse stress testing starts at the other end. The institution applies its modeling capabilities to work out how bad losses could get, then works backwards to try to understand how those losses were linked to its exposures and activities. How could the institution manage its activities to avoid the worst that might happen?

## 1.9 BALANCING RISK AND REWARD

A major advantage of a VaR approach is that it helps the firm to compare the risk exposures of different business lines. Firms come to understand the expected and unexpected loss levels associated with different activities. Furthermore, the firm can protect itself against these risks by making sure that its risk capital—also known as economic capital—is large enough to absorb the unexpected risk.

In the banking industry, economic or risk capital is the amount of capital the firm requires based on its understanding of its economic risks. It is distinct from regulatory capital, which is calculated based on regulatory rules and methodologies. Economic capital and regulatory capital are sometimes in alignment, but often generate quite different numbers.

Economic capital provides the firm with a conceptually satisfying way to balance risk and reward. For each activity, firms can compare the revenue and profit they are making from an activity to the amount of economic capital required to support that activity.

A firm can then take these risk capital costs into account when it prices a product and when it compares the performance of different business lines. There are clear reasons to do this. For example, Business A might attract significant costs every year in terms of EL but incur little in the way of unexpected losses. Business B, on the other hand, might attract very little in the way of EL but suffer from very large losses at the end of every business cycle.

Without a sophisticated risk-adjusted analysis of profitability, it will be difficult to compare Business Division A and Business Division B. Most likely, Business Division B will look very attractive during the benign part of the cycle. The firm might decide to cut product prices to build up business volume. This

frequently results in unexpected losses when the cycle turns. (Banking industries globally have tended to behave in exactly this manner, exacerbating the tendency for whole economies to go from boom to bust.)

To factor in the cost of risk of both expected and unexpected losses, the bank can apply a classic formula for risk-adjusted return on capital (or RAROC):<sup>20</sup>

$$\text{RAROC} = \text{Reward/Risk}$$

where reward can be described in terms of After-Tax Risk-Adjusted Expected Return, and risk can be described in terms of economic capital.

After-Tax Net Risk-Adjusted Expected Return also needs to be adjusted for Expected Losses:

$$\text{RAROC} = \frac{\text{After-Tax Net Risk-Adjusted Expected Return}}{\text{Economic Capital}}$$

For an activity/portfolio to add value to shareholders (and the stock price), RAROC should be higher than the cost of equity capital (i.e., the hurdle rate or minimum return on equity capital required by the shareholders to be fairly compensated for risk).

There are many variants on the RAROC formula, applied across many different industries and institutions. Their level of sophistication varies but all have the same purpose: to adjust performance for risk. Four day-to-day applications stand out.

- **Business comparison:** RAROC allows firms to compare the performance of business lines that require different amounts of economic capital.

<sup>20</sup> See M. Crouhy, D. Galai, and R. Mark, *The Essentials of Risk Management*, 2<sup>nd</sup> ed. (Ch. 17), McGraw Hill, 2014.

## BOX 1.7 HARD NUMBERS?

Risk reports are full of numbers that look objective and empirical. Risk analyses perform a confusing array of tasks (Figure 1.6). Some are intended to quantify risk in some absolute sense—for example, Risk Probability x Exposure x Severity—though the data and the modeling that underpin these numbers vary in quality.

Other risk reports track some component of this equation, such as risk exposure. However, a drop in one risk component may not mean risk is declining, unless everything else remains the same. For example, a bank losing market share might remedy this by loosening credit quality: The drop in loan volume may not mean less credit risk.

Other numbers track key risk indicators (KRIs), which are quantitative measurements that are used to assess potential risk exposures. For example, a staff turnover metric might act as a KRI for a type of operational risk. In this case, the relationship of the risk indicator to the risk under examination is often based on judgment. Decision-makers looking at risk metrics going up and down sometimes fool themselves that they are watching risk itself, when they are really watching a risk proxy of uncertain utility.

Through either judgment or calculation, businesses must balance risk and reward. That makes RAROC and similar measures the ninth building block of risk management.



**Figure 1.6** Risk metrics capture many different dimensions of risk.

- *Investment analysis:* A firm typically uses the RAROC formula that uses projected numbers to assess likely returns from future investments (e.g., the decision to offer a new type of credit product). RAROC results based on past returns can also be used to determine if a business line is providing a return above a hurdle rate demanded by the equity investors who are the providers of the firm's risk capital.
- *Pricing strategies:* The firm can re-examine its pricing strategy for different customer segments and products. For example, it may have set prices too low to make a risk-adjusted profit in one business segment, while in another it may have the ability to reduce prices and increase market share (and overall profitability).
- *Risk management cost/benefit analysis:* RAROC analyses can help a firm compare the cost of risk management (e.g., risk transfer via insurance, to the benefit of the firm).

There are many practical difficulties in applying RAROC, including its dependence on the underlying risk calculations. Managers of business divisions often dispute the validity of RAROC numbers, sometimes for self-interested reasons. As with other types of risk metrics (Box 1.7), decision-makers should always understand what the number means and what is driving it.

## 1.10 ENTERPRISE RISK MANAGEMENT (ERM): MORE THAN ADDING UP RISK?

One challenge to an effective firm-wide risk management process is that at many firms, business divisions manage their risk in a siloed approach (i.e., where each division manages its own exposures independently without considering the risk exposures of other divisions). Financial risk managers have long recognized that they must overcome this silo-based risk management process to build a broad picture of risk across risk types and business lines: enterprise risk management (ERM).

We devote Chapter 8 to ERM, the tenth building block of risk management. ERM projects encourage firms to think about enterprise risk using tools, such as a clear statement of corporate risk appetite, a cohesive approach to risk management through global risk committees, and so on.

Oftentimes, historic ERM efforts have overemphasized the need to express risk as a single number such as economic capital or VaR. Expressing risk as a single number was too simplistic an approach.

## BOX 1.8 DIGITAL RISK MANAGEMENT?

The digital era is changing the face of business in many ways, including the new ways that corporations interact with customers (mobiles, sensors) and new risks (cyber risk, privacy regulations). How will the digital era change the working day of the risk manager over the next few years?

According to a survey by McKinsey in 2017, the digital transformation of risk functions in financial institutions is occurring more slowly than the transformation of customer-facing operations. However, big changes are underway, including:

- Drawing information from a wider set of sources to apply advanced analytics to measure risk, for example, applying big data analytics to credit and operational risks;
- Faster and real-time decision-making based on more automated risk processes, for example, automated corporate credit scoring; and

- Greater productivity, as risk processes are engineered away from paper documents towards automated work flows, for example, for reviews of documentation.

The survey found that there are big challenges involved with digitizing risk management in the form of legacy infrastructure, limited data, and the need for new digital skills. Data scientists have the critical skill set for digitized risk functions and may soon be in as much demand as "rocket scientist" risk modelers.

Source: *McKinsey & Co and Institute of International Finance: The Future of Risk Management in the Digital Era, October 2017*; see Exhibit 23 regarding the need for data scientists in digital risk management functions.

Perhaps the biggest lesson of the 2007–2009 global financial crisis was that risk cannot be reduced to any single number.

- It is multi-dimensional, so it needs to be approached from many angles, using multiple methodologies.
- It develops and crosses risk types, so even a wide view of risk types—but at only one point in time—may miss the point.
- It demands expert judgment that is combined with application of statistical science.

Measuring risk in economic capital terms is important for balancing risk and reward. However, the key factor that saves an institution may come from another risk analysis tool—perhaps from worst-case scenario analysis or some new digital approach (Box 1.8). Firms need a comprehensive view of risk and this can only be built using a range of tools and a healthy amount of curiosity.

For example, insights might come from a risk manager digging deep and realizing the implications of a structural change in a market. It might come from looking at the competition and realizing that behavior across the industry might precipitate a market crisis. Or it might come from a new risk indicator such as a market-derived credit risk indicator that signals a change in credit condition at a major counterparty early enough for action to be taken.

That moment of realization, however, must be followed up with actions. The modern approach to ERM must also look at the processes that link information to action and also look at the

firm's corporate governance and risk culture, as we discuss in Chapters 3 and 4. If the firm embarks on an aggressive push for growth only to realize that risks have not been fully understood, what is its process for changing course? Has that fire drill been tested?

ERM is no longer simply about aggregating risk across risk types and businesses. It is about taking a more holistic approach to the entire risk management process and its relationship to strategic decisions. It is about the way the firm thinks about risk, and in doing so establishes its corporate identity (Figure 1.7).



**Figure 1.7** ERM needs to think a bit bigger.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## QUESTIONS

---

- 1.1** Describe and provide examples of fundamental risk factors and their sub-risk factors that drive the probability of a firm's default
- 1.2** What are the four components of a risk management process?
- 1.3** Provide an example of what is meant by basis risk.
- 1.4** What are two types of liquidity risk?
- 1.5** What drives market risk across all markets?
- 1.6** What is meant by strategic risk?
- 1.7** Describe how risk managers become involved in business risk.
- 1.8** What is reputation risk? Provide examples in your answer.
- 1.9** What is meant by economic capital? Contrast it with regulatory capital.
- 1.10** What is the basic idea of RAROC? Provide the RAROC equation in your answer.
- 1.11** What are a few applications of RAROC? Provide examples in your answer
- 1.12** What is counterparty risk and give an example?
- 1.13** If a bank's management is told that under normal market conditions, the daily VaR at the 97.5% confidence level for its trading portfolio is USD 14 million. What does that mean?
- 1.14** Provide a list of examples of risk management that can be seen in early history.
- 1.15** Provide a list of the key risk management building blocks.
- 1.16** Provide a list of the four choices involved in the classic risk management process.
- 1.17** Unsupervised machine learning can help the risk manager identify the "unknown unknowns" through identifying clusters and correlations without specifying the area of interest in advance.  
A. True  
B. False
- 1.18** Banking regulators are encouraging tools that support using advanced analytical formulas to calculate regulatory operational risk capital.  
A. True  
B. False
- 1.19** The three lines of defense consists of:  
• First line: Risk managers that specialize in risk management and day-to-day oversight;  
• Second line: Business line that generates, owns and manages risk; and  
• Third line: Periodic independent management oversight and assurance such as internal audit.  
A. True  
B. False
- 1.20** Reverse stress testing applies its modeling capabilities to estimate the size of potential losses.  
A. True  
B. False
- 1.21** Frank Knight referred to uncertainty as measurable risk.  
A. True  
B. False
- 1.22** The *expected shortfall* is the expected loss in the tail of the distribution.  
A. True  
B. False
- 1.23** Business risk involves making large, long-term decisions about the firm's direction, often accompanied by major investments of capital, human resources, and management reputation.  
A. True  
B. False
- 1.24** Enterprise Risk Management is the management of risk at the business unit level.  
A. True  
B. False
- 1.25** Track key risk indicators are quantitative measurements that are used to assess potential risk exposures.  
A. True  
B. False
- 1.26** Business risk applies only to large non-financial corporates.  
A. True  
B. False
- 1.27** Expected shortfall (ES) is  
A. a statistical measure designed to quantify the mean risk in the tail of the distribution beyond the cut-off of the VaR measure.  
B. the case where RAROC fails to be greater than a hurdle rate.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

**1.28** Tail risk techniques are dealt by

- A. Extreme Value Theory.
- B. VaR Theory.
- C. Probably of Default Theory.
- D. standard deviation.

**1.29** Operational risk includes

- A. legal risk.
- B. business risk.
- C. reputation risk.
- D. currency risk.

**1.30** Expected loss (EL) for a loan is based on

- A. probability of default (PD).
- B. exposure at default (EAD).
- C. loss given default (LGD).
- D. all of the above

**1.31** Which of various Greek measures can be added together across different currencies?

- A. Delta
- B. Gamma
- C. Theta
- D. None of the above

**1.32** Operational risk includes

- A. counterparty risk.
- B. cyber risk.
- C. reputation risk.
- D. business risk.

**1.33** The purpose of economic capital is to absorb

- A. expected loss.
- B. unexpected loss.
- C. tail loss.
- D. all of the above.

**1.34** Reputation risk

- A. is easy to quantify.
- B. is the responsibility of the chief market risk officer.
- C. cannot be managed at all.
- D. should be monitored by the board.

## ANSWERS

---

**1.1** PD of a firm is driven by a firm's strength or weakness in terms of key variables such as financial ratios, industry sector, country, quality of data, and management quality. Each fundamental set of risk factors is driven by sub-factors. For example, management years of experience is a sub-factor of the management quality variable.

**1.2** The risk manager first attempts to identify the risk then next analyzes the risk. Subsequently the risk manager assesses the impact of any risk event and ultimately manages the risk. In summary, the four components are

1. Identify the risk,
2. Analyze the risk,
3. Assess Impact of risk, and
4. Manage the risk.

**1.3** A form of market risk known as basis risk occurs if a position intended to hedge another position might do so imperfectly.

**1.4** The two types are funding liquidity risk and trading liquidity risk

*Funding liquidity risk* refers to the case where a firm cannot access enough liquid cash and assets to meet its obligations. For example, banks take in short-term deposits and lend the money out for the longer term at a higher rate of interest.

*Trading liquidity risk* refers to a case where markets temporarily seize up. For example, if market participants cannot, or will not, take part in the market, this may force a seller to accept an abnormally low price, or take away their ability to turn an asset into cash and funding at any price.

**1.5** Market risk is driven by (1) general market risk and (2) specific market risk. General market risk is the risk that an asset class will fall in value, leading to a fall in the value of an individual asset or portfolio. Specific market risk is the risk that an individual asset will fall in value more than the general asset class.

**1.6** Strategic risks involve making large investments, in long-term decisions about the firm's direction, that can affect its future direction and strategy.

**1.7** Risk managers have specific skills they can bring to bear in terms of quantifying aspects of business risk. For example, credit risk experts often become involved in

managing supply chain risk. Risk managers should be involved at the start of business planning. For example, it may be impossible to fund the construction of a power station without some form of energy price risk management strategy in place.

**1.8** Reputation risk is the danger that a firm will suffer a sudden fall in its market standing or brand with economic consequences. Rumors can be fatal in themselves. For example, a large failure in credit risk management can lead to rumors about a bank's financial soundness. Investors and depositors may begin to withdraw support in the expectation that others will also withdraw support. Unethical behavior of managers in the firm can hurt its reputation.

**1.9** Economic (risk) capital is the amount of capital the firm requires based on its understanding of its economic risks. Regulatory capital is calculated based on regulatory rules and methodologies.

**1.10** RAROC = Reward/Risk. Reward can be described in terms of After-Tax Risk-Adjusted Expected Return. Risk can be described in terms of economic capital. RAROC should be higher than the cost of equity capital.  $RAROC = \text{After-Tax Net Risk-Adjusted Expected Return} / \text{economic capital}$

\*After-Tax Expected Return is adjusted for EL

**1.11** RAROC can be used in business comparison, investment analysis, pricing strategy, and cost-benefit analysis.

- *Business comparison:* For example, compare the performance of business lines that require different amounts of economic capital.
- *Investment analysis:* For example, assess likely returns from future investments (e.g., the decision to offer a new type of credit product).
- *Pricing strategies:* For example, examine pricing strategy for different customer segments and products (e.g., it may have set prices too low to make a risk-adjusted profit).
- *Risk management cost/benefit analysis:* For example, compare the dollar cost of risk management (e.g., risk transfer via insurance, to the dollar benefits).

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

**1.12** Counterparty risk is the risk that the counterparty to a trade will fail to perform. Counterparty risk includes settlement or Herstatt risk.

**1.13** This VaR means that with respect to its trading portfolio, under normal market conditions, there is a 2.5% probability that the loss can be more than \$14 million in one day.

**1.14** See Figure 1.2 in Chapter 1

**1.15**

1. The risk management process
2. Identifying known and unknown risks
3. EL, unexpected loss, and tail loss
4. Risk factor breakdown
5. Structural change from tail risk to systemic crisis
6. Human agency and conflicts of interest
7. Typology of risks and risk interactions
8. Risk aggregation
9. Balancing risk and reward
10. Enterprise risk management (ERM)

**1.16**

1. Avoid Risk
2. Retain Risk
3. Mitigate
4. Transfer

**1.17** True

**1.18** False because the Basel Committee signaled a change of direction in 2016. Basel encourages banks to understand their operational risk using a variety of tools but capital allocation would be based on a simpler standardized approach using weighted bank size with a multiplier based on the bank's record of larger operational risk losses.

**1.19** False because business line is traditionally referred to as the first line and risk management is referred to as second line.

**1.20** True because risk managers work back from the reverse stress test to try to understand how those losses were linked to its exposures and activities. The goal is to help an institution risk manage its activities to avoid the worst that might happen.

**1.21** False because Knight said measurable risk applies to decision making in which the outcome of the decision is unknown, but the decision maker can fairly accurately quantify the probability associated with each outcome that may arise from that decision. It is his definition of risk, not uncertainty. This Knight called uncertainty "unmeasurable uncertainty" or "true uncertainty."

**1.22** True

**1.23** False

**1.24** False

**1.25** True

**1.26** False

**1.27** A. a statistical measure designed to quantify the mean risk in the tail of the distribution beyond the cut-off of the VaR measure.

**1.28** A. Extreme Value Theory.

**1.29** A. legal risk.

**1.30** D. because  $EL = EAD \times LGD \times PD$

**1.31** D. because Greeks for example do not imply the same level of risk across markets (e.g., delta in foreign exchange versus commodity markets).

**1.32** B. cyber risk.

**1.33** B. unexpected loss.

**1.34** D. should be monitored by the board.



# 2

# How Do Firms Manage Financial Risk?

## ■ Learning Objectives

After completing this reading, you should be able to:

- Compare different strategies that a firm can use to manage its risk exposures and explain situations in which a firm would want to use each strategy.
- Explain the relationship between risk appetite and a firm's risk management decisions.
- Evaluate some advantages and disadvantages of hedging risk exposures and explain challenges that can arise when implementing a hedging strategy.
- Apply appropriate methods to hedge operational and financial risks, including pricing, foreign currency, and interest rate risk.
- Assess the impact of risk management tools and instruments, including risk limits and derivatives.

It might seem obvious, given the discussion in Chapter 1, that firms should manage financial risk. However, it is not that simple in the corporate world. Specifically, a firm must answer several questions.

- Does managing risk make sense from the perspective of the firm's owners?
- What is the precise purpose of a risk management strategy?
- How much risk should the firm retain? What risks should be managed? What instruments and strategies should be applied?

The wrong answers can turn risk management itself into a major threat to the firm.

Figure 2.1 lays out these issues as a road map. But while this chapter follows this road map, the risk management process itself is iterative. For example, once a firm understands the costs and complexities of risk management for a particular business unit, it might revisit whether it should be involved in that risk-generating business activity at all.

## 2.1 BACKGROUND: THE MODERN IMPERATIVE TO MANAGE RISK

Firms have always managed their core business risks. They try to understand what drives customer demand, cultivate a range of suppliers for critical components, backup their data, and insure their warehouses. However, they have not always managed financial risks with the same intensity. So why do firms today stress the importance of financial risk management?

The answer lies in a potent mix of need and opportunity.

- **Need:** The need to manage financial risk grew significantly from the 1970s as markets liberalized (e.g., commodities, interest rates, credit, and foreign exchange), price volatility shot up, and the global economy gathered steam.
- **Opportunity:** The growth in market volatility helped spawn a fast-evolving selection of financial risk management instruments in the 1980s and 1990s, giving firms many more opportunities to manage their risk profiles.

There was a rapid growth in instrument types after the 1970s that was fueled by theoretical advances such as the Black-Scholes-Merton option pricing model and securitization technology.<sup>1</sup> This process continued with the more recent arrival

<sup>1</sup> Securitization involves the packaging (i.e., pooling) of loans and receivables and the issuance one or more securities backed by the pool. Examples include mortgage-backed securities, asset-backed securities, and collateralized loan obligations. Securitization is explained further in Chapter 4.

1. Identify risk appetite.
  - Identify key corporate goals and risks.
  - Should we manage risk?
  - Which risks should we manage?
  - Create a risk appetite statement (broad terms).
2. Map risks, make choices.
  - Map risks.
  - Assess or measure risk/impact.
  - Perform risk/reward analysis of risk management strategy (RAROC etc.)
    - Prepare comparative cost/benefit of risk management tactics.
  - Choose basic strategy/tactics.
  - Create a risk appetite statement (detailed terms).
3. Operationalize risk appetite.
  - Express risk appetite in operational terms.
  - Assess risk policies.
  - Set risk limit framework.
  - Rightsize risk management team.
    - Resources, expertise, infrastructure
    - Incentives and independence
4. Implement.
  - Choose tactics/instruments.
  - Make day-to-day decisions.
  - Establish oversight.
5. Re-evaluate regularly to capture changes in:
  - Risk appetite/risk understandings/stakeholder viewpoints,
  - Business activity and risk environment (remapping), and
  - New tools, tactics, cost-benefit analyses.

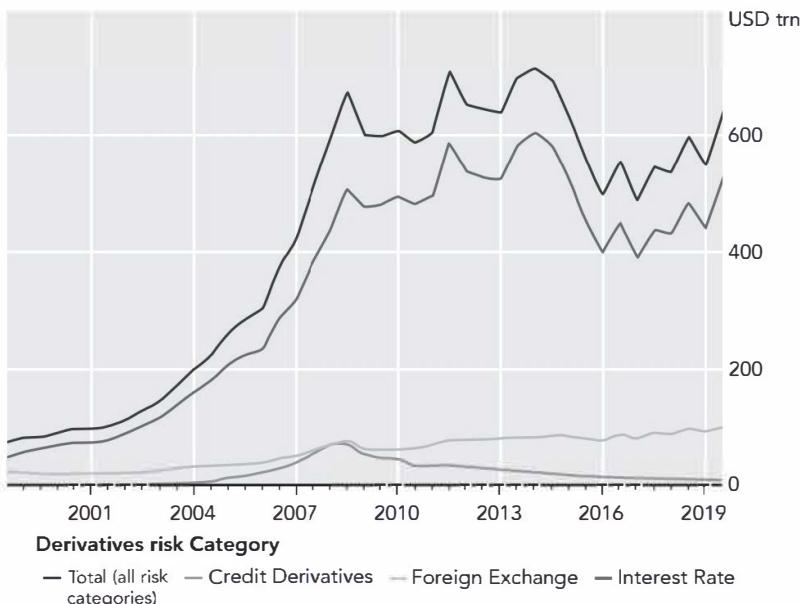
**Figure 2.1** Risk Management Road Map: Five Milestones.

of credit and weather derivatives in the 1990s along with the ongoing emergence of cyber risk transfer instruments beginning in the twenty first century.

Two decades of growth in the principal derivatives markets are captured in Figure 2.2. The numbers behind this figure include trading as well as end-user risk management. The distinct leveling off of growth in some risk market categories has been driven by a decline in speculative use, tightening bank regulation,<sup>2</sup> and a decline in interest rates and market volatility following the 2007–2009 global financial crisis. At the same time, there are

<sup>2</sup> For example, see A. Nag and J. McGeever, "Foreign Exchange, the World's Biggest Market, Is Shrinking," Reuters, February 2016: <https://www.reuters.com/article/us-global-fx-peaktrading-idUSKCN0VK1UD>.

OTC derivative notional volumes by risk type (1999–2019)



**Figure 2.2** OTC derivative notional volumes by risk type (1999–2019).

Source: BIS Derivatives Statistics, see [https://www.bis.org/statistics/about\\_derivatives\\_stats.htm](https://www.bis.org/statistics/about_derivatives_stats.htm). Reprinted by permission.

other risk transfer markets (e.g., cyber risk management) that are continuing to grow rapidly.

## Risks from Using Risk Management Instruments

Risk management instruments allow firms to hedge economic exposures, but they can also have unintended negative consequences. They can quickly change a firm's entire risk profile

(i.e., within days or hours) in ways that can either reduce risk or create a speculative position. Furthermore, this change may not be immediately apparent.

For example, a firm with an exposure to a variable interest rate might use a complicated instrument that dampens this exposure, provided that interest rates stay within certain bounds. But the same instrument might increase the firm's financial exposure if interest rates break through a given ceiling. Is this risk management, or a bet?

Modern corporations can potentially have risk profiles traditionally associated with investment banks. All that is needed is a computer, the right passwords, and (hopefully) the approval of the board. The growing resources devoted to corporate risk management exist partly to ensure these new corporate capabilities are used wisely.

## Hedging Philosophy

Just because a risk can be hedged does not mean that it *should* be hedged. Hedging is simply a tool and, like any tool, it has limitations.

For example, hedging can only stabilize earnings within a relatively short time horizon of a few years. Hedging also has costs that are both transparent (e.g., an option premium) and opaque (e.g., the dangers arising from tactical errors and rogue trading). Meanwhile, as Box 2.1 notes, equity investors (i.e., the owners of the firms) might feel that risk is diversified away in the context of their investment portfolios.

### BOX 2.1 DO EQUITY INVESTORS WANT MANAGERS TO HEDGE RISK?

The answer is generally "yes" if the investor has concentrated their investment in a specific firm, (e.g., a family-owned firm or even a state-owned firm). The answer is potentially "no" in the more common case where the investor holds the investment as part of a diversified portfolio.

Note that in a large portfolio, any risks specific to the firm in question are diversified away. Reducing firm-specific volatility in the value of an individual stock is therefore of minimal value to investors.

Meanwhile, systematic risks that are not diversified away by portfolio diversification (e.g., interest rate risk) can be managed at the portfolio level by the investor. The investor, therefore, receives little benefit from such risk management

at the level of the individual firm. At the same time, some investors want exposure to certain macroeconomic risks (e.g., the price of oil or gold).

The argument against hedging risk at the balance-sheet level is well grounded in finance theory. However, finance theory itself makes several unrealistic assumptions about financial markets. This chapter explores powerful "real-world" counter arguments in favor of hedging.

Meanwhile, a decades-long series of empirical studies aimed at revealing whether hedging helps firms or not (e.g., in terms of raising their stock price compared to non-hedgers) has yet to deliver a knock-out blow for any one side of the argument. The answer may turn out to vary across different industries.

These theoretical and practical objections to hedging should lead firms to question whether and how risk should be managed. But there are also powerful counterarguments in favor of hedging.

The theoretical arguments against hedging rest on the idea that markets are, in some sense, perfect and frictionless. In fact, there are many market imperfections. Hedging is often intended to reduce the chance of financial distress, which incurs both direct costs (e.g., bankruptcy costs) and major opportunity costs. A firm hit by an unexpected market loss will reduce its investment in other areas and move more cautiously.

Improving revenue stability also sends an important message to potential creditors who may be concerned about the firm's soundness. Creditors usually get no upside from a firm's revenue volatility. They are only interested in whether the firm can fulfill its promises. That's also true for key customers and suppliers.

In addition, hedging can make sense for investors if it is used as a tool to increase the firm's cash flows (rather than to reduce equity investor risk). For example, firms may need to offer their customers a stable price over the next three years, which may be impossible without hedging a key cost input. If hedging like this increases customer demand, then equity investors are happy.

Likewise, a firm that commits to supply a product into a foreign market in one year's time will need to hedge the relevant currency to lock in profit margins. For managers, perhaps the most important operational benefit of hedging is the planning benefit. Without the use of hedging, the random uncertainty of a fluctuating currency can make planning almost impossible.

Finally, equity investors are not the only stakeholders, and certainly not the only decision-makers. Furthermore, these other stakeholders/decisionmakers may have different hedging needs and desires. Whereas managers, regulators, and general staff expect the firm to be financially sound and protected from sudden mishaps, managers may have incentives to use hedging to ensure their firm meets key short-term targets (e.g., stock analyst expectations) that affect their prestige and compensation. Risk managers need to pay close attention to how derivatives can leverage agency risks.

There are important arguments for and against hedging, as well as a variety of potential motivations. Firms need to explain their rationale for hedging in terms of basic aims (e.g., managing accounting risk, balance-sheet risk, economic risk, or operational risk). They also need to be clear on the size of their risk appetite.

## 2.2 RISK APPETITE—WHAT IS IT?

Risk appetite describes the amount and types of risk a firm is willing to accept. This contrasts with risk capacity, which describes the maximum amount of risk a firm can absorb.<sup>3</sup>

A recent trend among corporations is to use a board-approved risk appetite to guide management and (potentially) to inform investors via annual filings. But what exactly is a risk appetite in practical terms? It is two things.

1. A statement about the firm's willingness to take risk in pursuit of its business goals. The detailed *risk appetite statement* is usually an internal document that is subject to board approval. However, attenuated versions can appear in some annual corporate reports.
2. The sum of the mechanisms linking this top-level statement to the firm's day-to-day risk management operations. These mechanisms include the firm's detailed risk policy, business-specific risk statements, and the framework of limits for key risk areas.

The operational expression of the risk appetite statement should also be approved by the board and needs to be congruent with a wider set of risk-related signals that the firm sends to its staff (e.g., incentive compensation schemes).

The banking industry, pushed by regulators and a series of crises, is perhaps at the forefront of developing risk appetite as a concept. Box 2.2 describes how one leading global bank defines its risk appetite and sets it to work.

There is a trend toward making corporate risk appetites more explicit, both in terms of the *kinds* of risks deemed acceptable and in terms of forging a link to quantitative risk metrics. However, one fundamental question concerns the meaning of the phrase *risk appetite*, which is used to mean many different (if related) concepts in the business literature (Box 2.3).

Is risk appetite the total amount of risk the firm could bear without becoming insolvent? Or is it the amount of risk the firm is taking today? Or the amount that it would be happy to bear at any one time?

In Figure 2.3, the answer is the latter. Here, the risk appetite is set well below the firm's total risk bearing capacity, and above the amount of risk the firm is exposed to currently (labeled here as the firm's risk profile). The dotted lines are upper and lower trigger points for reporting purposes. These are designed to let

<sup>3</sup> For example, from a risk capacity perspective, a bank is not allowed to lower its leverage ratio below 3% (where leverage ratio is a measure of the bank's tier 1 capital as a percentage of its assets + off balance-sheet exposures).

## BOX 2.2 HOW IS HSBC USING ITS RISK APPETITE STATEMENT? (EXTRACT FROM 2016 ANNUAL REPORT)

"The group's Risk Appetite Statement describes the types and levels of risk that the group is prepared to accept in executing its strategy. Quantitative and qualitative metrics are assigned to 13 key categories, including: earnings, capital and leverage, liquidity and funding, interest rate risk in the banking book, credit risk, traded risk, operational risk, financial crime compliance and regulatory compliance. Measurement against the metrics:

- Guides underlying business activity;
- Informs risk-adjusted remuneration;
- Enables the key underlying assumptions to be monitored and, where necessary, adjusted through subsequent business planning cycles; and
- Promptly identifies business decisions needed to mitigate risk.

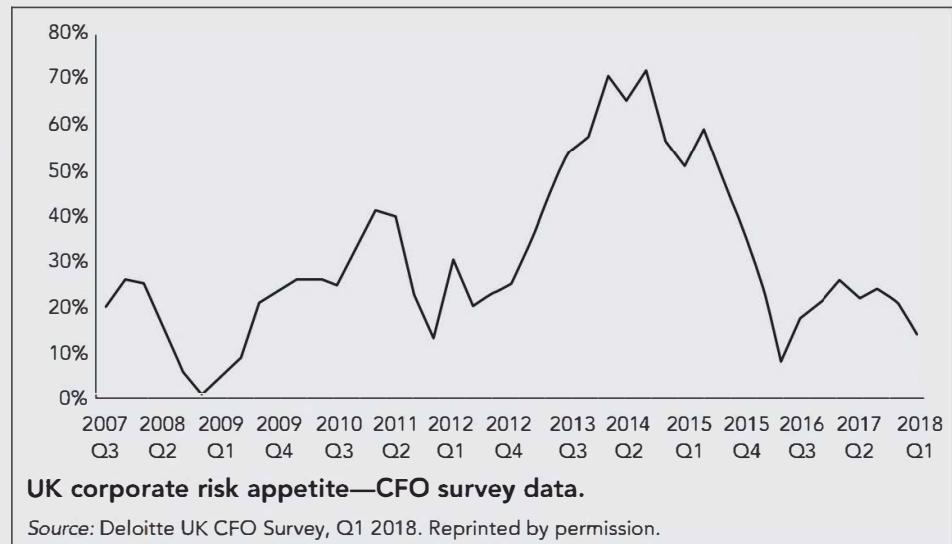
The Risk Appetite Statement is approved by the Board following advice from the Risk Committee. It is central to the annual planning process, in which global businesses, geographical regions and functions are required to articulate their individual risk appetite statements. These are aligned with the group strategy, and provide a risk profile of each global business, region or function in the context of the individual risk categories."

Source: Excerpted from HSBC Bank plc, Annual Report and Accounts 2016, page 20.

## BOX 2.3 FIRM-LEVEL VERSUS INDUSTRY-LEVEL RISK APPETITE

The main text talks about the risk appetite of an individual firm. But how does this relate to the industry-level risk appetite discussed in the business press? For example, economists often survey the *risk appetite* felt by business leaders and use the results to track how eager firms are to invest and grow (figure).

It may be best to think of a firm's internal risk appetite as a relatively stable "through the cycle" attitude toward risk at an individual firm. Meanwhile, the figure is a "point in time" barometer of sentiment across the industry, driven largely by external environmental factors (e.g., Brexit or GDP growth).

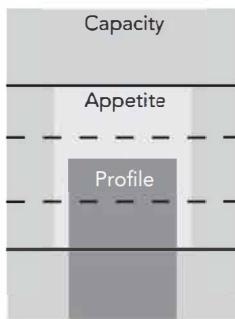


the board know if risk taking looks unnaturally low or if there is a danger of breaching the agreed risk appetite.<sup>4</sup>

<sup>4</sup> Our arguments in this paragraph, and the exhibit it refers to, follow the discussion in Deloitte, *Risk Appetite Frameworks, How to Spot the Genuine Article*, 2014, page 8: <https://www2.deloitte.com/content/dam/Deloitte/au/Documents/risk/deloitte-au-risk-appetite-frameworks-financial-services-0614.pdf>. There are also useful discussions in COSO, "Enterprise Risk Management: Integrating with Strategy and

Another key issue concerns consistency of risk appetite across risk types. Generally, firms regard themselves as more or less "conservative" or "entrepreneurial" in their attitude toward risk. However, this characterization should logically depend on the type of risk, and on the firm's risk management expertise.

Performance," June 2017, volume 1. Note that the terminology around risk appetite—particularly capacity and tolerance—is not always used consistently across the literature.



**Figure 2.3** Risk appetite as a metric.

Source: Deloitte, Risk Appetite Frameworks, How to Spot the Genuine Article, 2014, detail from Figure 1, page 8: <https://www2.deloitte.com/content/dam/Deloitte/au/Documents/risk/deloitte-au-risk-appetite-frameworks-financial-services-0614.pdf>.

For example, a high-tech firm might decide to adopt a very high-risk strategic objective in the belief that this is within its expertise. It might even believe that it will lose its purpose entirely if it does not outpace competitors. Here, taking a bet is risk management. However, the same firm could logically take a very conservative view of how it manages its foreign exchange exposures. Furthermore, the firm may already be managing some risks (e.g., cyber risk) much more explicitly and adeptly than a more conservative firm across the road.

Risk appetite is therefore part of a firm's wider identity and capabilities. Firms must ask, "Who are we?" and "Who do our stakeholders think we are?" well before they get to the point of trying to operationalize a risk appetite. (Whether crafting a corporate "mission statement" will help in this endeavor is another question.)

In truth, forging a robust link between top-of-house risk appetite statements and the operational metrics of risk appetite in a particular risk type or business line is a challenging task. As seen in Chapter 1, there is no single measure of risk, even within a single risk type, that allows us to monitor risk at the business level and then easily aggregate this to the enterprise level.

The result is that firms operationalize their risk appetite using a multiplicity of measures. For financial firms, this can include business and risk-specific notional limits, estimates of unexpected loss, versions of value-at-risk (VaR), and stress testing. The level of detail needs to reflect the nature of the risk and the sophistication of the risk management strategy.

## 2.3 RISK MAPPING

The risk appetite statement tells a firm what the basic objective is. But it also needs to map out its key risks at the cash flow level and assess its size and timing over particular time horizons.

For example, a firm might be exposed to a major commodity price risk (e.g., the price of copper) arising from its manufacturing operations. In this case a risk manager might begin by looking ahead to the amount of copper the firm will need to keep in stock. When will it need the metal, and where will it need to be delivered? Which local price benchmark most closely represents its risk?

A firm may also be exposed to foreign exchange risk. The first step here is to map out existing positions as well as contracts and other upcoming transactions. The firm then needs to develop a policy that dictates which exposures should be hedged (e.g., should hedging include sales that are probable but not yet certain?) It also needs to set down the timing of the various cash flows as well as understand the assets and liabilities exposed to exchange rates.

It may well be that (by design or accident) some of the cash flows cancel each other out. Mapping risk is a way to recognize important netting and diversification effects and to put in place a plan for increasing these effects in future years.

A firm may also be exposed to risks that it will need to insure against (e.g., the risk of natural catastrophes, physical mishaps, and cyber incidents). Risk mapping should not ignore risks that are difficult to track in terms of exposure and cashflow. For example, a new business line might attract large, difficult to quantify data privacy risks as well as foreign exchange exposures.

## 2.4 STRATEGY SELECTION: ACCEPT, AVOID, MITIGATE, TRANSFER

Once a risk manager understands the firm's risk appetite and has mapped its key risks, then he or she can decide how to best handle each risk.

First, risk managers must define the most important risk exposures and make some basic prioritization decisions. Which risks are most severe and most urgent?

Second, the firm needs to assess the costs and benefits of the various risk management strategies.

- **Retain:** Firms will want to accept some risks in their entirety, or to accept part of a loss distribution. Note that retained risks are not necessarily small. For example, a gold mining company may choose to retain gold price risk because its investors desire such an exposure. Alternatively, an input price risk that expresses itself as expected loss can be retained and priced into the product. A key part of risk management is making carefully considered decisions to retain risk.
- **Avoid:** Firms may want to avoid the types of risk that they regard as "unnatural" to their business. Some risks can only be avoided by stopping a business activity. Firms sometimes

say they have “zero tolerance” for certain kinds of risk or risky behavior. But unless the right safeguards are in place, this sentiment may be more hopeful than descriptive.

- **Mitigate:** Other risks can be mitigated in various ways. Examples include a firm asking for additional collateral to mitigate a credit risk and an airline investing in more efficient aircraft to mitigate its exposure to jet fuel price risk.
- **Transfer:** Firms can transfer some portion of their risks to third parties. For example, insurance contracts, financial derivatives, and securitization offer ways to transfer risks (at a financial cost).

Senior management and the board will be responsible for selecting risk management strategies for larger risks. However, the risk manager needs to help them choose among the various options. Which strategy allows the firm to stay within its risk appetite in the most efficient manner?

It is rare for the costs of each strategy to be completely transparent. The cost of transferring the risk, for example, would ideally include the cost of employing a risk manager and the cost of managing any residual risks (e.g., basis risks).

Meanwhile, a firm that hedges a commodity price might find that its competitors gain a short-term advantage from any fall in the spot price. Can it really put a number against that potential competitive weakness? While numbers are critical, a great deal of business judgment is also required.

Finally, firms may have to conduct this kind of analysis for risks that are harder to quantify than market risk—including new insurable risks.<sup>5</sup> For example, firms may need to estimate the size of a cyber risk loss through worst-case analysis and expert judgment (e.g., a 5% estimated chance of a USD 100 million data loss event), and then compare this to the mitigation offered by a costly data systems upgrade. That in turn may need to be compared to the costs and benefits of transferring part of the risk to the fast-evolving cyber insurance market.

## 2.5 RIGHTSIZING RISK MANAGEMENT

Once a firm has an idea of its goals in key risk areas, it needs to make sure it has a risk management function that can develop and execute the approach (Figure 2.4). One issue is the need to *rightsizing* risk management.

For example, transferring a well-understood risk through a one-off market hedge or the purchase of annual insurance can be

<sup>5</sup> For example, see the discussion in M. Crouhy, D. Galai, and R. Mark, “Insuring vs Self-Insuring Operational Risk: The Viewpoint of Depositors and Shareholders,” *Journal of Derivatives* 12 (2), 2004, pp. 51–55.

- Determine the following:
  - Risk appetite/hedging philosophy;
  - Basic goals (e.g., reducing volatility, enhancing market-perceived soundness of firm, reducing taxes paid, reducing limit breach risk);
  - Accounting treatment (cost center, economic center, or profit center); and
- Risks covered:
  - Risk type (financial risk, operational risk, business risk, reputational risk, strategic risk, etc.); and
  - Time horizons
- Rightsizing the function:
  - Resources, and
  - Budget
- Set reporting lines/accountability/oversight:
  - Independence
- Establish policy and procedures (documentation).
- Evaluate performance:
  - Evaluation methodology, and
  - Incentive compensation

**Figure 2.4** Ensuring the risk management unit is fit for purpose.

(relatively) simple. Running a dynamic and sophisticated hedging strategy that involves continual readjustment in the markets is another matter entirely.

Dynamic strategies can offer cost savings, but they require a much bigger investment in systems and trader expertise. They may require the firm to build complex models and to apply sophisticated metrics (e.g., VaR) and a wider-ranging limit system (Figure 2.5). It also becomes more important to separate out the trading function from the back-office and risk oversight functions.

Without rightsized teams in place, firms using sophisticated risk management instruments and strategies can become too dependent on suppliers such as investment banks. For example, they may end up without a good way to independently price an instrument. At several points during the year, firms need to conduct a board-level gap analysis to make sure their level of sophistication matches the conservatism of their strategy.

A firm will also need to make sure the risk management function has a clear accounting treatment in terms of whether it operates as a cost center or a profit center. Risk management at many non-financial firms is regarded a cost center, while some forms of risk management in banking adopt a profit center approach.

Firms also need to decide on a related issue: should the costs of risk management be proportionally distributed to the areas that risk management serves? The answers to all these questions depend on an organization’s risk culture and appetite.

Limit	Nature	Example Weakness
Stop Loss Limits	Loss threshold and associated action (e.g., close out, escalation)	Will not prevent future exposure, only limit realized losses
Notional Limits	Notional size of exposure	Notional amount may not be strongly related to economic risk of derivative instruments, especially options.
Risk Specific Limits	Limits referencing some special feature of risk in question (e.g., liquidity ratios for liquidity risk)	These limits are difficult to aggregate; may require specialized knowledge to interpret.
Maturity/Gap Limits	Limit amount of transactions that mature or reset/reprice in each time period	These limits reduce the risk that a large volume of transactions will need to be dealt with in a given time frame, with all the operational and liquidity risks this can bring. But they do not speak directly to price risk.
Concentration Limits	Limits of concentrations of various kinds (e.g., to individual counterparties, or product type)	These limits must be set with the understanding of correlation risks. They may not capture correlation risks in stressed markets.
Greek Limits	Option positions need to be limited in terms of their unique risk characteristics (e.g., delta, gamma, vega risk)	These limits suffer from all the classic model risks and calculation may be compromised at trading desk level without the right controls and independence.
Value-at-Risk (VaR)	Aggregate statistical number	VaR suffers from all the classic model risks and may be misinterpreted by senior management. Specifically, VaR does not indicate how bad a loss might get in an unusually stressed market.
Stress, Sensitivity, and Scenario Analysis	These limits are based on exploring how bad things could get in a plausible worst-case scenario. Stress tests look at specific stresses. Sensitivity tests look at the sensitivity of a position or portfolio to changes in key variables. Scenario modeling looks at given real-world scenarios (hypothetical or historical).	Varies in sophistication. Dependent on deep knowledge of the firm's exposures and market behavior. Difficult to be sure that all the bases are covered (e.g., there are endless possible scenarios).

**Figure 2.5** Limits—Example Types.

## 2.6 RISK TRANSFER TOOLBOX

In many cases, the risk manager will decide to transfer a portion of a financial risk to the risk management markets. The range of instruments available for hedging risk is can be categorized (broadly) into swaps, futures, forwards, and options.

These instruments have different capabilities like the different tools in a toolbox (Figure 2.6).

The use of these instruments requires firms to make key decisions based on their specific needs. For example, firms must decide how much they are willing to pay to preserve flexibility. Note that a forward contract provides price stability, but not much flexibility (because it requires the transaction to occur at the specified time and price). A call option provides both price stability and flexibility, but it comes with its own added cost (i.e., the option premium).

Another key difference cuts across instrument types: trading mechanics. Is the instrument offered through one of the large exchanges, or is it a private bilateral OTC agreement between two parties? OTC and exchange-based derivatives have different strengths and weaknesses, particularly relating to liquidity and counterparty credit risk.

Exchange-based derivatives are designed to attract trading liquidity. Not all succeed, but most can be traded easily at a relatively low transaction cost. The downside of this approach is like that of buying an off-the-rack suit: it is difficult for the risk manager to find a perfect fit. For example, a commodity risk manager may find the available futures contract does not cover the exact risk type, has a timing mismatch, or captures the price in the wrong location. These mismatches create basis risk.

More positively, exchange-based derivatives minimize counterparty credit exposure through margin requirements and netting

Instrument Type	Defining Features
Forwards	It is a tailored agreement to exchange an agreed upon quantity of an asset at a pre-agreed price at some future settlement date. The asset may be delivered physically, or the contract may stipulate a cash settlement (i.e., the difference between the agreed upon price and some specified spot or current price).
Futures	It is an exchange-listed forward with standardized terms, subject to margining.
Swap	It is an over-the-counter (OTC) agreement to swap the cash flows (or value) associated with two different economic positions until (or at) the maturity of the contract. For example, one side to an interest rate swap might agree to pay a fixed interest rate on an agreed upon notional amount for an agreed upon period, while the other agrees to pay the variable rate. Swaps take different forms depending on the underlying market.
Call Option	The purchaser of a call option has the right, but not the obligation, to <i>buy</i> the underlying asset at an agreed upon strike price, either at the maturity date (European option) or at any point during an agreed upon period (American option).
Put Option	The purchaser of a put option has the right, but not the obligation, to <i>sell</i> the underlying asset at the agreed upon strike price at the maturity date (European option) or at any point during an agreed upon period (American option).
Exotic Option	There are many different options beyond the standard or plain vanilla puts and calls. These include Asian (or average price) options and basket options (based on a basket of prices).
Swaption	It is the right, but not the obligation, to enter a swap at some future date at pre-agreed terms.

**Figure 2.6** The risk management toolbox.

arrangements. Counterparty credit risk in the OTC markets often looks rather low until a financial crisis occurs. At that point, banks and other counterparties suddenly look fragile. Clearing houses have begun to play a bigger role in the OTC market, so the distinction between exchange-based and OTC instruments in terms of counterparty risk is no longer as clear cut.

Risk managers can mix and match the various OTC and exchange-based instruments to form a huge variety of strategies. The next few sections look at strategy formulation in three key markets: agricultural products, energy, and interest rate/foreign exchange.

## Beer and Metal

The modern history of risk management arguably began with the agricultural futures contracts listed on the Chicago Board of Trade (CBOT) in the 1860s. Farmers, as well as food and drink producers, manage commodity price risks of many kinds. For example, the U.S. brewer Anheuser-Busch has big price exposures to wheat, barley, hops, corn grits, corn syrup, and other agricultural products, as well as to the aluminum it uses for its beer cans and the energy it uses in its processes.<sup>6</sup> Like other brewers, it is a major user of derivatives to manage these risks (Figure 2.7).

<sup>6</sup> Anheuser-Busch InBev, 2018 Annual Report, Section C: Commodity price risk, page 135.

Commodity Derivative	Notional Outstanding (Dec 31, 2018) (in USD Millions)
Aluminum Swaps	1,670
Exchange-Traded Sugar Futures	62
Natural Gas and Energy Derivatives	313
Corn Swaps	196
Exchange-Traded Wheat Futures	424
Rice Swaps	194
Plastic Derivatives	84

**Figure 2.7** Anheuser-Busch: Selected commodity derivatives usage.

Source: Anheuser-Busch InBev, 2018 Annual Report, Commodity price risk, page 135.

Anheuser-Busch and other big U.S. brewers have various strategies available to them.<sup>7</sup> For example, the brewers can manage wheat price exposures by fixing the price they pay per bushel of wheat using futures contracts (e.g., contracts traded on the CBOT). They can then hold these contracts for some months until they mature. At that point, the brewers can either take

<sup>7</sup> For an enlightening account of Anheuser-Busch's strategy see the first part of B. Tuckman, "Derivatives: Understanding Their Usefulness and Their Role in the Financial Crisis," *Journal of Applied Corporate Finance*, Volume 28, Number 1, Winter 2016.

delivery as specified by the exchange or sell it near the delivery date and use the proceeds to purchase from their favored supplier. Either way, they have largely managed the price risk of wheat for that period using a liquid exchange contract.

For a different commodity, such as the aluminum used in beer cans, the same brewer might instead turn to the OTC market and enter a swap with a bank. Here, the brewer pays the bank a fixed price for a given quantity of aluminum every few weeks for the life of the swap. In return, the bank pays the brewer the variable market price charged by the brewer's local aluminum suppliers. By tailoring an OTC swap, the brewer can manage the basis risks that arise from its production requirements (i.e., in terms of the precise time it needs the metal and any variability in local pricing).

If the price of aluminum rises, the bank could end up with a heavy loss. More likely, the bank will lock in a profit margin by hedging its own position using its expertise in the metals markets. Meanwhile, the brewer is happy because it has fixed an aluminum price that might otherwise prove highly volatile and subject to random geopolitical factors (e.g., trade disagreements, tariffs, or sanctions against key aluminum producing countries).<sup>8</sup>

## Airline Risk Management: Turbulence Ahead

Airlines are heavily exposed to volatile jet fuel prices, with as much as 15–20% of airline operating costs burnt in the air. In their fiercely competitive industry, airlines cannot easily raise passenger ticket prices in response to spikes in oil prices. This is because ticket pricing follows consumer demand rather than airline costs.

As a result, the industry has used a sophisticated combination of swaps, call options, collars (i.e., calls and puts), current oil contracts, and other instruments to manage its price risks since the mid-1980s. (The market matured quickly after the 1990–1991 Gulf War caused a spike in energy prices. Note that many management markets are born out of crises.)

One problem for airlines is that there are few futures contracts available for jet fuel. Using widely available exchange instruments to hedge against the price of crude oil or some other oil product (e.g., heating oil) is one way to get around this.

However, this method leaves airlines open to changes in the volatile "spread" between the price of jet fuel and the price of crude oil. Airlines using this approach therefore need to hedge this differential, as well as other basis risks in terms of timing and location. As an alternative, many firms use OTC instruments to tailor their hedging to jet fuel prices and to their specific delivery requirements.

Despite decades of jet fuel hedging, there is still industry disagreement about whether airlines ought to be hedging at all. Most airlines hedge some of their price risk, but some prefer to retain it all.

The naysayers cite the expense of hedging programs, as well as the risk hedging will lock in jet fuel prices at a high point in the market just before a steep price fall. This might not seem so bad. Few airlines are 100% hedged so a price fall is always good news. However, it can lead to severe hedging losses and make the profitability of the hedged airline look poor compared to its unhedged competitors.

Unhedged American Airlines reported a bumper year for 2014 because it could take full advantage of a 40%–50% fall in the price of jet fuel. American, unlike its hedged competitors,<sup>9</sup> ended up saving USD 600 million. With oil prices staying low in the years after 2014, many of American Airlines' competitors began cutting back on their hedging operations.

But remaining unhedged is also a bet. Back in 2008, oil had reached unexpected highs even as the world was enveloped in a financial crisis. That year, the airlines with the tightest hedging programs were the ones that looked clever.<sup>10</sup>

Airlines can try to get around this conundrum by hedging only a portion of their jet fuel costs, using options, or entering long forward contracts on jet fuel. But options-based strategies, while arguably the purest form of risk management, can be expensive to put in place.

Might vertical integration help? Delta Air Lines, one of the world's largest airlines, bought its own oil refinery in 2012 as part of its fuel management strategy. Over the years, the investment has allowed the airline to manage jet fuel availability in a key region while helping to cover the spread between jet fuel costs and the cost of crude oil.

<sup>8</sup> See A. Petroff, "Sanctions Have Sent Aluminium Soaring. That Could Hurt Your Wallet," CNN Money, April 11 2018, see <http://money.cnn.com/2018/04/11/investing/aluminum-prices-sanctions-rusal/index.html>. The price of the metal is also affected by more fundamental factors such as bauxite mining and smelting costs. See C. Harris, "Long-term Metal Price Development," *Managing Metals Price Risk*, Risk Publications, 1997, pages 167–187.

<sup>9</sup> H. Martin, "American Airlines' Fuel-Buying Bet Pays Off in Record Profit," Los Angeles Times, January 28, 2015; see <http://www.latimes.com/business/la-fi-airlines-fuel-hedging-20150128-story.html>

<sup>10</sup> For an accessible overview of airline hedging ups and downs, see H. Gosai, Part Two: Fuel Hedging in the Airline Industry, September 2017: <https://airlinegeeks.com/2017/09/18/part-two-fuel-hedging-in-the-airline-industry/>

## BOX 2.4 MCDONALD'S FINANCING AND MARKET RISK—FORM 10-K EXCERPTS

"The Company generally borrows on a long-term basis and is exposed to the impact of interest rate changes and foreign currency fluctuations. Debt obligations at December 31, 2017 totalled USD 29.5 billion, compared with USD 26.0 billion at December 31, 2016. . . .

The Company uses major capital markets, bank financings and derivatives to meet its financing requirements and reduce interest expense. The Company manages its debt portfolio in response to changes in interest rates and foreign currency rates by periodically retiring, redeeming and repurchasing debt, terminating swaps and using derivatives. The Company does not hold or issue derivatives for trading purposes. All swaps are over-the-counter instruments.

In managing the impact of interest rate changes and foreign currency fluctuations, the Company uses interest rate

swaps and finances in the currencies in which assets are denominated. The Company uses foreign currency debt and derivatives to hedge the foreign currency risk associated with certain royalties, intercompany financings and long-term investments in foreign subsidiaries and affiliates. This reduces the impact of fluctuating foreign currencies on cash flows and shareholders' equity. Total foreign currency-denominated debt was USD 12.4 billion and USD 8.9 billion for the years ended December 31, 2017 and 2016, respectively. In addition, where practical, the Company's restaurants purchase goods and services in local currencies resulting in natural hedges."

Source: Excerpts are from McDonald's Corporation, Form 10-K annual report for the fiscal year ended December 31, 2017, pages 26–27.

However, the refinery industry has its own ups and downs, which could be a potential distraction for Delta. Furthermore, owning a refinery arguably increases the airline's exposure to crude oil price volatility.<sup>11</sup> After all, most of a refinery's output is not jet fuel. In airline risk management, as in life, there are no easy answers.

### Interest Rate Risk and Foreign Exchange Risk Management

Interest rate and foreign currency risks are critical areas of price risk management for many firms. Box 2.4 presents excerpts from McDonald's 2017 Form 10-K (i.e., its annual report) that help explain why this is so. As a global business with a presence in over 100 countries, the fast food operator and franchiser has an active risk management function.

While individual transactions can be important, large firms like McDonald's have many financial exposures that balance and

offset each other. In fact, the business activities of a large firm often create natural hedges (e.g., the inflows and outflows of foreign currency).<sup>12</sup>

Moreover, the relationship between interest rates and foreign exchange rates is itself important. For example, should a firm raise money in the same currency as its overseas operations to minimize its exposure to foreign exchange risk? This may not be a practical option in some markets.

For many firms, interest rate risk is a major concern. Their fundamental task is to avoid taking on too much debt at high interest rates and avoid overexposure to variable rates of interest. This balancing act is determined by:

- Each firm's financial risk appetite, which may set out the levels of debt the board is happy with, and
- The proportion of fixed interest to variable interest, (perhaps across several time horizons).

A firm's financial risk appetite needs to be congruent with its target credit rating and any covenants it has made to banks and other financing providers.

Even if the firm's risk appetite remains stable, the rest of its risk management environment is constantly changing (Figure 2.8). These changes will come as the debt portfolio matures, business financing needs evolve, as well as when regulations and taxes

<sup>11</sup> The refinery, situated on the East Coast of the United States, has had some good and some less good years in terms of profitability, but has given Delta some leverage on jet fuel prices and more generally the "crack spread" in the region. See A. Levine-Weinberg, "Delta Air Lines' Refinery Bet is About to Pay Off Again," *The Motley Fool*, September 2017: <https://www.fool.com/investing/2017/09/03/delta-air-lines-refinery-bet-is-about-to-pay-off-a.aspx>; J. Renshaw, "Exclusive: Delta Hires Consultant to Study Refinery Options—Sources," March 14, 2017: <https://www.reuters.com/article/us-delta-air-refineries-monroe-exclusive-delta-hires-consultant-to-study-refinery-options-sources-idUSKBN16L24H>; A. M. Almansur et al., "Hedging Gone Wild: Was Delta Air Lines' Purchase of Trainer Refinery a Sound Risk Management Strategy?" October 4, 2016. This final reference includes a review of the literature on the value of hedging price risk, see pages 4–7.

<sup>12</sup> There is reason to think that many firms use derivatives only to fine-tune their risk profile, with much of the risk management already accomplished through business decisions and natural hedges. See discussion in W. Guay and S. P. Kothari, "How Much Do Firms Hedge with Derivatives," March 2002, p. 3.

<b>Firm Risk Appetite</b>	The firm's risk appetite sets the key goals.
<b>Market Practicalities</b>	It may be easier to raise money in one marketplace and then shift risk characteristics (currency, fixed versus. variable, etc.) into another using derivatives.
<b>Changing Business and Financing Needs</b>	Deals roll over, and businesses grow.
<b>Basic Aims: Cost Center versus Profit Center</b>	The treasurer may be permitted to take a view on the market direction.
<b>Regulations and Taxes</b>	The treasurer may need to respond to changes in the regulations and taxes.
<b>Market Direction and Behavior</b>	The treasurer may need to prepare for rising interest rates or respond to yield curve behavior.

**Figure 2.8** What drives interest rate risk management—examples of factors.

change. More urgently, interest rates change and so do the relationships between rates across a range of maturities (i.e., yield curve risk).

Changes in interest rates are linked to the broader economy and consumer demand. They may affect the fundamental health of a business, including its ability to meet debt obligations. On the upside, the falling cost of servicing variable rate debt can offer an important natural hedge in a deteriorating business environment.

Treasurers meet this complex challenge by using a variety of instruments, such as OTC interest rate swaps and currency swaps. When formulating specific strategies, the risk manager should return repeatedly to the firm's risk appetite and their directive. Often, that directive is to create a more stable version of the future around which the firm can plan.

## 2.7 WHAT CAN GO WRONG IN CORPORATE HEDGING?

The answer to this question: everything! A firm can misunderstand the type of risk to which it is exposed, map or measure the risk incorrectly, fail to notice changes in the market structure, or suffer from a rogue trader on its team. Figure 2.9 sets out some simple tips that might have prevented many corporate risk management disasters.

One cause of a mishap is to create a "risk management" program that is not really intended to manage risk. For example, it may seem legitimate for the firm to use risk management instruments to lower the amount of interest that it pays. Swaps and other derivatives can be used to attempt to reduce the amount of interest paid, but in exchange the hedger may be forced to take on much more downside risk, or to alter the structure of the interest paid to minimize payments in the short-term in exchange for ballooning payments in the future.

This kind of program is often more about artificially enhancing returns to meet analyst forecasts, or covering up fundamental

Tips
Set out clear goals.
Keep instruments and strategies simple.
Disclose the strategy and explain ramifications.
Set resources and limits suitable for the strategy.
Stress test and set up early warning indicators.
Watch for counterparty and break clause risk.
Consider the ramifications of many different market scenarios, for example, margin calls.

**Figure 2.9** Simple tips for conservative end users.

business problems, than it is about true risk management. At worst, the program might be characterized by unnecessarily complex derivative structures, leverage, or strategies that turn sour after some superficially unlikely but entirely plausible event (such as an unexpected shift in interest rates or a rise in basis risk). This is not really a failure of risk management, but of corporate governance.

A purer cause of failure is poor communication about the risk management strategy and its potential consequences. The classic example of this is perhaps the implosion of the MGRM (MG Refining and Marketing) hedging program in 1993.

MGRM, the energy trading US subsidiary of Metallgesellschaft AG, had promised to supply end users with 150 million barrels of gasoline and heating oil over ten years at fixed prices. It hedged this long-term price risk with a supersized rolling program of short-dated futures and OTC swaps.

The hedging strategy might well have worked if it had been pursued to the end. However, changes in the underlying oil market (i.e., a fall in cash prices and a shift in the price curve from backwardation to contango) meant that the program generated huge margin calls that became a severe and unexpected cash drain.

As a result, MGRM's startled parent company liquidated the hedges at a considerable loss. What happened next is that the market reversed and moved against the now unhedged MGRM, resulting in even greater losses on its original customer commitments. Essentially, MGRM lost twice:

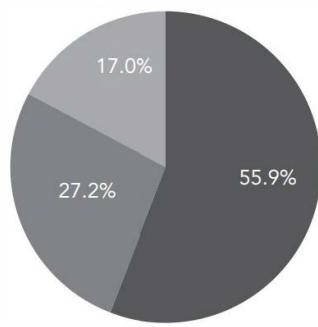
- First, when it unwound the hedges at a loss due to the cash drain from the margin calls, and
- Second, when the market moved against the original contracts (which were by then unhedged).

In this case, no rogue traders were involved. Instead, MGRM remains a lesson in the importance of thinking through the possible consequences of hedging programs and communicating the ramifications to stakeholders. If MGRM's management had anticipated the potential liquidity impact of hedging with futures, they could have set aside enough capital to meet the margin calls and maintain the hedge. Or maybe they might have decided to hedge differently in a way that did not create so much liquidity risk from collateral calls.

Of course, the world never hears about the hedges that go right. Or about the firms that would have gone bust if they had not put a well-managed, well communicated hedging program

Do you think derivatives end-user activity (hedging, trading) in the industry will increase, decrease, or stay the same over the next three to five years?

■ Increase ■ Stay the same ■ Decrease



**Figure 2.10** Professionals believe derivatives end-user activity will increase.

Source: ISDA, Future of Derivatives Survey, April 2018, page 4; survey conducted February–March 2018; respondents comprised 43% buy-side firms (financial and non-financial firms). Reprinted by permission.

into place. There's a reason most professionals believe end-user activity will continue to increase in the derivatives markets in the years ahead (Figure 2.10).

## SUMMARY

This chapter has set out a logical way to think through the corporate risk management process. But there are no silver bullets and no easy answers.

Firms must understand their business exposure and their natural hedges. They must think through and justify their hedging philosophy. They must set out their risk appetite, and link this to specific goals as well as to practical levers (e.g., risk limit frameworks and a rightsized risk management function). They must communicate about risk goals and hedging strategies so that consequences are well understood, and expectations are managed.

Finally, they must do something less tangible: build the right risk culture in which everyone works together to the same end. Risk culture can be assessed. Important questions to ask include the following.

- Can the firm show it regularly communicates about risk and responds to warning signs and near misses?
- Has it tested whether key staff have a common understanding of the firm's risk appetite?
- Can it demonstrate that its board has an awareness of the firm's top ten risks?<sup>13</sup>

All this is important for firms, but it is also important for those at the coalface of risk management. A risk manager that attains a pre-agreed risk management goal (e.g., stabilizing a volatile business exposure over a three-year time horizon) has done a difficult job. That risk manager deserves to know that his or her success is part of a bigger strategic plan that has already been communicated to stakeholders and is supported by the whole firm.

<sup>13</sup> For further discussion see S. Heilitag, A. Schlosser, and U. Stegemann, "Enterprise-risk-management practices: Where's the Evidence? A survey across two European industries," *McKinsey Working Papers on Risk*, Number 53, February 2014, Exhibit 6.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## QUESTIONS

- 2.1** What are the key risk management components that need to be re-evaluated on a regular basis for designating a risk management road map?
- 2.2** Provide several examples to demonstrate that the C-suite supports a strong risk culture.
- 2.3** Describe what is meant by risk appetite in practical terms.
- 2.4** Provide examples of what factors drive interest rate risk management.
- 2.5** Provide examples of hedging tips for conservative end users.
- 2.6** Describe why modern firms make such a big deal of financial risk management?
- 2.7** Provide examples of commodity derivatives that a brewery might use to manage their risk.
- 2.8** Risk appetite includes asking "Who are we?" and "Who do our stakeholders think we are?" well before trying to operationalize a risk appetite.  
A. True  
B. False
- 2.9** The MGRM (MG Refining & Marketing) hedging program in 1993 is a classic example of good communication about the risk management strategy and its potential consequences.  
A. True  
B. False
- 2.10** A firm can find a complicated tailored instrument that always dampens their exposure to a variable interest rate.  
A. True  
B. False
- 2.11** Airlines are heavily exposed to volatile jet fuel prices, with as much as 45–60% of airline operating costs burnt in the air.  
A. True  
B. False
- 2.12** MGRM's hedging strategy might well have worked if it had been pursued to the end.  
A. True  
B. False
- 2.13** Airlines have used a sophisticated combination of swaps, call options, collars (calls and puts), futures contracts, and other instruments to manage their price risks since around the mid-1980s.  
A. True  
B. False
- 2.14** MGRM was exposed to a shift in the price curve from backwardation to contango, which meant that the program generated huge margin calls that became a severe and unexpected cash drain.  
A. True  
B. False
- 2.15** There is an agreement among experts that all airlines ought to be hedging their jet fuel price risk.  
A. True  
B. False
- 2.16** If a risk exists then the firm *should* always hedge it.  
A. True  
B. False
- 2.17** McDonalds uses major capital markets, bank financings, and derivatives to meet its financing requirements and reduce interest expense.  
A. True  
B. False
- 2.18** Risk appetite refers to the total amount of risk  
A. the firm could bear without becoming insolvent.  
B. the firm is taking today.  
C. the amount that it would be happy to bear at any one time.  
D. none of the above.
- 2.19** Risk capacity refers to the total amount of risk  
A. the firm could bear without becoming insolvent.  
B. the firm is taking today.  
C. the amount that it would be happy to bear at any one time.  
D. none of the above.
- 2.20** Transferring risk to a third party includes  
A. insurance contracts.  
B. financial derivatives.  
C. all of the above.  
D. none of the above.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

- 2.21** Exchange-based derivatives are designed to
- A. be traded easily at a relatively low transaction cost.
  - B. be a perfect fit hedge.
  - C. avoid basis risk.
  - D. reduce counterparty credit risk.
- 2.22** Minimizing counterparty credit exposure can be obtained through the use of
- A. margin requirements.
  - B. netting arrangements.
  - C. all of the above.
  - D. it cannot be minimized at all.
- 2.23** The agricultural futures contracts first listed on the Chicago Board of Trade (CBOT) in the
- A. 1860s.
  - B. 1920s.
  - C. 1940s.
  - D. after the 1950s.
- 2.24** Do equity investors want managers to hedge risk?
- A. Generally yes, if the investor has concentrated their investment in a particular firm
  - B. Always yes

- 2.25** Brewers can fix the price they pay per bushel of wheat to manage wheat price exposures by buying futures contracts and
- A. holding these futures contracts until they mature and take delivery specified by the exchange in terms of quality and location.
  - B. selling these futures contracts near the delivery date and using the proceeds to purchase the wheat now from their favored supplier.
  - C. All of the above
- 2.26** Once the firm/bank makes a risk appetite statement
- A. it is committed to follow it for at least three years.
  - B. it must report it in their annual financial report.
  - C. the board must approve it.
  - D. all of the above.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## ANSWERS

**2.1** Re-evaluate regularly changes in:

- Risk appetite/risk understandings/stakeholder viewpoint,
- Business activity and risk environment (remapping), and
- New tools, tactics, cost/benefit analysis.

**2.2** The C-Suite can demonstrate it has a strong risk culture through:

- Regularly communicating about risk,
- Responding in a timely manner to warning signs and near misses,
- Periodically testing whether there is a common understanding of the firm's risk appetite,
- Demonstrating that it has an awareness of the firm's top ten risks, and
- Communicating that the success of the risk manager is part of a bigger strategic plan.

**2.3** First, it is a statement about the firm's willingness to take risk in pursuit of its business goals. Second, it is the sum of the mechanisms that link this top-level statement to the firm's day-to-day risk management operations. It assesses the risk exposures the firm is willing to assume in relation to the expected returns from engaging in risky activities.

**2.4**

Firm Risk Appetite	The firm's risk appetite sets the key goals.
Market Practicalities	It may be easier to raise money in one marketplace and then shift the risk characteristics (currency, fixed versus variable etc.) in another using derivatives.
Changing Business and Financing Needs	Meanwhile, deals roll over, businesses grow.
Basic Aims: Cost Center versus Profit Center	The treasurer may be permitted to take a view on the market direction.
Regulations and Taxes	The treasurer may need to respond to change in the rules of the game.
Market Direction and Behavior	The treasurer may need to prepare for rising interest rates or respond to yield curve behavior.

**2.5**

Tips include

- Setting clear goals,
- Keeping instruments simple,
- Keeping strategies simple,
- Disclosing the strategy,
- Explaining ramifications,
- Setting resources and limits suitable for the strategy,
- Stress testing, and
- Setting early warning indicators.

**2.6** The answer lies in two aspects of risk management. First, the need to manage financial risk grew significantly from the 1970s on because commodity, interest rate, and foreign exchange markets liberalized, and price volatility shot up. Second, growth in market volatility helped spawn a fast-evolving market in financial risk management instruments through the 1980s and 1990s, giving more opportunities to manage their risk adjusted returns. Globalization of companies and of trading introduced additional financial risk exposures.

**2.7** These commodity derivatives might include

- Aluminum swaps,
- Natural gas and energy derivatives,
- Exchange-traded wheat futures,
- Exchange-traded sugar futures,
- Corn swaps, and
- Rice swaps.

**2.8** True

**2.9** False

**2.10** False, because only true if interest rates stay within certain bounds. If interest rates later break through a given ceiling, then the firm's financial exposure might increase.

**2.11** False, because only 15–20% of airline operating costs are burnt in the air.

**2.12** True

**2.13** True

**2.14** True

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

- 2.15** False, most airlines hedge some of their price risk, but some prefer to retain it all. The naysayers cite the expense of hedging programs and fear that they will lock in jet fuel prices at a high point in the market, just before a steep price fall.
- 2.16** False
- 2.17** True
- 2.18** C. the amount that it would be happy to bear at any one time
- 2.19** A. the firm could bear without becoming insolvent
- 2.20** C. all of the above.
- 2.21** D. reduce counterparty credit risk
- 2.22** C. all of the above
- 2.23** A. 1860s
- 2.24** Generally yes. Potentially no in the case where the investor holds the investment as part of a diversified portfolio.
- 2.25** C. all of the above
- 2.26** The board must approve it.





# 3

# The Governance of Risk Management

## ■ Learning Objectives

After completing this reading, you should be able to:

- Explain changes in regulations and corporate risk governance that occurred as a result of the 2007–2009 financial crisis.
- Describe best practices for the governance of a firm's risk management processes.
- Explain the risk management role and responsibilities of a firm's board of directors.
- Evaluate the relationship between a firm's risk appetite and its business strategy, including the role of incentives.
- Illustrate the interdependence of functional units within a firm as it relates to risk management.
- Assess the role and responsibilities of a firm's audit committee.

Corporate governance is the way in which companies are run.<sup>1</sup> It describes the roles and responsibilities of a firm's shareholders, board of directors, and senior management.

Corporate governance, along with its relationship to risk, has become a major issue in the banking industry. This chapter traces the development of risk governance (i.e., how firms undertake and oversee risk management) over the past two decades. It describes how risk governance morphed from a vague principle into a well-defined set of best practices and became a central tenet of modern banking regulation.

The ascendance of risk governance is closely linked to a series of high-profile corporate scandals that occurred in the first decade of the twenty-first century. The first wave of these failures included the bankruptcies of Enron in 2001, WorldCom and Global Crossing in 2002, and Parmalat SpA in late 2003. In these cases, corporate failure was precipitated by financial or accounting fraud.

While this fraud was perpetrated primarily by executives, it is important to note that their actions were seemingly unchecked by the firms' auditors and boards of directors. Specifically, boards and shareholders were not informed of the economic risks undertaken by corporate management. This lack of communication reflected a fundamental breakdown in corporate disclosure and accountability. Financially engineered products (e.g., derivatives) were often involved and were used at times to disguise the severity of the failing firms' financial positions.

These scandals, and the faulty corporate governance that allowed them to occur, led to regulatory reforms designed to enhance the governance of public firms, increase transparency and executive accountability, and improve financial controls and oversight. In the United States, these changes took the form of federal legislation: the Sarbanes-Oxley Act<sup>2</sup> (SOX). This law laid the foundation for federally enforced corporate governance rules based on stricter securities regulation. The law was passed in 2002 and the new standards were put into effect the following year, with the Securities and Exchange Commission requiring US-based securities exchanges and associations to make sure that their listing standards conformed to the new mandated standards set forth by SOX.<sup>3</sup> In addition to governance, these rules also had significant implications for risk management.

Europe refrained from a legislative approach. Instead, European regulators pursued a voluntary reform of corporate codes and a regime of "comply-or-explain" for departures from these codes. These reforms focused on internal controls, governance mechanisms, and financial disclosure and did not directly address risk management.

The 2007–2009 global financial crisis was directly tied to risk management failures. The crisis itself was triggered by the downward turn in a previously "hot" housing market, which was fueled by an all-too-easy mortgage market and accelerated by a booming market for privately issued mortgage-backed securities that were traded by leading financial institutions.<sup>4</sup> During this time, lenders engaged in unsound practices by extending mortgages to unqualified individuals and encouraging homeowners to take on more debt than they could handle. Investment banks securitized these loans into complex asset-backed securities, which found their way into the mainstream credit market. The financial institutions responsible for originating and trading these structured instruments, as well as the rating agencies that assigned them credit ratings, failed to accurately appraise their value and risk.

As the number of mortgage defaults climbed, the system unraveled and several major investment banks holding low-quality assets to use as collateral for privately issued mortgage-backed securities found themselves on the verge of collapse. As the crisis unfolded, it became apparent that the problems encountered in the mortgage market extended far beyond homeowner lending. During the boom years preceding the crisis, risk management at many financial institutions was marginalized as executive management threw caution to the wind in pursuit of greater returns. The decline in underwriting standards, the breakdown in oversight, and a reliance on complex credit instruments came to characterize the credit markets. This eventually led to the failure of numerous financial institutions. Although originating in the United States, the crisis affected banking and economic activity all around the world. It was systemic in nature and global in scope.

The events of 2007–2009 underscored the inadequacy of the corporate governance regulation adopted earlier in the decade.

<sup>1</sup> Report of the Committee on the Financial Aspects of Corporate Governance (1992), <http://cadbury.cjbs.archios.info/report>.

<sup>2</sup> The Sarbanes-Oxley Act - Pub. L. 107-204, 116 Stat. 745.

<sup>3</sup> The final rule on standards for Listed Companies Audit Committees was put into effect in April of 2003, with exchanges required to have their own internal rules for compliance approved by the SEC by December 1, 2003.

<sup>4</sup> Mortgage-backed securities are issued by Ginnie Mae (a government agency), Fannie Mae and Freddie Mac (which at the time were Government Sponsored Enterprises), and private issuers such as banks and other financial institutions. Mortgage-backed securities issued by private issuers are not backed by any government entity. These mortgage-backed securities are also called non-agency mortgage-backed securities. Privately issued mortgage-backed securities were (at the time) backed by collateral that included loans to high grade borrowers (called prime borrowers) and those to borrowers with a blemished credit history (called subprime borrowers). It is the subprime mortgage-backed securities that caused the most problems in the mortgage market.

## BOX 3.1 SARBANES-OXLEY (SOX)

SOX came into effect on July 30, 2003, creating stricter legal requirements for boards, senior management, as well as both external and internal auditors.

Some of the important aspects of SOX are

- Chief executive officers (CEOs) and chief financial officers (CFOs) must ensure that reports filed with the SEC are accurate for publicly traded firms.<sup>a</sup> This includes certifying that “[such reports do] not contain any untrue statement of a material fact or omit to state a material fact.”<sup>b</sup>
- CEOs and CFOs must affirm that disclosures provide a complete and accurate presentation of their company’s financial conditions and operations.
- CEOs and CFOs are also responsible for internal controls, including their design and maintenance.
- Furthermore, firm officers are required to disclose any significant deficiencies in internal controls, as well as any

fraudulent activities related to individuals who have a material role in the control systems, to external auditors, the internal audit function, and the firm’s audit committee.

- The effectiveness of a firm’s reporting procedures and controls must be reviewed annually.
- The names of individuals who serve on the board audit committee are to be disclosed.

These individuals are expected to:

- Understand accounting principles,
- Be able to comprehend financial statements, and
- Have experience with internal audits and understand the functions of the audit committee.

<sup>a</sup> Such reports are filed quarterly and annually.

<sup>b</sup> The Sarbanes-Oxley Act - Pub. L. 107-204, 116 Stat. 745, section 302.

**Table 3.1 Key Post Crisis Corporate Governance Concerns—The Banking Industry**

<b>Stakeholder Priority</b>	Enquiries into the 2007–2009 financial crisis found that often little attention was paid to controlling tail risks and considering truly worst-case outcomes. This has led to a debate about the uniquely complicated set of stakeholders in banking and the potential impact on corporate governance.  In addition to equity, banks have large amounts of deposits, debt, and implicit government guarantees. Depositors, debtholders, and taxpayers have a much stronger interest in minimizing the risk of bank failure than do most shareholders, who often seem to press for short-term results. Shareholder empowerment, the usual remedy to corporate governance ills, may therefore be an inadequate solution for the banking industry’s woes. <sup>5</sup>
<b>Board Composition</b>	The crisis reignited a longstanding debate as to how to ensure bank boards can achieve the appropriate balance of independence, engagement, and financial industry expertise. Analyses of failed banks do not show any clear correlation between success and a predominance of either insiders or outsiders. One can note, however, that failed bank Northern Rock had several banking experts on its board.
<b>Board Risk Oversight</b>	The importance of boards being proactive in risk oversight became increasingly recognized following the crisis. This has led to a focus on educating boards about risk and making sure they maintain a direct link to the risk management infrastructure (e.g., by giving CROs direct reporting responsibilities to the board).
<b>Risk Appetite</b>	Regulators have pushed banks to articulate a formal, board-approved risk appetite that defines a firm’s willingness to undertake risk and tolerate threats to solvency. This can be translated into an enterprise-wide setting of risk limits. Engaging the board in the limit-setting process helps to make sure it thinks clearly about risk-taking and its implications for day-to-day decision-making.
<b>Compensation</b>	One of a board’s key levers in determining risk behavior is its control over compensation schemes. Boards have a duty to examine how pay structures might affect risk-taking and whether risk-adjustment mechanisms capture all key long-term risks. Some banks have started instituting reforms, such as limiting the scope of bonuses in compensation packages, as well as introducing deferred bonus payments and clawback provisions.

Neither the regulation of Sarbanes-Oxley nor the principle-based light touch approach in Europe were able to avert the crisis in the banking and securities industries. Nonetheless, many saw the absence of executive accountability and the failure of internal corporate oversight as significant contributors to the crisis and the ensuing loss of confidence in the banking system. The debate

on corporate governance continued in the aftermath of the crisis. Table 3.1 summarizes some of the key issues in this debate.

<sup>5</sup> See discussion in H. Mehran, A. Morrison, and J. Shapiro “Corporate Governance and Banks: What Have We Learned from the Financial Crisis?” Federal Reserve Bank of New York, Staff Report No. 502, June 2011.

## 3.1 THE POST-CRISIS REGULATORY RESPONSE

The concerns regarding risk governance in the banking industry, summarized in the previous table, were and continue to be addressed in post-crisis financial regulation. The Basel Committee on Banking Supervision (BCBS), an organization comprised of the central banks and bank supervisors from 27 jurisdictions, focuses on formalizing international standards for prudential banking regulation. The standards set by the BCBS are not legally binding, but they are incorporated voluntarily in the regulatory systems of members and other jurisdictions.

The 1988 Basel Accord (Basel I) focused on devising a uniform method for setting capital adequacy standards in the wake of the Latin American debt crisis earlier that decade. Focusing primarily on credit risk, Basel I introduced a risk-weighted approach to capital requirements, setting the prescribed minimum capital at 8% of a firm's risk-weighted assets.

In 1999, the BCBS began work on a revised capital adequacy framework designed to supersede Basel I. This initiative, called the Basel II framework, was finalized in 2006 and incorporates a bank's trading activity alongside its lending activity in the calculation of risk. The 8% minimum remained, but the risk-weighting methodology was refined. This made Basel II more risk-sensitive and better attuned to financial innovation compared to its predecessor. Basel II also introduced standards for supervisory bank reviews as well as disclosure requirements to reinforce market discipline through transparency.

Many jurisdictions were in the process of implementing Basel II when the global financial crisis unfolded. The Basel III Accord was a direct response to the crisis and focused on injecting greater systemic resiliency in the banking system. Basel III focuses on both firm-specific risk and systemic risk (i.e., the risk associated with the failure of a major financial institution causing other interconnected financial institutions to fail, resulting in major harm to the economy).

Most of the reforms being phased in under Basel III continue to emphasize capital adequacy issues, such as the coverage required from regulatory capital along with its quantity and quality. Basel III raises capital quality by limiting core Tier 1 capital<sup>6</sup> to common equity and retained earnings, which provide loss absorption unlike other forms of hybrid debt. Basel III also imposes new ratios for short-term and long-term liquidity, such as the 30-day Liquidity Coverage Ratio (LCR) and the one-year net stable funding ratio (NSFR). In particular, the NSFR should

help to counter pro-cyclicality because it is designed to ensure banks lessen their dependence on wholesale short-term funding.<sup>7</sup>

The risk-based capital requirements adopted in Basel II have been expanded to better address risks emanating from capital markets activities. These risks include exposure to central counterparties, margins on non-centrally cleared derivatives, exposure to counterparty credit risks, and securitization.

Basel III has also designed a *macroprudential overlay* intended to reduce systemic risk and lessen procyclicality. The macroprudential overlay consists of five elements:

1. A leverage ratio of 3%,
2. A countercyclical capital buffer,
3. Total loss-absorbing capital (TLAC) standards that apply to global systemically important banks (G-SIBs),
4. Systemically important markets and infrastructures (SIMIs); in the case of OTC derivatives, the Basel Committee is pushing the market to move as many trades as possible through centralized clearing and trade reporting, and
5. Capturing systemic risk and tail events in risk modeling and stress testing.

The framework for handling market risk was revised in 2016 with the Fundamental Review of the Trading Book (FRTB).<sup>8</sup> Specifically, disclosure requirements were enhanced to reflect a more comprehensive approach to describing and calculating risk, as well as to facilitate comparative risk analysis.

The BCBS also confronted governance issues exposed by the crisis. In October 2010, it issued several principles designed to improve corporate governance in the banking industry. These principles addressed the duties of the board and the qualification of board members, as well as the importance of an independent risk management function.<sup>9</sup> These principles were revised in 2015 with an eye towards reinforcing the board's active role in collective oversight and risk governance.<sup>10</sup> The revised guidance report defines roles of the board and the board risk committees, senior management, chief risk officers (CROs), and internal auditors.

<sup>7</sup> When this funding evaporates during a credit crisis, it forces banks to shed assets at depressed prices to meet liquidity requirements.

<sup>8</sup> Basel Committee for Banking Supervision, *Minimum Capital Requirements for Market Risk*, January 2016.

<sup>9</sup> Basel Committee for Banking Supervision, *Principles for Enhancing Corporate Governance*, October 2010.

<sup>10</sup> Basel Committee for Banking Supervision, *Corporate Governance Principles for Banks*, July 2015.

<sup>6</sup> Tier 1 capital, also called core capital and primary capital, is the sum of common stock, retained earnings, and certain reserves.

**Table 3.2 Corporate Governance Principles for Banks**

1.	<b>Board's Overall Responsibilities</b>	The board has overall responsibility for the bank, including approving and overseeing management's implementation of the bank's strategic objectives, governance framework and corporate culture.
2.	<b>Board Qualifications and Composition</b>	Board members should be and remain qualified, individually and collectively, for their positions. They should understand their oversight and corporate governance role and be able to exercise sound, objective judgment about the affairs of the bank.
3.	<b>Board's Own Structure and Practices</b>	The board should define appropriate governance structures and practices for its own work and put in place the means for such practices to be followed and periodically reviewed for ongoing effectiveness.
4.	<b>Senior Management</b>	Under the direction and oversight of the board, senior management should carry out and manage the bank's activities in a manner consistent with the business strategy, risk appetite, remuneration, and other policies approved by the board.
5.	<b>Governance of Group Structures</b>	In a group structure, the board of the parent firm has the overall responsibility for the group and for ensuring the establishment and operation of a clear governance framework appropriate to the structure, business, and risks of the group and its entities. The board and senior management should know and understand the bank group's organizational structure and the risks that it poses.
6.	<b>Risk Management Function</b>	Banks should have an effective independent risk management function, under the direction of a chief risk officer (CRO), with sufficient stature, independence, resources, and access to the board.
7.	<b>Risk Identification, Monitoring, and Controlling</b>	Risks should be identified, monitored, and controlled on an ongoing bank-wide and individual entity basis. The sophistication of the bank's risk management and internal control infrastructure should keep pace with changes to the bank's risk profile, the external risk landscape, and to industry practice.
8.	<b>Risk Communication</b>	An effective risk governance framework requires robust communication within the bank about risk, both across the organization and through reporting to the board and senior management.
9.	<b>Compliance</b>	The bank's board of directors is responsible for overseeing the management of the bank's compliance risk. The board should establish a compliance function and approve the bank's policies and processes for identifying, assessing, monitoring, reporting, and advising on compliance risk.
10.	<b>Internal Audit</b>	The internal audit function should provide independent assurance to the board and should support the board and senior management in promoting an effective governance process and the long-term soundness of the bank.
11.	<b>Compensation</b>	The bank's remuneration structure should support sound corporate governance and risk management.
12.	<b>Disclosure and Transparency</b>	The governance of the bank should be adequately transparent to its shareholders, depositors, other relevant stakeholders, and market participants.
13.	<b>Role of Supervisors</b>	Supervisors should provide guidance for and supervise corporate governance at banks, including through comprehensive evaluations and regular interaction with boards and senior management; should require improvement and remedial action as necessary; and should share information on corporate governance with other supervisors.

Source: Basel Committee on Banking Supervision, *Guidelines: Corporate Governance Principles for Banks*, July 2015, 8–40.

Corporate governance in banking has been strongly impacted by the post-crisis regulatory response. This includes Basel III, but also the U.S. Dodd-Frank Act and the European Supervisory Review and Evaluation Process (SREP).<sup>11</sup>

## After the Crisis: Industry Restructuring and the Dodd-Frank Act

Until 1999, commercial banking in the United States was segregated from investment banking by law under the Glass-Steagall Act. That year, the Graham-Leach-Biley Act largely abolished the restrictions embodied in the Glass-Steagall Act. Specifically, it enabled bank holding companies to convert into financial services holding companies (FSHCs). As FSHCs could combine investment banking, commercial banking, insurance, and broker-dealer activities under one corporate umbrella, it was intended to encourage the growth of universal banking in the United States.<sup>12</sup>

Despite the repeal of Glass-Steagall, however, commercial and investment banking remained as two separate industries operating under two regulatory paradigms. While U.S. banking regulation involves both supervision of business conduct (i.e., investor protection) and prudential regulation aimed at ensuring bank stability, investment banking did not come under the purview of bank regulators and was therefore not subject to prudential oversight. In addition, investment banking was generally regarded as marginal to the stability of the United States banking system (until the 2007–2009 crisis proved otherwise).

The competitive structure of the banking industry was altered dramatically during, and as the result of, the crisis. Investment giants, including Bear Stearns and Merrill Lynch, were merged (under duress) with banking institutions. Lehman Brothers went bankrupt. The last two major investment banks, Goldman Sachs and Morgan Stanley, were converted into bank holding companies (BHCs). This made them subject to the full force of banking regulation, but also eligible for the credit extended to banking institutions by the Federal Reserve System.

In July 2010, the Dodd-Frank Act<sup>13</sup> was signed into law. The Act's 2,300 pages overhauled the regulation of the financial industry in the United States, aiming to improve both consumer protection and systemic stability. Specifically, it attempted to address several issues.

<sup>11</sup> This is new approach to bank supervision for European banks regulated by the Single Supervisory Mechanism.

<sup>12</sup> A. Saunders and L. Allen, (2010). *Credit Risk Measurement In and Out of the Financial Crisis: New Approaches to Value at Risk and Other Paradigms*, Hoboken, N.J.: Wiley, 2010.

<sup>13</sup> Dodd-Frank Wall Street Reform and Consumer Protection Act - Pub.L. 111-203, H.R. 4173.

- **Strengthening the Fed:** The Act extended the regulatory reach of the Federal Reserve (i.e., the Fed) in the areas concerned with systemic risk. All the systemically important financial institutions (SIFIs), which are defined as bank holding firms with more than USD 50 billion<sup>14</sup> of assets, are now regulated by the Federal Reserve and the Fed's mandate now includes macroprudential supervision.
- **Ending too-big-to-fail:** Dodd-Frank proposed an end to "too-big-to-fail" by creating an orderly liquidation authority (OLA).
- **Resolution plan:** SIFIs are required to submit a so-called "living will" to the Federal Reserve and the Federal Deposit Insurance Corporation (FDIC) that lays out a corporate governance structure for resolution planning.
- **Derivatives markets:** The Act launched a transparency-focused overhaul of derivatives markets regulation with the aim of helping market participants with counterparty risk.
- **The Volcker Rule:** This rule imposes a prohibition on proprietary trading, as well as the partial or full ownership/partnership of hedge funds and private equity funds by banking entities.<sup>15</sup>
- **Protecting consumers:** The Act created a Consumer Financial Protection Bureau (CFPB) to regulate consumer financial services and products.
- **Stress testing:** The Act instituted a radically new approach to scenario analysis and stress testing, with the following characteristics:
  - A top-down approach with macroeconomic scenarios unfolding over several quarters;
  - A focus on the effects of macroeconomic downturns on a series of risk types, including credit risk, liquidity risk, market risk, and operational risk;
  - An approach that is computationally demanding, because risk drivers are not stationary, as well as realistic, allowing for active management of the portfolios;
  - A stress testing framework that is fully incorporated into a bank's business, capital, and liquidity planning processes; and
  - An approach that not only looks at each bank in isolation, but across all institutions. This allows for the collection of systemic information showing how a major common scenario would affect the largest banks collectively.

<sup>14</sup> In 2018 the U.S. Congress raised this threshold to USD 250 billion.

<sup>15</sup> This provision, originally proposed by the former Chairman of the Federal Reserve Paul Volcker, is nicknamed the *Volcker Rule* and it became effective in July 2015. With the proposed 2018 reform of the Dodd-Frank Act, the smallest banks (i.e., those with less than USD 10 billion in assets) would be exempt from the Volcker Rule.

The Federal Reserve Board (FRB) conducts two stress testing exercises:

1. The Dodd-Frank Act Stress Test (DFAST) for banks with assets above USD 10 billion, and
2. The Comprehensive Capital Analysis and Review (CCAR) for banks with assets above USD 50 billion.<sup>16</sup>

CCAR is an annual exercise with the three supervisory scenarios and two internally generated scenarios (i.e., BHC baseline and BHC adverse). BHCs must present a capital plan describing all planned actions (e.g., dividend increases, share repurchases, major acquisitions) over a planning horizon of nine quarters. Banks must have a Tier 1 capital ratio of at least 5% throughout the planning period. Those that exceed this ratio should revise their risk appetites downward. Meanwhile, the Fed's qualitative assessment of a capital plan revolves around the adequacy of the internal processes.

## The European Regulatory Response to the GFC: SREP and EBA Stress Tests

A new approach to bank supervision, called the Supervisory Review and Evaluation Process (SREP), is taking hold for banks in Europe.

The SREP introduces three new principles to banking supervision:

1. A forward-looking emphasis on the sustainability of each bank's business model, including during conditions of stress,
2. An assessment methodology based on best practices within the banking industry, and
3. An expectation that every bank will ultimately operate under the same standards.

The internal capital adequacy assessment process (ICAAP) and the internal liquidity adequacy assessment process (ILAAP) are the two key components of SREP.

1. The ICAAP incorporates scenario analysis and stress testing. It outlines how stress testing supports capital planning.
2. The ILAAP incorporates the potential losses from asset liquidations and increased funding costs during stressful periods.

European banks with assets of EUR 30 billion and above must run European Banking Authority (EBA) stress tests. These stress tests are run at the consolidated banking group level (insurance activities are excluded). Two supervisory macroeconomic scenarios covering a three-year period are provided by the regulator: a baseline scenario and an adverse scenario.

Although the scenarios unfold over a three-year period, the approach (contrary to CCAR) is fundamentally static and banks

are only required to look at the immediate impact of the cumulative shocks over the three-year period.

## 3.2 INFRASTRUCTURE OF RISK GOVERNANCE

This section discusses the infrastructure of risk governance and address three critical questions.

1. Are corporate governance best practices related to best practice in risk management, and if so, how?
2. How is risk management delegated through the organization? What roles do the executive staff and board committees undertake in the execution and oversight of risk management?
3. How does risk management policy filter down to business managers and how is it reflected in the way regular business is conducted?

These questions seek to outline how corporate risk management should be designed and diffused throughout financial institutions. While the focus of this section is on the banking industry, the concepts, principles, and protocols articulated below are relevant for other corporations as well.

### The Board and Corporate Governance

One of the key duties of a corporate board of directors is to protect the interests of shareholders. Traditionally, the board has been cast as the gatekeeper for all shareholders. A growing number of analysts, however, argue that the responsibility of the board extends beyond shareholders to include all corporate stakeholders (e.g., debtholders and employees). Given the divergent interests of the various stakeholders, managing this responsibility is not always an easy task. Debtholders, for example, are primarily interested in the extreme downside risk. This is because their stake in the firm is most at risk during times of distress (i.e., when corporate solvency is on the line).

The board is also charged with overseeing executive management. Analyzing the risks and returns from corporate activity is one of the board's fundamental duties. If management assumes a given risk, the board must understand the type and magnitude of the threat posed should that risk come to fruition.

Addressing conflicts of interest between management and shareholders lies at the heart of corporate board oversight. Such conflicts are referred to in the financial literature as agency problems, and they are often manifested as the unwarranted assumption of risk to pursue short-term profits or to enhance apparent performance. These activities put the interests of management squarely against those of longer-term stakeholders.

<sup>16</sup> Under the 2018 reform of the Dodd-Frank Act, it is now mandatory only for banks with assets above USD 250 billion.

Conflicts of interest are easily created, rendering agency risk a perennial governance challenge. For example, giving executives stock options (which take on value only if the firm's shares exceed a certain price) can incentivize senior management to take actions designed to temporarily boost the firm's share price, even if these actions hurt the firm in the long term.

Even the best-designed executive compensation systems cannot fully prevent executives from being tempted to pursue short-term results to the detriment of long-term objectives. For this reason, the scope and structure of executive compensation has become a major concern and measures to strengthen executive accountability are gaining traction.

Ongoing tensions between the interests of CEOs and the interests of longer-term stakeholders have become a prominent feature of corporate management. Agency risks arising from these tensions provide an important rationale for the board's independence from executive management. They also explain the recommended best practice of separating the position of CEO from that of board chairman.

The bankruptcy of brokerage firm MF Global in 2011 illustrates the perils of agency risk, particularly when the board's independence from executive management is questionable.

In 2010, MF Global appointed Jon Corzine<sup>17</sup> as chairman of the board and CEO. At the time, the firm was already experiencing liquidity and compliance problems. Under Corzine's leadership, and despite repeated warnings by the firm's CRO at the time,<sup>18</sup> MF Global made huge proprietary investments in European sovereign debt. These investments soured in 2011, exacerbating the firm's liquidity problems. This led to a loss of shareholder and client confidence, and ultimately to the firm's collapse. During this time, the firm allegedly misappropriated client funds in an attempt to keep the firm solvent. This prompted the U.S. Commodity Futures Trading Commission (CFTC) to act against Corzine and the firm's assistant treasurer.<sup>19</sup>

## From Corporate Governance to Best-Practice Risk Management

The experience of the past two decades illustrates how the objectives of corporate governance and risk management have converged. The 2007–2009 crisis exposed extreme deficiencies in risk management and oversight among financial institutions. As a

result, post-crisis regulation has raised the bar for risk governance with the aim of reining in both financial and agency risks.

Risk governance involves setting up an organizational infrastructure to articulate formal procedures for defining, implementing, and overseeing risk management. It is also about transparency and establishing channels of communication within the organization as well as with external stakeholders and regulators.

The mix of the measures adopted, and the degree to which they are enshrined in law, varies between jurisdictions. In 2012, the World Bank articulated a set of standards for risk governance aimed at improving the effectiveness of risk management and control, enhancing risk management standards, and promoting the competitiveness and sustainability of financial institutions.<sup>20</sup>

The board of directors plays a central role in both the shaping and oversight of risk management. Its primary responsibility in risk governance is to assess the fundamental risks and rewards engendered in the firm's business strategy. This assessment must be based on a clear understanding of the institution's direction and goals. The board must proactively participate in strategic planning as well as outline the appropriate risk appetite (as discussed in Chapter 2).

Risk appetite is intimately related to business strategy and capital planning. Certain activities may be categorically inappropriate for an enterprise given the type of risk involved. The appropriateness of other activities may be a function of their scope relative to the firm's total asset value. Business planning must take risk management into consideration from the outset, and the matching of strategic objectives to risk appetite must be incorporated into the planning process. Equally important is a clear communication of risk appetite and risk position throughout the firm. This allows the firm to set appropriate limits on its various risk-bearing activities.

The board is also responsible for oversight and risk transparency. It must ascertain whether any major transaction undertaken by the firm is consistent with the authorized risk and associated business strategies. Similarly, it must ensure that the disclosure to managers and relevant stakeholders is both adequate and compliant with internal corporate rules and external regulations. Given the board's accountability to stakeholders, the board is ultimately responsible when risk policy is ignored or violated.

To fulfill its role in risk governance, the board must assess whether the firm has put an effective risk management system in place that enables it to further its strategic objectives within the confines of its risk appetite. The board must also make sure that procedures for identifying, assessing, and handling the various types of risk (e.g., business, operational, reputational, market, liquidity, compliance, and credit) are in place. While a willful

<sup>17</sup> As a U.S. Senator, Corzine helped draft the Sarbanes-Oxley Act in 2002.

<sup>18</sup> M. Peregrine, "Another View: MF Global's Corporate Governance Lesson," *New York Times*, December 16, 2011, <https://dealbook.nytimes.com/2011/12/16/another-view-mf-global-s-lesson-in-corporate-governance>.

<sup>19</sup> CFTC Press Release 7508-17, January 5, 2017. <https://www.cftc.gov/PressRoom/PressReleases/pr7508-17>.

<sup>20</sup> IFC, Standards in Risk Governance for Financial Institutions, 2012.

assumption of excessive risk lies at the heart of many corporate failures, just as many can be attributed to an inability to identify risk or assess it properly in a timely manner.

The risk management process may seem complex and confounding and boards may find this task difficult to take on. However, the strategic principles underlying risk governance are simple. Ultimately, only four basic choices need to be made in the management of corporate risk:

1. The choice to undertake or not to undertake certain activities;
2. The choice to transfer or not transfer either all or part of a given risk to a third party (or third parties); such transfers can be accomplished via the purchase of insurance policies, hedging activities, and so on;
3. The choice to preemptively mitigate risk through early detection and prevention; and
4. The choice to assume or not assume risk, fully cognizant of both the upside and downside implications.

Risk management must be implemented across the entire enterprise<sup>21</sup> under a set of unified policies and methodologies. (This is called enterprise risk management and is discussed in Chapter 8.) The infrastructure of risk management, which includes both physical resources and clearly defined operational processes, must be up to the task of an enterprise-wide scope. The task of assessing the fitness of a risk management system is daunting, but doable nonetheless. One way to measure the seriousness of a risk management process is to examine the human capital employed and the risk managers' standing within the corporate hierarchy.

- Is the risk manager considered to be a member of the executive staff and can this position lead to other career opportunities?
- How independent is the risk manager? What authority does he or she hold? To whom does he or she report?
- Are risk managers paid well relative to other employees who are rewarded for performance (e.g., traders)?
- To what extent can one characterize the enterprise's ethical culture as being strong and resilient against the actions of bad actors? Has the firm set clear-cut ethical standards and are these standards actively enforced?

The board must also evaluate the firm's performance metrics and compensation strategy. It has the critical responsibility of making sure executives are compensated based on their

<sup>21</sup> The OECD's paper on *Corporate Governance and the Financial Crisis: Conclusions and Emerging Good Practices to Enhance Implementation of the Principles*, February 2010, p. 4, states that "... an important conclusion is that the board's responsibility for defining strategy and risk appetite needs to be extended to establishing and overseeing enterprise-wide risk management systems".

risk-adjusted performance and that the incentives inherent in such compensation do not clash with shareholder interests.

Within the framework of risk governance oversight, the board should ensure the information it obtains concerning the implementation of risk management is accurate and reliable. Information should be gathered from multiple sources, including the CEO, other senior executives, and both internal and external auditors. Board members must also arm themselves with additional knowledge, because they are required not only to ask tough questions but also understand the answers they are told.

The board's scope in risk governance is comprehensive. However, its responsibility to take a proactive approach does not suggest a day-to-day involvement. Rather, its role is to ensure that the processes and procedures around the delegation and implementation of risk management decisions are performing as planned. As discussed previously, the 2007–2009 financial crisis highlighted the need to strengthen the role of the board and its commitment to risk management.

Board members need to be trained on risk issues and on how to evaluate and define the firm's risk appetite. They need to be able to assess the firm's capacity for risk over a specified time horizon while considering the firm's mix of business activities, earnings goals, strategic objectives, and competitive position. This will allow the board to understand the firm's risk profile and monitor its performance relative to the risk appetite.

The board should also have a risk committee whose members have enough analytic sophistication and business experience to properly analyze key risks. The board risk and audit committees should be two separate entities, given that each requires different skills to meet its respective responsibilities.

### 3.3 RISK APPETITE STATEMENT

Publishing a risk appetite statement (RAS) is an important component of corporate governance. The Financial Stability Board (FSB)<sup>22</sup> describes an RAS as "a written articulation of the aggregate level and types of risk that a firm will accept or avoid in order to achieve its business objectives." The RAS includes both qualitative and quantitative statements.<sup>23</sup>

The objectives of an RAS should be clearly articulated. For example, as shown in Box 3.2, objectives include maintaining a balance between risk and return, retaining a prudent attitude

<sup>22</sup> Financial Stability Board. (2013, November 18). Principles for an Effective Risk Appetite Framework. Retrieved from [https://www.fsb.org/2013/11/r\\_131118/](https://www.fsb.org/2013/11/r_131118/)

<sup>23</sup> The FSB also makes the point that an RAS should address "difficult to quantify risks such as reputation and conduct risks as well as money laundering and unethical practices."

## BOX 3.2 RISK APPETITE STATEMENT OBJECTIVES\*

### Risk Appetite Statement

Our risk appetite statement defines the amount of risk we are willing to assume in pursuit of our strategic and financial objectives. Our guiding principle is to practice sound risk management, supported by strong capital and funding positions, as we pursue our client-focused strategy. In defining our risk appetite, we take into consideration our purpose, vision, values, strategy and objectives, along with our risk capacity (defined by regulatory constraints). It defines how we conduct business, which is to be consistent with the following objectives:

- Safeguarding our reputation and brand;
- Doing the right thing for our clients/stakeholders;
- Engaging in client-oriented businesses that we understand;

- Make our client's goals our own in a professional and radically simple manner;
- Maintaining a balance between risk and returns;
- Retaining a prudent attitude towards tail and event risk;
- Meeting regulatory expectations and/or identifying and having plans in place to address any issues in a timely manner;
- Achieving/maintaining an AA rating; and
- Meeting/exceeding stakeholders' expectations with respect to the ESG criteria including achieving net zero greenhouse gas emissions.

\* Reference CIBC 2022 Annual report, page 50.

Reprinted with permission of the Canadian Imperial Bank of Commerce.

## BOX 3.3 RISK POLICIES, LIMITS, AND MANAGEMENT OVERSIGHT\*

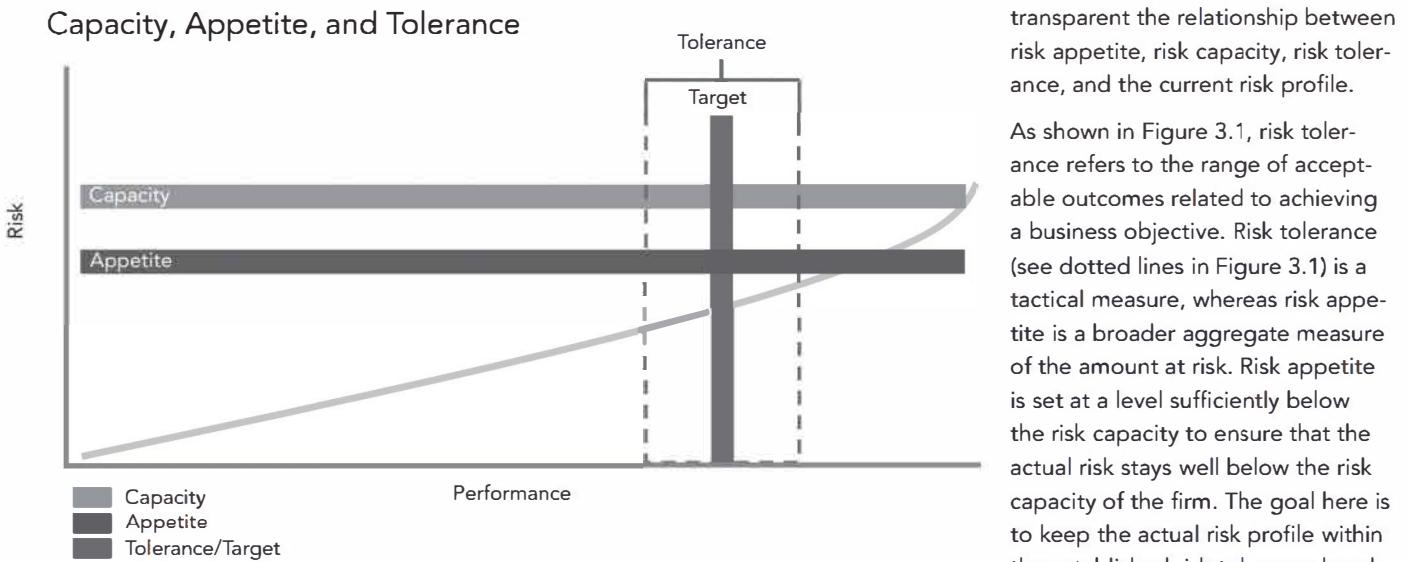
### Risk Management Framework

#### Risk Appetite Statement and Risk Appetite Framework

Risk	Overarching Framework/Policy	Risk Limits	Management Oversight
Credit	Credit Risk Management Policy Trading Credit Risk Management Policy	Credit Concentration Limits Delegated Credit Approval Authorities Trading Credit Risk Limits	Credit Committee Personal and Business Banking Credit Risk Committee Global Risk Committee Traded Risk Committee
Market	Market Risk Management Policy Structural Risk Management Policies	Market Risk Limits Delegated Risk Authorities	Global Risk Committee Global Asset Liability Committee Traded Risk Committee
Operational	Operational Risk Management Framework Control Framework Conduct and Culture Risk Framework	Key Risk Indicators	Operational Risk and Control Committee Global Risk Committee Technology Operational Risk Committee Model and Parameter Risk Committee Cyber Security Committee Traded Risk Committee Third Party Risk Council Executive Fraud Risk Council
Reputation	Global Reputation Risk Management Framework and Policy	Key Risk Indicators	Reputation and Legal Risks Committee
Liquidity	Liquidity Risk Management Policy Pledging Policy	Liquidity and Funding Limits Pledging Limits	Global Asset Liability Committee Global Risk Committee
Strategic	Strategic Planning Policy	Risk Appetite Statement	Executive Committee Global Risk Committee

Regulatory	Regulatory Compliance Management Policy Enterprise Anti-Money Laundering Framework and Enterprise Anti-Money Laundering and Anti-Terrorist Financing Policy	Key Risk Indicators Risk Appetite Statement Key AML Metrics	Global Risk Committee AML Executive Steering Committee
------------	--	---	---

\* Reference CIBC 2022 Annual report, page 52.  
Reprinted with permission of the Canadian Imperial Bank of Commerce.



**Figure 3.1** Risk profile, risk appetite, risk capacity and performance.

Source: COSO, Enterprise Risk Management, Integrating with Strategy and Performance, June 2017, Figure 7.5, page 62. Reprinted by permission.

toward tail and event risk, and achieving a desired credit rating.

The FSB states that:

- "[a]n effective risk appetite statement should:
  - Include key background information and the assumptions that informed the financial institution's strategic and business plans at the time they were approved
  - Be linked to the institution's short- and long-term strategic, capital, and financial plans, as well as compensation programs . . ."

A summary list of key risk policies and limits should be made transparent to all shareholders. For example, Box 3.3 shows a list of all the key risk types, the relevant policies, the types of risk limits, and the management responsible for oversight.

An RAS should contain risk appetite and risk tolerance measures that limit the amount of risk taken at the business unit level as well as the organizational level. The RAS should also make

transparent the relationship between risk appetite, risk capacity, risk tolerance, and the current risk profile.

As shown in Figure 3.1, risk tolerance refers to the range of acceptable outcomes related to achieving a business objective. Risk tolerance (see dotted lines in Figure 3.1) is a tactical measure, whereas risk appetite is a broader aggregate measure of the amount at risk. Risk appetite is set at a level sufficiently below the risk capacity to ensure that the actual risk stays well below the risk capacity of the firm. The goal here is to keep the actual risk profile within the established risk tolerance bands. Operating within the risk tolerance bands provides management with comfort that the firm can achieve the

desired risk-adjusted return objectives subject to limiting the amount at risk.

## 3.4 IMPLEMENTING BOARD-LEVEL RISK GOVERNANCE

The previous sections have outlined the rationale and some of the objectives of risk governance. This section examines the mechanisms used by financial institutions (as well as other risk-taking corporations) to implement risk governance best practices.

At most firms, the key risk management policies and procedures are approved by the board audit and risk management committees. These committees also review the implementation of these policies and examine their efficacy. They interpret the board-approved risk appetite and break it down into a set of practical restrictions and limitations. These new rules are then disseminated throughout the organization by the executive staff and department heads.

## The Board Audit Committee

An effective audit committee is essential to the directors' oversight of the firm. In addition to being accountable for the accuracy and completeness of a firm's financial and regulatory disclosures, the audit committee is responsible for ensuring the firm's compliance with best-practice standards in non-financial matters as well. Regulatory, legal, compliance, and risk management activities all fall under the purview of the audit committee.

An audit provides the board with independent verification of whether the firm is doing what it claims to be doing. This critical verification function sets the audit committee's work apart from the work of other risk committees.

At the same time, however, the audit committee's duties extend beyond the search for discrepancies and infringements. The committee must assess not only the veracity, but also the quality of the firm's financial reporting, compliance, internal controls, and risk management processes. For example, in its review of financial statements, the audit committee must not only confirm the accuracy of the financial statements, but that the firm sufficiently addresses the risk of possible material misstatements in its reporting as well. The financial crisis revealed the failure of many firms' audit committees to uncover the excess risk undertaken in proprietary trading, or to alert their boards to the risk of holding disproportionately large positions in structured credit products.

To successfully execute their duties, audit committee members must be knowledgeable, capable of independent judgment, financially literate, and have the utmost integrity. Members cannot be afraid to challenge management and ask hard questions when needed. In most banks, a director who is not a member of the executive staff chairs the audit committee, and most of its members are independent as well. Although the audit committee's relationship with management can be adversarial at times, the two groups need to foster an amicable and productive relationship in which all lines of communication are always kept open.

## The Evolving Role of a Risk Advisory Director

It is unreasonable to expect the entire board to possess the skills necessary to analyze the financial condition of complex risk-taking corporations (which financial institutions are by definition). This is particularly true if the appointed independent directors include individuals who originate from other industries beyond the financial services sector<sup>24</sup> and who have no connections to the enterprise. This practice can be problematic,

because (historically) it has been a simple matter for executives to befuddle non-executives who lack the skills and/or confidence to challenge them. Director training programs, as well as outside professional support, can be helpful in this regard.

One approach is for the board to include a risk specialist. This is typically an independent member of the board (not necessarily a voting member) who specializes in risk analysis and management. This person's job is usually to enhance the efficacy of the executive risk committee and the audit committee. This involves examining risk governance in terms of the risk policies approved by the board, as well as the methodologies and infrastructure used to execute and oversee them.

These risk advisory directors can also keep board members apprised as to the best practices in corporate governance and risk management. They can also give their professional opinion on risks associated with the firm's core business model and the areas of activity in which the firm operates or seeks to pursue.

## The Special Role of the Board Risk Management Committee

A board risk management committee is responsible for setting the firm's risk appetite and independently reviewing the governance of all material risks. The committee's review includes an analysis of policy guidelines, methodologies, and risk management infrastructure. By maintaining direct contact with external and internal auditors, a board risk management committee can allow for better communication between the board and management.

In addition, the board of directors typically delegates the responsibility for approving and reviewing the risk levels to the board risk management committee. Its role, as well as the terms of its oversight, are usually formally approved and documented by the board. The board risk management committee also monitors financial, operational, business, reputational, and strategic risks. It reports to the board on various issues (e.g., the extension of special credit should the firm exceed the risk limits set by the board).

## 3.5 RISK APPETITE AND BUSINESS STRATEGY: THE ROLE OF INCENTIVES

This section illustrates how structure meets process to ensure that a firm's regular activities are appropriate given its risk appetite and the limits defined by the various board and executive committees.

<sup>24</sup> This is often done by design.

The process can be summarized as follows.

- The board risk committee approves the firm's risk appetite on an annual basis. This risk appetite is based on a set of broad, yet clearly defined, risk metrics (e.g., the total interest rate risk assumed by the bank).
- The firm's senior risk committee (which is led directly by the CEO and typically includes the CRO, the CFO, the treasurer, chief compliance officer, and the executives in charge of the various business units) is empowered by the board to implement and oversee the risk appetite framework.
- Under the board's authority, the senior risk committee determines the limiting parameters for financial (e.g., credit and market) and nonfinancial risk (e.g., business risk and operational risk) undertaken by the firm. Sub-committees may be established to handle each type of risk independently. For example, the firm's credit risk committee would set limits on the magnitude and type of credit risk undertaken, as well as oversee credit risk reporting.
- After setting risk ceilings, the senior risk committee then reports back to the board risk committee with recommendations regarding the total risk deemed prudent (which are subject to the latter's consideration and approval).

## The Role of the CRO

The senior risk committee also bears responsibility for the establishment, documentation, and enforcement of any corporate policies concerning risk. It also sets risk limits for specific business activities, which are then delivered to the CRO. The CRO is usually a member of the risk committee and is responsible for the design of the firm's risk management program (in addition to other responsibilities). The CRO is also responsible for risk policies, analysis approaches, and methodologies, as well as the risk management infrastructure and governance inside the organization.

The bank's senior risk committee delegates the power to make day-to-day decisions to the CRO. This includes the ability to approve risks exceeding preset limits imposed on the various business activities, provided these exceptions remain within the bounds of the overall board-approved limits.

For example, each business unit may be given authorization to assume a certain maximum level of risk up to a certain ceiling. The firm's senior risk committee reviews and approves each business unit's mandate periodically, and the CRO is responsible for monitoring these limits. In larger financial institutions, the best practice is for such processes (e.g., the development and approval/renewing of such risk-taking allowances) is clearly defined. Usually, any such approval is valid for one year following approval by the

senior risk committee. However, the CRO may approve an extension of the mandate to accommodate the committee's schedule.

Although CROs are typically part of the management team, it is critical for them to be granted both the authority and independence to effectively discharge their duties. The global financial crisis, along with the problems exemplified by the MF Global bankruptcy, underscore the need to fortify CRO independence and authority. CROs should be proactively involved in setting risk strategy as well as in the implementation and managerial oversight of risk management. They should also report directly to the CEO, maintain a seat on the board risk committee, and have a voice in approving new financial instruments and lines of business. Most importantly in this regard, the CRO should have a clear mandate to bring any situation that potentially compromises the bank's risk appetite guidelines or its risk policy to the attention of management at all levels and to the board.

At many banks, CROs act as a liaison between the board and management. They keep the former apprised as to the enterprise's risk tolerance and the efficacy of its risk management program, alerting it to deficiencies in the system. At the same time, the CRO communicates the board's views to management and distributes this information throughout the entire organization.

All organizations must strike a balance between ensuring they can achieve their objectives and maintaining risk standards. The CRO is responsible for independently monitoring these standards on an ongoing basis. He or she may order specific units to cut back or entirely close positions in the wake of concerns regarding exposures to market, credit, operational, or business risks.

Corporations may also appoint business risk committees for each major line of business. A business risk committee typically comprises both business and risk personnel. Its goal is to align business unit decisions with the organization's desired risk/reward tradeoff and ensure proper risk management at the business line level. The business risk committee can be responsible for articulating how a given risk will be handled in accordance with how risk management for a specific business relates to the overall risk function. Additionally, the authority to approve policies related to more business-specific risk and to conduct detailed reviews of business-level risk limits can also be entrusted to the business risk committee.

## Limits Policies

Optimal risk governance requires the ability to link risk appetite and limits to specific business practices. Accordingly, appropriate limits need to be developed for each business as well as for the specific risks associated with the business (as well as for the entire portfolio of the enterprise).

Market risk limits are designed to constrain exposure to risk derived from price, interest rate, and currency changes. Credit risk limits are intended to cap a firm's exposure to defaults or an erosion in the quality of credit exposures (e.g., those originating from the lending portfolio or through derivative transactions). Banks also tend to place exposure to other types of risk (e.g., asset/liability management, liquidity, or even catastrophe risk) on their policy agenda as well. The nature of any given limit will vary and is driven by the nature of the risk in question, the competitive positioning of the firm, and the span of its activities. Best practice dictates that the processes involved in setting risk limits, reviewing exposures, approving exceptions to risk limit policy, and analyzing methodologies be documented.

Best practice in risk management often employs analytical methodologies to measure risk. When analyzing credit risk, a bank's potential exposure can be analyzed by risk grade. Risk-sensitive methodologies (e.g., VaR) are useful in the assessment of risk for most typical portfolios under an assumption of relatively normal market conditions. However, they are less applicable in stressed circumstances or for more specialized portfolios. Accordingly, best practices call for scenario analysis and stress testing to be included in the risk analysis toolbox and incorporated within the limit framework in order to validate survivability under worst-case conditions.

Most banking entities set two types of limits.

1. Tier 1 limits are specific and often include an overall limit by asset class, an overall stress-test limit, and a maximum drawdown limit.
2. Tier 2 limits are more generalized and relate to areas of business activity as well as aggregated exposures categorized by credit rating, industry, maturity, region, and so on.

Standards for the metrics employed by risk limits are proposed by the CRO and approved by the internal risk committee. Practically speaking, these limits should be designed such that the probability of exceeding them during the normal course of business is low. Limit determination needs to take the business unit's historical behavior into account and to aim for a figure that gives the business unit a margin for error. For example, a bank may decide to design their Tier 1 limits on market risk such that, during the normal course of business and under normal market conditions, the unit's exposures range from 40% to 60% of the set limit and perhaps the peak limit utilization (again, under normal market conditions) should hit 75% to 85% of this ceiling.<sup>25</sup>

A consistently designed limit structure helps banks to consolidate their risk management across diverse businesses. When

limits are calculated in a unified manner and expressed in terms of economic capital, or a similar unified term, it is then possible to apply Tier 2 limits across business lines.

## Monitoring Risk

The setting of meaningful risk limits marks the beginning, rather than end, of the risk management process. Once set, these limits must be closely monitored to verify compliance. Of all the types of risks discussed in the previous section, market risk is the most time-sensitive and thus requires continual monitoring.

To monitor market risk limits effectively, the daily valuation of asset positions is imperative. Profit and loss statements should be prepared outside of the bank's trading department and submitted to (non-trading) executive management. In addition, all assumptions used in the valuation models should be independently verified. Similarly, the trading team's adherence to risk policy and market risk limits, as well as the bank's escalation plan for dealing with exceptions, should be documented on a timely basis. Procedures covering the treatment of acceptable limit exceptions and unacceptable violations should be articulated in writing and made clear to managers and traders alike.

The assessment of portfolio valuation methods constitutes an integral part of risk limit monitoring. The variance between a portfolio's actual volatility and that predicted under the bank's risk measurement methodology should be evaluated on a regular basis. Stress tests should be done to ascertain the impact of material changes to market and credit risk on the bank's earnings.

Where time is of the essence, the most appropriate source of information may well be the front office. For example, risk measures relating to the monitoring of intra-day trading exposures may need to be extracted directly from the day's accumulated client orders. Data used in the monitoring of market limits, in contrast, should be obtained from consolidated market data feeds not connected to front office systems. To ensure integrity, this data must be reconciled with entries in the bank's official books and their format must facilitate risk measurement, such as with VaR methodologies for calculating market or credit risk.

In the implementation of both Tier 1 and Tier 2 limits, business units must adhere to strict protocols regarding prior disclosure of anticipated limit violations to the risk management function. The CRO must be notified well in advance of potential limit deviations. If risk management is alerted to a planned excess, the probability that this excess will be approved is higher.

For example, business unit heads may be compelled to issue an alert when an exposure reaches a certain threshold (e.g., 85% of the limit). The CRO, jointly with the unit head, could then petition the bank's business risk committee for a temporary limit increase.

<sup>25</sup> This is just an illustrative example; some organizations may prefer limits set at higher or lower levels.

Upon approval, the business risk committee would then submit the request for final approval by the senior risk committee.

Should the limit be breached, the risk management function should immediately record all excesses on a daily *limit exception report* that distinguishes between Tier 1 and Tier 2 limit exceptions. This report specifies the circumstances and rationale for the exceedances and outlines how the bank plans to handle them.

Tier 1 limit exceedances must be cleared or corrected immediately. Tier 2 exceedances are less urgent and can be cleared within a few days or a week. The CRO should then list all Tier 1 and Tier 2 limit exceedances on an enterprise exception report, which captures all exceptional risk activity at the enterprise level. This report is then submitted for discussion at the daily risk meeting. No manager, including the CEO, should be authorized to exclude risk limit exceedances from the daily exception report.

There is an opportunity cost inherent in effective risk limit management. Because the bank prevents the preemptive assumption of additional risk, it may have to forfeit opportunities for additional profits. As a given limit is neared, a bank should conduct a cost-benefit-risk analysis to decide if an exception should be made.

## 3.6 INCENTIVES AND RISK-TAKING

One lesson from the global financial crisis is that the prevailing executive compensation schemes at many financial institutions encouraged short-term risk-taking, causing management to often underestimate and at times entirely ignore long-term risks. The trend to reward bankers and traders with bonuses tied to short-term profits, or to the volume of business activity, had grown in the two decades preceding the crisis. This incentivized these individuals to front load income and push off risk. Compensation schemes were structured like call options in that they had unlimited upside but were capped on the downside. Executives collected bonuses when the bank posted profits, but there was no real penalty attached to poor performance or losses. Aided by excessive leverage, bank personnel were literally able to "bet the bank" on astonishingly reckless investment strategies.

In many jurisdictions, regulations now require public firms to establish a dedicated board compensation committee to set executive compensation. Such regulation is driven by concerns over the ability of CEOs to persuade board members to compensate themselves and other executives at the expense of shareholders, who have virtually no say in such decisions.

It is now widely recognized that compensation is part of a sound risk culture. Specifically, it should be aligned with the long-term

interests of shareholders and other stakeholders, as well as with risk-adjusted return on capital. It should incentivize employees to take calculated, rather than reckless, risks. Banks must address any potential distortions arising from the way they structure compensation. The incorporation of risk management considerations into the setting of performance milestones is on the rise and is already considered a leading practice. Compensation planning is increasingly considered a key facet of enterprise-wide risk management.

That said, one must recognize that firms will always be tempted to offer attractive compensation packages to so-called "rain-makers" who exhibit an unusual talent for generating revenues. Absent international cooperation, the market for human capital may be subject to regulatory arbitrage as banking enterprises cherry pick the jurisdictions in which they operate.

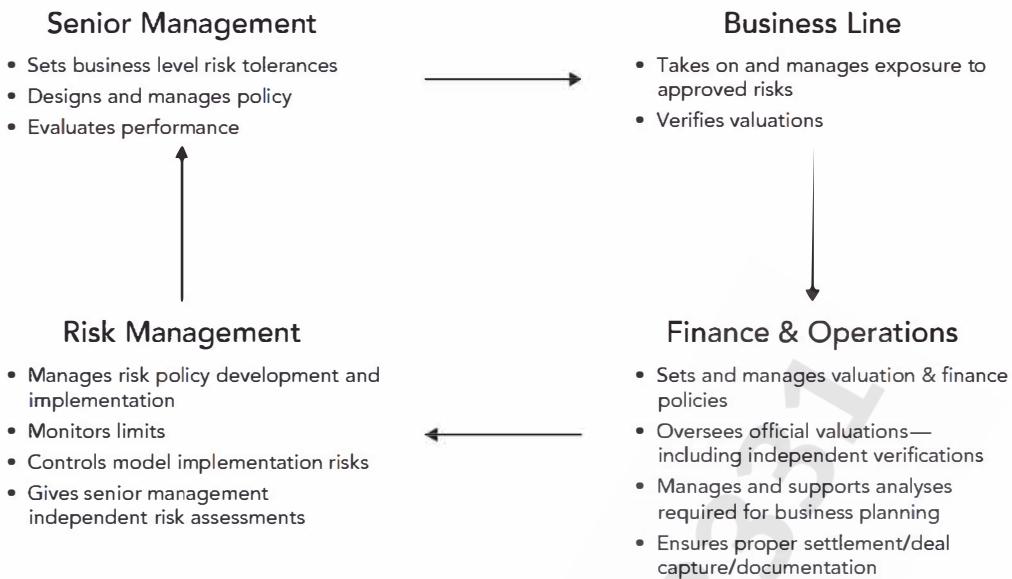
In September 2009, the G-20 countries called on their respective central bank governors and finance ministers to establish an international framework to promote financial stability, including a reform of compensation practices. In an endorsement of the FSB's implementation standards, the G-20 recommendations included:

- The elimination of multi-annual guaranteed bonuses;
- The incorporation of executive downside exposure through the deferral of certain compensation, the adoption of share-based remuneration to incentivize long-term value creation, and the introduction of clawback provisions that require reimbursement of bonuses should longer-term losses be incurred after bonuses are paid;
- Limitations on the amount of variable compensation granted to employees relative to total net revenues;
- Disclosure requirements to enhance transparency; and
- Affirming the independence of the committees responsible for executive compensation oversight to ensure their alignment with performance and risk.<sup>26</sup>

In 2014, the FSB reported that implementation of these standards was essentially complete in almost all FSB jurisdictions. In some jurisdictions (e.g., the European Union), regulators went beyond the recommended standards and adopted bonus caps equal to 100% of an executive's salary or, if approved by two-thirds of shareholders, 200% of their salary.

Share-based compensation aims to align the respective interests of executives and shareholders. Theoretically, occupying the same boat as other shareholders should curb excessive executive risk-taking. However, this is not necessarily the case. Prior to the collapse of Lehman Brothers, for

<sup>26</sup> G20 Leaders Statement: The Pittsburgh Summit, September 24–25, 2009, Pittsburgh <http://www.g20.utoronto.ca/2009/2009communique0925.html> (accessed 19/4/2018).



**Figure 3.2** Interdependence in risk management.

example, employees held approximately one third of the firm's shares. One must also bear in mind that share ownership can also encourage risk-taking because while potential shareholder gains are infinite, losses are limited to their investment.

One remedy for this dilemma could be to turn employees into the bank's creditors by introducing restricted notes or bonds tied to compensation schemes. Swiss bank UBS adopted such a solution in 2013. It paid its most highly compensated employees in part with *bonus bonds* that are forfeited if the bank's regulatory capital ratio falls below 7.5% or the company needs a bailout.<sup>27</sup>

### 3.7 THE INTERDEPENDENCE OF ORGANIZATIONAL UNITS IN RISK GOVERNANCE

The implementation of risk management at virtually all levels of the enterprise is primarily the responsibility of the bank's staff, rather than the board committees. Executives and line business managers need to work together to manage, monitor, and report the various types of risk being undertaken. Figure 3.2 outlines how risk management flows and is shared by various management functions. Business managers also play an important part in the verification of timely, accurate, and complete

deal capture and their affirmation of official profit and loss (P&L) statements.

A bank's operations function not only shares in the implementation of risk management but plays a critical role in risk oversight as well. In investment banks, for example, its role is to independently execute, record, and settle trades; reconcile front and back-office positions; and chronicle all transactions. The operations staff also prepares earnings reports as well as independent valuations of the bank's positions (e.g., mark-to-market).

The finance group, on the other hand, is responsible for developing valuation and finance policies, ensuring the accuracy and completeness of reported earnings, and reviewing independent valuation methodologies and processes. Finance also manages business planning and is called upon to support the financial needs of the various business lines.

### 3.8 ASSESSING THE BANK'S AUDIT FUNCTION

The previous sections outlined a risk management process that conforms to risk governance. Adherence to this process can prevent the assumption of unbridled excessive risk. However, the risk governance function alone cannot ascertain compliance to the policies established by the board and external regulations.

This is where the audit function comes in. It is incumbent upon the internal audit function to ensure the set-up, implementation, and efficacy of risk management/governance.

<sup>27</sup> In December 2012, the European Banking Authority expressed the view that senior bankers should be required to receive part of their annual bonus in bonds that would suffer losses during a financial crisis.

To this point, regulators typically require the internal audit function to review all processes, policies, and procedures related to risk management. A comprehensive review includes, among other things, assessing the organization of the risk control unit and documentation along with analyzing the integrity of risk governance and the efficacy of the risk management process. This analysis includes the integration of risk measures into daily business management.

Internal auditors are responsible for:

- Reviewing monitoring procedures,
- Tracking the progress of risk management system upgrades, assessing the adequacy of application controls in generating and securing data, and
- Affirming the efficacy of vetting processes.

Best practices also call for the internal audit function to review documentation relating to compliance and to compare this with the standards stipulated in the regulatory guidelines.<sup>28</sup> It should also offer its opinion on the reliability of any VaR reporting framework.

Taking market risk as an example, bank auditors are called upon to review the vetting process pertaining to the derivative valuation models used by both the front office and the back office. They must sign off on any significant changes to the risk quantification process as well as validate the range of risks analyzed by the various risk measurement models. Internal auditors are also required to inspect the reliability of information systems as well as the validity and completeness of the data on which market risk metrics are computed.

Regulatory requirements notwithstanding, a key task undertaken by the audit function should be the evaluation of the design and conceptual soundness of risk measurement. Internal auditors should validate market risk models by back testing investment strategies. Additionally, they should evaluate the soundness of risk management information systems (also called risk MIS) used in the quantification of risk throughout the enterprise. These can include coding processes, internal model applications, and controls over position data capture. Similarly, auditors should analyze assumptions pertaining to volatility, correlations, and other parameter estimates. An auditor's responsibilities often include

ensuring the veracity of the market databases used to generate VaR parameters.

A risk management function can be rated. This rating may be used internally or by third parties (e.g., rating agencies) that undertake comparative analyses of multiple enterprises. There is no one formula for excellence in risk management. Despite this, the rating of risk management practices would be instrumental in facilitating comparisons across an organization so that both the internal and external parties can benefit from such objective critiques.

The Institute of Internal Auditors (IIA) has devised a set of standards relating to internal controls, governance, and risk management. The organization's International Professional Practices Framework (IPPF) articulates standards, some of which are mandatory and others that are strongly recommended. The mandatory standards and ethical code define the requirements for professional practice.<sup>29</sup> The recommended guidance outlines how these standards should be applied and implemented in practice.<sup>30</sup>

Within the industry, there has been an active debate as to whether the audit function should have effective oversight of the firm's operational risk management.<sup>31</sup> Note that the audit has a natural interest in the quality of internal controls. While subject to auditor review, however, the implementation of risk management must remain separate from the auditing function. As a basic principle, auditor independence from the underlying activity is essential to ensure confidence in any assurances or opinions rendered by the auditors to the board, and this applies equally to the risk management function and its associated processes. Unless this independence is maintained, conflicts of interest could compromise the quality of both risk management and audit activity and seriously jeopardize risk governance.

---

<sup>28</sup> See the Professional Guidance section of the IIA's website: <https://global.theiia.org/standards-guidance/Public%20Documents/IPPF-Standards-2017.pdf>.

<sup>29</sup> The Institute of Internal Auditors. (n.d.). Recommended Guidance. Retrieved from <https://global.theiia.org/standards-guidance/recommended-guidance/Pages/Strongly-Recommended-Guidance.aspx>

<sup>31</sup> See M. Crouhy, D. Galai, and R. Mark, "Key Steps in Building Consistent Operational Risk Measurement and Management." In *Operational Risk and Financial Institutions*, ed. R. Jameson, London: Risk Books, 1998.

---

<sup>28</sup> Such standards include qualitative and quantitative criteria.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## QUESTIONS

### True/False Questions

- 3.1** After establishing a risk limit, a bank should plan to maintain a risk exposure level just below the limit during the normal course of business.
- A. True  
B. False
- 3.2** The standards set in the "Basel Accord" are legally binding in all banks in most countries.
- A. True  
B. False
- 3.3** Basel III designed a macroprudential overlay leverage ratio of 5% intended to reduce systemic risk and lessen pro-cyclicality.
- A. True  
B. False
- 3.4** The board of directors should be responsible for overseeing and approving a firm's risk governance.
- A. True  
B. False
- 3.5** Conflicts of interest between senior management and other internal management are referred to as "agency problems."
- A. True  
B. False

### Short Concept Questions

- 3.6** The Dodd-Frank Act overhauled the regulation of financial institutions in the United States, aiming at improving both consumer protection and systemic stability. List and discuss three issues that the Dodd-Frank Act tried to address?
- 3.7** Describe what is involved in risk governance.
- 3.8** What went wrong in MF Global after 2010? How was it related to corporate governance issues?
- 3.9** Describe key points involved in constructing a risk appetite.
- 3.10** What are the four basic choices a bank needs to make regarding a potential risk exposure?
- 3.11** How would one assess the stature of the CRO in the organization?
- 3.12** Describe what a "Risk Appetite Statement" (RAS) is and the objectives of a RAS.
- 3.13** What is the difference between Tier 1 and Tier 2 limits?
- 3.14** What were three recommendations from the Financial Stability Board regarding compensation after the 2007–2009 financial crisis?
- 3.15** What are the roles of the senior management risk committee?
- 3.16** What are the key roles and responsibilities of an internal audit function?
- 3.17** Describe three key roles and responsibilities of the board of directors.
- 3.18** Describe the roles and responsibilities of the board audit committee.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## Multiple Choice Questions

**3.19** According to the Sarbanes-Oxley (SOX) Act, who is required to certify the accuracy of the financial reports?

- A. The chief risk officer (CRO) only
- B. The chief executive officer (CEO) only
- C. The chief financial officer (CFO) only
- D. CEO, CFO, and CRO only
- E. CEO and CFO only

**3.20** Which of the following is not a concern of corporate governance in banks?

- A. Ensuring competitive positioning of the bank in each market
- B. Determining the risk appetite
- C. Board composition
- D. Compensation policy

**3.21** Which of the following was not an aim of the Dodd-Frank Act?

- A. Verifying the accuracy of financial reports
- B. Living Will and resolution plan
- C. Stress testing and scenario analysis
- D. Protecting consumers

**3.22** Risk governance does not include

- A. setting limits on risk exposures.
- B. setting the infrastructure for risk management information flows.
- C. allowing for transparency of risk procedures.
- D. setting methodologies to assess credit risk.

**3.23** The major roles of the audit committee do not include

- A. reviewing the risk management process.
- B. preparing the annual financial report.
- C. analyzing the integrity of risk governance.
- D. affirming the reliability of vetting processes.

**3.24** The roles of the senior management risk committee include

- A. calculations of the daily VaR.
- B. reviewing the daily VaR.
- C. planning the scenario analysis.
- D. setting risk limits for specific business activities.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## ANSWERS

**3.1** False, because the bank should operate well below its risk limits during the normal course of business

**3.2** False

**3.3** False, because the leverage ratio is 3%.

**3.4** True

**3.5** False, because “agency risk” puts the interests of management squarely against those of a company’s longer-term stakeholders.

**3.6** Include any of the following seven elements.

- **Strengthening the Fed:** The Act extended the regulatory reach of the Federal Reserve (i.e., the Fed) in the areas concerned with systemic risk. All the systemically important financial institutions (SIFIs), which are defined as bank holding firms with more than USD 50 billion of assets, are now regulated by the Federal Reserve and the Fed’s mandate now includes macro-prudential supervision.
- **Ending too-big-to-fail:** Dodd-Frank proposed an end to “too-big-to-fail” by creating an orderly liquidation authority (OLA).
- **Resolution plan:** SIFIs are required to submit a so-called “living will” to the Federal Reserve and the Federal Deposit Insurance Corporation (FDIC) that lays out a corporate governance structure for resolution planning.
- **Derivatives markets:** The Act launched a transparency-focused overhaul of derivatives markets regulation with the aim of helping market participants with counterparty risk.
- **The Volcker Rule:** This is a prohibition on proprietary trading, as well as the partial or full ownership/partnership of hedge funds and private equity funds by banking entities.
- **Protecting consumers:** The Act created a Consumer Financial Protection Bureau (CFPB) to regulate consumer financial services and products.
- **Stress testing:** The Act instituted a radically new approach to scenario analysis and stress testing, with the following characteristics.
  - A top-down approach with macroeconomic scenarios unfolding over several quarters;

- A focus on the effects of macroeconomic downturns on a series of risk types, including credit risk, liquidity risk, market risk, and operational risk;
- An approach that is computationally demanding, because risk drivers are not stationary, as well as realistic, allowing for active management of the portfolios;
- A stress testing framework that is fully incorporated into a bank’s business, capital, and liquidity planning processes; and
- An approach that not only looks at each bank in isolation, but across all institutions. This allows for the collection of systemic information showing how a major common scenario would affect the largest banks collectively.

**3.7** Risk governance involves

- Setting up an organizational infrastructure of human, IT, and other resources as well as articulating formal procedures for defining, implementing, and overseeing risk management; and
- Transparency and the channels of communication established within the organization as well as with external stakeholders and regulators.

**3.8** Key points include the following.

- Jon Corzine was appointed chairman of the board and CEO of MF Global In 2010.
- MF Global was experiencing liquidity and compliance problems.
- Despite repeated warnings by the company’s chief risk officer, MF Global made huge proprietary investments in European sovereign debt. These investments soured in 2011, exacerbating the company’s liquidity problems.
- Liquidity problems led to the loss of shareholder and client confidence, and ultimately to the firm’s collapse.
- The company allegedly misappropriated client funds to meet the cash crunch.

**3.9** Key points include the following.

- Risk appetite is intimately related to business strategy and capital planning.
- Certain activities may be categorically inappropriate for an enterprise given the type of risk involved.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

- Business planning must take risk management into consideration from the outset.
- The matching of strategic objectives to the risk appetite must be incorporated into the planning process.
- Clear communication of the firm's risk position and risk appetite is essential so that appropriate limits can be set on various risk-bearing activities.

**3.10** The choice to:

- Not undertake certain activities,
- Transfer either all or part of a certain risk to third parties,
- Preemptively mitigate risk through early detection and prevention, and
- Assume the risk while being fully cognizant of both the upside and downside implications.

**3.11** Questions to ask include the following.

- Is the risk manager a member of the executive staff and can this position lead to other career opportunities?
- How independent is the risk manager?
- What authority does the risk manager hold?
- To whom does the risk manager report?
- Are risk managers comparatively well paid relative to other employees who are rewarded for performance?
- Is the enterprise's ethical culture strong and resilient to the actions of bad actors?
- Has the bank set clear-cut ethical standards and are these standards actively enforced?

**3.12** A risk appetite statement:

- Is an important component of corporate governance,
- Articulates the level and types of risk a firm is willing to accept to reach its business goals,
- Includes both qualitative and quantitative statements, and
- Helps to reinforce a strong risk culture.

Objectives include

- Maintaining a balance between risk and return;
- Retaining a prudent attitude toward tail risk and event risk;
- Achieving a desired credit rating;
- Linking short-term capital and long-term capital, financial and strategic plans, as well as compensation structure;

- Setting risk appetite and risk tolerance measures which limit the amounts at risk that are expressed at the business unit level and on an enterprise level; and
- Making transparent the relationship between risk appetite, risk capacity, risk tolerance and a firm's current risk profile.

**3.13** Tier 1 limits:

- Are specific and often include overall limits by asset class, an overall stress-test limit, and a maximum drawdown limit; and
- Excesses must be cleared or corrected immediately.

Tier 2 limits:

- Are more generalized;
- Relate to areas of business activity and aggregated exposures to credit ratings, industries, maturities, regions, and so on; and
- Excesses are less urgent and can be cleared within a few days or a week.

**3.14** Recommendations include:

- The elimination of multi-annual guaranteed bonuses;
- The incorporation of executive downside exposure through the deferral of certain compensation, the adoption of share-based remuneration to incentivize long-term value creation, and the introduction of clawback provisions requiring reimbursement of bonuses should longer-term losses be incurred after bonuses are paid;
- The placement of limitations on the amount of variable compensation granted to employees relative to total net revenues; and
- The imposition of disclosure requirements to enhance transparency.

**3.15** The senior management risk committee:

- Reports back to the board risk committee with recommendations regarding the total at risk deemed prudent for the latter's consideration and approval;
- Establishes, documents, and enforces all corporate policies in which risk plays a part;
- Sets risk limits for specific business activities, which are then delivered to the CRO; and
- Delegates the power to make day-to-day decisions to the CRO. This delegation includes the power to

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

approve risks exceeding preset limits imposed on the various business activities, provided these exceptions remain within the bounds of the overall board-approved limits.

**3.16** Key roles and responsibilities include:

- Independently assessing risk governance as well as the implementation and efficacy of risk management;
- Reviewing the risk management process, a comprehensive review includes, among other things, assessing adequacy of the organization of the risk control unit and documentation;
- Analyzing the integrity of risk governance and the efficacy of the risk management process, including the integration of risk measures into daily business management;
- Examining the monitoring procedures, for tracking the progress of risk management system upgrades;
- Assessing the adequacy and effectiveness of application controls in generating and securing data;
- Affirming the reliability of vetting processes;
- Comparing compliance documentation with qualitative and quantitative criteria stipulated by regulations;
- Offering its opinion on the reliability of any risk exporting framework; and
- Evaluating the risk measurement methodologies both in terms of theory as well as implementation, including stress-testing methodologies.

**3.17** Such roles and responsibilities include:

- Assessing the fundamental risks and rewards engendered in the bank's business strategy, based on a clear understanding of the latter's direction and goals;
- Harmonizing risk appetite with the bank's strategic plan;
- Being accountable for risk transparency; and
- Making sure that:
  - Any major transaction undertaken is in-line with authorized risk taking as well as with the relevant business strategies.
  - An effective risk management system is in place that enables corporation to further its strategic objectives within the confines of its risk appetite.
  - Procedures for identifying, assessing, and handling the various kinds of risk are effective.
  - Executives are compensated based on their risk-adjusted performance and that the incentives

inherent in such compensation do not clash with shareholder interests.

- Disclosure to managers and relevant stakeholders is both adequate and compliant with internal corporate rules and external regulations.
- The information it obtains concerning the implementation of risk management is accurate and reliable.

**3.18** The board audit committee is responsible for:

- Assessing the veracity and the quality of the firm's financial reporting, compliance, internal control and risk management processes; and
- Compliance with best-practice standards in non-financial matters.

Regulatory, legal, compliance, and risk management activities also fall under the purview of the audit committee.

**3.19** E. CEO and CFO only

SOX specifically requires the CEO and CFO to affirm the accuracy of all financial disclosures.

**3.20** A. Ensuring competitive positioning of the bank in each market

Corporate governance is concerned with proper controls around the running of a business entity—not the specifics of strategy.

**3.21** A. Verifying the accuracy of financial reports

Accuracy of financial reports was an aim of Sarbanes-Oxley, not Dodd-Frank.

**3.22** D. Setting methodologies to assess credit risk

The specifics of risk methodologies are not a part of risk governance. However, risk governance does extend to ensuring the activities around the development of the methodologies are appropriately controlled and disclosed.

**3.23** B. Preparing the annual financial report

The audit committee serves as a check on processes and procedures. In this case, the audit committee would ensure that the process around the report was properly controlled and delivered accurate results.

**3.24** D. Sets risk limits for specific business activities

The senior management risk committee empowers the CRO to have oversight into the specifics of how risk is reported and analyzed as well as the overall day-to-day management of risk.



# Credit Risk Transfer 4 Mechanisms

## ■ Learning Objectives

After completing this reading, you should be able to:

- Compare different types of credit derivatives, explain their applications, and describe their advantages.
- Explain different traditional approaches or mechanisms that firms can use to help mitigate credit risk.
- Evaluate the role of credit derivatives in the 2007–2009 financial crisis and explain changes in the credit derivative market that occurred as a result of the crisis.
- Explain the process of securitization, describe a special purpose vehicle (SPV), and assess the risk of different business models that banks can use for securitized products.

## 4.1 OVERVIEW OF CREDIT RISK TRANSFER MECHANISMS

The core risk exposure for banks is credit risk. Traditionally, banks have taken short-term liquid deposits and provided long-term, illiquid loans. Before the new millennium, banks had only a limited capacity for managing credit risk exposure. That all changed by the end of the twentieth century.

In 2002, then-Federal Reserve Chairman Alan Greenspan spoke of a "new paradigm of active credit management." He argued that the United States banking system had withstood the 2001–2002 economic slowdown in part because it had transferred and dispersed credit exposures using novel credit derivatives and securitizations. These included credit default swaps

(CDSs), collateralized debt obligations (CDOs), and collateralized loan obligations (CLOs).<sup>1</sup> The investment vehicles are briefly described in Table 4.1. The concept of securitization is described in Section 4.3.

This praise may seem misguided, given the role of credit transfer instruments in the build-up of systemic risk that preceded the 2007–2009 global financial crisis. However, the blame initially assigned to credit derivatives should in fact be laid at the feet of those who used and abused them.

The CDS and CLO markets remained robust, in certain respects, during and following the crisis. As a result, they fulfilled their purpose of helping to manage and transfer credit risk. Although there were major systemic deficiencies (e.g., conflicts of interest and transparency issues) that needed to be addressed, the

**Table 4.1** Definition of key terms and investment vehicles

Vehicle	Brief definition
Asset-backed security (ABS)	A structured product backed by loans and receivables created using the securitization process. Examples include: credit card ABS, student loan ABS, automobile and ABS.
Asset-backed commercial paper (ABCP)	Commercial paper is used by a special purpose vehicle (SPV) to finance a pool of longer-term receivables.
Collateralized debt obligation (CDO)	A structured product backed by a pool of debt instruments (e.g., bonds created using the securitization process).
CDO Squared	An investment vehicle issued by an SPV using the securitization process that is backed by tranches of a collateralized debt obligation.
Commercial mortgage-backed security	A structured product backed by a pool of commercial mortgage loans created using the securitization process.
Credit default swap (CDS)	The most popular type of credit derivative. In a CDS, the protection buyer pays a fee to the protection seller in return for the right to receive a payment conditional on a credit event by the reference obligation or the reference entity. Should a credit event occur, the protection seller must make a payment. A single-name CDS is one in which there is one reference entity. When there are multiple reference entities, they are referred to as basket CDS.
Credit derivative	A vehicle to transfer credit risk from one party to another. Examples include credit default swaps, credit debt obligations, and credit-linked notes.
Credit loan obligation (CLO)	A structured product backed by a pool of commercial bank loans created using the securitization process.
Mortgage-backed security (MBS)	A structured product backed by a pool of residential mortgage loans created using the securitization. There are government backed MBS (i.e., MBS backed by Fannie Mae and Freddie Mac) and MBS issued by private entities (including subprime MBS)
Structured investment vehicle (SIV)	A pool of investment assets that seeks to generate a return from the credit spread between short-term rates and long-term structured financial products such as asset-backed securities and mortgage-backed securities,

Note: Some of these definitions are obtained from Fabozzi, Frank J., *Capital Markets*, Fifth Edition, Table 4.1, © 2015 Massachusetts Institute of Technology, by permission of The MIT Press.

<sup>1</sup> A. Greenspan, "The Continued Strength of the U.S. Banking System," speech, October 7, 2002.

mechanisms themselves were not the real culprit in precipitating the crisis.

Many commentators have come to the view that the role of these mechanisms in causing the crisis may have had more to do with failings of the pre-crisis securitization process than with the underlying principle of credit risk transfer. Note that the performance of credit derivative markets was, and remains, highly varied. Some parts of the securitization industry remained viable through much of the crisis and beyond. This is perhaps because their risks remained relatively transparent to investors.

While some credit transfer markets and instruments met their demise following the financial crisis, some are now reappearing (though not as they were in the past). Some of these instruments may again become popular as the economy improves and if interest rates rise high enough to support costly securitization processes. Still others were relatively unaffected by the crisis.

Some of the more robust instruments that survived the crisis include CDS and asset-backed securities (ABS), which can be backed by assets such as auto loans, credit card receivables, equipment leases, and student loans. In addition, asset-backed commercial paper (ABCP) and private-issue mortgage backed securities (MBS) are expected to survive and draw renewed interest. While the CLO market was dormant for a few years following the crisis, new CLO issuance has grown significantly since 2011, surpassing pre-crisis volumes.

Collateralized debt obligations squared (CDOs-squared), as well as other forms of overly complex securitized instruments (e.g., single-tranche CDOs and complex ABCP) are unlikely to be revived. Their complexity was not meant to make these instruments better at hedging risk. Rather, it was meant to make them easier to market.

Meanwhile, new credit risk transfer strategies are emerging. One example can be seen in the growing number of insurance companies buying bank loans with the aim of building asset portfolios that match their long-term liabilities. The high capital costs associated with post-crisis reforms suggest the “buy-and-hold” banking model will remain a relatively inefficient way for banks to manage risks generated by lending and other banking activities. Regulators, as well as industry practitioners, are interested in securitization market reforms aimed at helping banks obtain funding, optimizing risk management, and encouraging liquidity and economic growth. In the longer term, the 2007–2009 crisis may end up being viewed more as a constructive test of the credit transfer market than its undoing.

## 4.2 HOW CREDIT RISK TRANSFER CAN BE USEFUL

Banks have long had several ways to reduce their exposure to credit risk—both on an individual name and an aggregate basis. Such credit protection techniques include the following.

- **Purchasing insurance from a third-party guarantor:** When done on an individual obligor basis, this is termed a *financial guarantee* and is provided by a special type of insurance company called a *monoline insurer*. Financial guarantees by monoline insurers had been common in the U.S. municipal bond market and in the ABS market. However, the downgrading<sup>2</sup> and failure of monoline insurers during the financial crisis resulted in fewer issuances of municipal bonds and ABS with financial guarantees.
- **Netting of exposures to counterparties:** Netting is done by examining the difference between the asset and liability values for each counterparty and having in place documentation specifying that these exposures can be netted against each other. Otherwise, if a counterparty goes bankrupt, the value of the obligation that counterparty has to the bank vanishes while the bank itself remains liable for any funds due to the counterparty.
- **Marking-to-market/margining:** This entails having an agreement in place among counterparties to periodically revalue a position and transfer any net value change between the counterparties so that the net exposure is minimized. This requires relatively sophisticated systems and has historically been seen in the market for exchange-traded derivatives.
- **Requiring collateral be posted:** Collateral can offset credit losses in the event of default. Note that there are instances when the circumstances precipitating the default could negatively impact the value of the collateral. For example, with an oil company offering barrels of crude as collateral, the probability of the company defaulting increases as the price of oil falls (this is known as *wrong way risk*).
- **Termination/Put option:** At inception, the counterparties agree to a set of trigger events that, if realized, would require the unwinding of the position using a pre-determined methodology (often the mid-market valuation). Such triggers could be downgrades, metrics based on balance sheet/

<sup>2</sup> A financial guarantee of a monoline insurer depended upon the insurer having a AAA credit rating. This is because insuring a bond so that it can receive a AAA credit rating could not be done by a monoline insurer that had a credit rating below AAA. Just before the global financial crisis, monoline insurers had insured a substantial number of ABS and private issued MBS. As defaults in these two structured products occurred, monoline insurers became responsible for making payments to fulfill their guarantees and were subsequently downgraded.

## BOX 4.1 SYNDICATION AND THE SECONDARY MARKET

For larger loan transactions, it is typical for banks to syndicate loans to disperse the credit risk incurred through large transactions. Banks can also sell off the loans they originate (or otherwise own) in the secondary market.

Syndication comes into play for very large transactions. In these cases, the lead bank originates the transaction and makes arrangements to distribute the deal among a larger group of investors. For these efforts, the bank earns a percentage fee. Typically, the lead bank will hold about 20% of the loan for its own book.

There are two basic types of syndicate arrangements: *firm commitment* and *best efforts*. With firm commitments, the

banks guarantee the obligor will receive a set dollar amount and any failure of the bank to recruit additional investors will result in the bank taking a larger portion of the loan onto its own books. For best efforts, the amount raised is based upon how well the bank does in generating interest in the deal and there is no guarantee that the target amount will be raised.

Syndicated loans form the backbone of the secondary market for bank loans, as the originating bank is obligated to ensure the ability of investors to trade the loan after initial distribution. As the secondary market (as well as the market for credit derivatives) has grown, pricing has become more transparent and liquidity has increased.

income statement items, and so on. In the case of a put option, the lender has the right to force early termination at a pre-determined price.

- Reassignment of a credit exposure to another party in the event of some predefined trigger (e.g., a ratings downgrade).

The strategies discussed above are effective but require specific agreements between the counterparties to enact. For this and other reasons, they may not easily fit the needs/goals of the counterparties. Critically, they are limited in that they do not isolate credit risk from the underlying positions for redistribution to a broader class of investors. Nor do they effectively "slice and dice" risk to enable the fine tuning of positions or credit portfolios.

Credit derivatives (e.g., CDSs) were formulated precisely to enable this fine tuning. Credit derivatives are off-balance sheet instruments that facilitate the transfer of credit risk<sup>3</sup> between two counterparties (the beneficiary who sells the risk and the guarantor who buys the risk) without having to sell the given position. Credit derivatives permit the isolation of credit risk (e.g., in a loan or a bond) and transfer that risk without incurring any funding or client management issues. They are to credit risk what interest rate and foreign exchange derivatives are to market risk (because these innovations isolated market risk from funding and liquidity risk concerns).

Credit derivatives come with their own set of challenges. Each of the counterparties is obliged to understand the full nature of the risk transfer: how much risk is transferred, the nature of that risk, how the trigger events are defined, any periodic payment obligations, the obligations and rights for each counterparty in trigger scenarios, and so on. Counterparties in a credit derivative contract also need to understand when the contract is enforceable and when (if ever) it is not. There are also issues of

systemic concentration risk—even prior to the 2007–2009 financial crisis, regulators were concerned about the relatively small number of liquidity providers in the credit derivatives markets. They feared this nascent market could face disruption if any of the major participants were to experience distress (in isolation or in concert). It is interesting to note, however, that the single-name and index CDS markets operated relatively smoothly at the height of the credit crisis under the leadership of the International Swaps and Derivatives Association (ISDA).

Risk transfer and securitization enables institutions to effectively tailor pools of credit risk exposures by facilitating the sale and repackaging of risk. Securitization is also a key source for funding consumer and corporate lending. According to the International Monetary Fund (IMF), the issuance of securitized loans soared from nearly nothing in the early 1990s to almost USD 5 trillion in 2006. Trading volumes for many credit derivatives and securitized products collapsed following the subprime crisis. Only credit card receivables, auto loans, and lease-backed securities remained relatively unaffected.

With the huge expansion in the issuance of corporate bonds since 2012, there has been a revival in the market for securitized corporate loans. This is because their CLO structure is transparent for investors and the collateral is reasonably easy to value.

The Securities and Exchange Commission, in conjunction with U.S. federal banking regulators, finalized Section 15G of the Securities and Exchange Act in 2014. This imposed risk retention provisions on asset-backed securities, including CLOs. Specifically, the rules require securitizers to retain, without recourse to risk transfer or mitigation, at least 5% of the credit risk.<sup>4</sup>

<sup>3</sup> Based upon some reference asset.

<sup>4</sup> Pub. L. No.111-203, 124 Stat. 1376(2010). Section 941 of the Dodd-Frank Act. For further information, see: <https://www.sec.gov/rules/final/2014/34-73407.pdf>.

Moreover, securitizers are not permitted to hedge this risk. These provisions were designed to align securitizers' interests with those of investors, requiring the former to "have skin in the game."<sup>5</sup>

When properly executed in a robust, liquid, and transparent market, credit derivatives contribute to the process of credit price discovery (i.e., they clarify and quantify the market value for a given type of credit risk). In addition to quantifying the default risk incurred by many large corporations, CDS prices also offer a means to monitor default risks in real time (as opposed to credit rating assessments, which are periodic). The hope is that improvements in price discovery will eventually lead to enhanced liquidity, along with a more efficient market pricing of credit spreads for the full spectrum of instruments with credit risk exposure.

Historically, it has been true that corporate bond markets perform price discovery. However, bonds blend interest rate and credit risk (and sometimes liquidity risk) together. Moreover, the corporate bond market is only useful for understanding the credit risk for those companies that issue bonds—which is generally limited to the largest public companies.<sup>6</sup> On the other hand, credit derivatives can potentially help in pricing the credit risk embedded in privately traded high-yield loans and loan portfolios.

Credit risk in a mature credit market goes beyond default risk to include credit spread risk. The credit spread is the difference in the yield on instruments subject to credit risk (e.g., bonds, derivatives, and loans) and comparable maturity Treasury bonds. When the credit spread widens, this affects the valuation of all associated instruments subject to credit risk. Accordingly, the traditional "credit risk" evolves to the "market risk of credit risk" (for certain liquid assets).

## 4.3 THE MECHANICS OF SECURITIZATION

Securitization involves the repackaging of loans and other assets into new securities that then can be sold in the securities markets. The collateral for the new securities is the pool of loans and other assets. The performance of the new securities will depend upon the performance of the collateral.

<sup>5</sup> The U.S. Court of Appeals for the District of Columbia Circuit, 17-5004, February 9, 2018 – Loan Syndication and Trading Association (LSTA) vs. the Securities Exchange Commission and Board of Governors of the Federal Reserve System, 1:16-cv-00652.

<sup>6</sup> Corporate bonds that offer enough liquidity and market activity to facilitate credit risk analysis generally are from large corporations.

Securitization provides a funding vehicle for financial institutions and non-financial corporations. This is important because today banks throughout the world do not have sufficient capital by themselves to satisfy the needs of businesses, consumers, and governments. Moreover, securitization offers financial institutions and non-financial corporations a tool for risk management.

Banks, for example, have used securitization to remove mortgage loans, corporate bank loans, credit card receivables, and automobile loans from their balance sheets. The securitization of these assets resulted in the creation of mortgage-backed securities, collateralized loan obligations, credit card-backed securities, and automobile-backed securities, respectively. The latter two securitized products are referred to as asset-backed securities (ABS).

Prior to securitization, entities that originated loans simply held them in their portfolio as an investment. This is referred to as the traditional "buy-and-hold" strategy. Because an entity would originate a loan and then hold it in its portfolio, the traditional buy-and-hold strategy is also referred to as the "originate-and-hold" strategy. The key risks that the originating entity faced by following this strategy were credit risk, price risk, and liquidity risk.

Securitization, instead, involves the originating entity assembling a pool of similar loans and using that pool as the collateral for the new securities. This strategy is referred to as "originate-to-distribute" strategy. It reduces the originating entity's risks compared to the originate-to-hold strategy. First, the originating entity does not own the collateral, so it does not face credit risk. Second, there is no price risk faced by the originating entity because it does not own the individual assets included in the pool. Finally, by using illiquid loans or receivables as collateral for a securitization, the originating entity no longer holds an illiquid asset and therefore does not face liquidity risk.

The key element in a securitization is a legal entity that is established by the originating entity called a special purpose vehicle (SPV). The SPV purchases the pool of loans from the originating entity (the "sponsor") and takes ownership of those loans. The SPV obtains the funds to purchase the pool of loans from the originating entity by selling the new securities. The holders of these new securities receive interest and principal payments based on rules for the distribution of interest and principal and how defaults will be treated. Typically, the SPV issues senior bonds, junior bonds, and equity. These are referred to as "classes" or "tranches." The senior bond class has the highest level of protection against credit risk and typically has a credit rating of AAA. There can

be more than one class of junior bonds with varying credit ratings below AAA. The equity class, also referred to as the residual class, only receives proceeds after all of the debt classes receive payments and therefore is exposed to the greatest credit risk.

It is important to emphasize that it is not just banks that have used securitization. Manufacturing companies, for example, have used securitization as a risk management tool and a mechanism for raising funds. Here are four examples of non-bank sponsors of securitizations:

- General Motors has created GM Financial (a captive finance company) to provide automobile loans (as well as leases) to its customers. GM Financial and its affiliates have created SPVs to buy the loans (and leases) originated by GM Financial and its affiliates. The SPVs include AmeriCredit Automobile Receivables Trust (AMCAR), GM Financial Automobile Leasing Trust (GMALT), and GM Financial Consumer Automobile Receivables Trust (GMCAR).
- Harley-Davidson created Harley-Davidson Financial Services (a captive finance company) to provide loans to its customers who want to purchase the company's motorcycles. Its SPV issued its first securitization in 2016, a USD 301.9 million deal, and in 2019 came to market with a USD 552.16 million deal.
- SoFi, a personal finance company, uses securitization extensively. In April 2018, SoFi (through its SPV) issued two student loan-backed securitizations (USD 960 million in SOFI-A Notes and USD 869 million in SOFI-B notes) and a consumer loan securitization (USD 774 million in SCLP 2018-1 Notes), for a total of USD 2.6 billion in securitizations.<sup>7</sup>
- Sprint Corporation has a wide range of wireless and wireline communications services for consumers, businesses, and governments. It has used securitizations for its wireless accounts receivable.

The trend toward securitization began in 1968 with the birth of the Government National Mortgage Association (GNMA, also known as Ginnie Mae).<sup>8</sup> Consumer ABSs in the United States and residential mortgage-backed securities (RMBS) in the U.K. emerged in the 1980s. The 1990s saw the development of commercial mortgage-backed securities (CMBS) in the United States. Between 2000 and 2007, there was a surge in the issuance of very complex, risky, and opaque CDOs in the U.S. private label securitization market. Figure 4.1

summarizes the major milestones in the development of the securitization markets (as depicted by the International Monetary Fund).

## 4.4 FROM BUY-AND-HOLD TO ORIGINATE-TO-DISTRIBUTE

Now that we understand what securitization is, let's take a closer look at the buy-and-hold strategy, the OTD strategy, and their roles in the global financial crisis. Starting in the 1980s, certain banking activities shifted from the traditional buy-and-hold strategy to the new OTD business model. Credit risk that would have once been retained by banks on their balance sheets was sold, along with the associated cash flows, to investors in the form of ABSs and similar investment products. In part, the banking industry's enthusiasm for the OTD model was driven by the Basel capital adequacy requirements. Specifically, banks sought to optimize their use of capital by moving capital-consuming loans off their books. Accounting and regulatory standards also tended to encourage banks to focus on generating the upfront commissions associated with the securitization process.

The shift toward the OTD business model seemed to offer the financial services industry many benefits.<sup>9</sup>

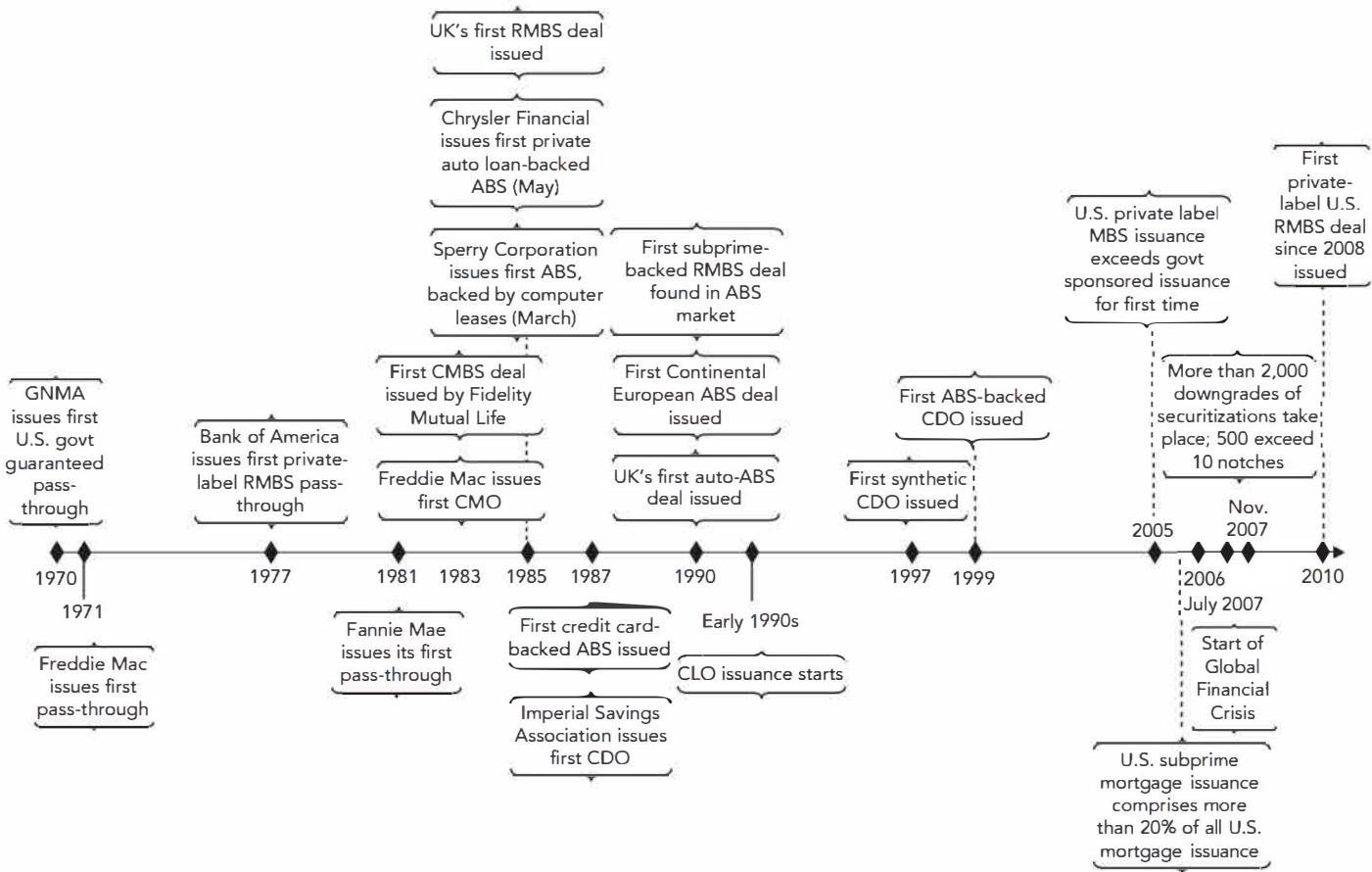
- Originators benefited from greater capital efficiency and enhanced funding opportunities, as well as lower earnings volatility (at least in the short term), because the OTD model seemingly dispersed credit risk and interest rate risk across many market players.
- Investors benefited from a wider array of investments, allowing them to diversify their portfolios and better synchronize their risk/return profiles with their goals and preferences.
- Borrowers benefited from the expansion of available credit and product options, as well as from the lower borrowing costs resulting from these benefits.

However, benefits of the OTD model progressively eroded as risks accumulated in the years leading up to the financial crisis. And while there is widespread disagreement regarding the OTD model's relative contribution to the crisis, there is a consensus that it created moral hazard by lowering the incentives for lenders to maintain high loan underwriting standards and monitor the creditworthiness of borrowers. There is also agreement that too few safeguards were in place to offset this moral hazard.

<sup>7</sup> <https://www.sofi.com/press/sofi-issues-record-2-6-billion-abs-notes-first-quarter-2018/>.

<sup>8</sup> GNMA is the primary mechanism for securitizing government-insured and government-guaranteed mortgage loans.

<sup>9</sup> See Report of the Financial Stability Forum on Enhancing Market and Institutional Resilience (Rep.). (2008, April 7). [https://www.fsb.org/wp-content/uploads/r\\_0804.pdf](https://www.fsb.org/wp-content/uploads/r_0804.pdf)



**Figure 4.1** Milestones in the development of the securitization markets.<sup>10</sup>

Source: Used with permission of International Monetary Fund, from *Securitization: Lessons Learned and the Road Ahead*, Vol. 13 (2013); permission conveyed through Copyright Clearance Center, Inc.

Nevertheless, leading up to the financial crisis, banks deviated from, rather than followed, the OTD business model. Instead of acting solely as intermediaries (i.e., transferring risk from mortgage lenders to capital market investors), many banks took on the role of the investor.<sup>11</sup> In the mortgage market, for example, relatively little credit risk was transferred. Instead, many banks retained or even acquired a considerable amount of securitized mortgage credit risk.

Risks that should have been broadly dispersed under the OTD model were instead concentrated in entities primarily established to skirt mandatory capital requirements. Banks and other financial institutions achieved this by establishing highly levered

off-balance sheet ABCP conduits and structured investment vehicles (SIVs), an investment vehicle described in Table 4.1.

Banks misjudged the risks (e.g., reputation risk) contained in the commitments made to SIV investors. They also (falsely) assumed that there would be a substantial ongoing access to liquidity funding and that markets in these assets would be sufficiently liquid to support securitization.

Firms that were selling their credit exposures found themselves retaining a growing pipeline of credit risk. Furthermore, they did not adequately measure and manage the risks that would materialize if assets could not be sold. Some levered SIVs suffered from significant liquidity and maturity mismatches, making them vulnerable to a classic bank run.

These problems shed light on the need to strengthen the foundations of the OTD model. The factors that exacerbated these weaknesses included bank leverage, faulty origination practices (i.e., poor underwriting standards), and the fact that many financial firms chose to retain (rather than fully transfer) the credit

<sup>10</sup> M. Segoviano, B. Jones, P. Lindner, and J. Blankenheim (2013, November). *Securitization: Lessons Learned and the Road Ahead*(Rep.). Retrieved <https://www.imf.org/external/pubs/ft/wp/2013/wp13255.pdf>

<sup>11</sup> According to the *Financial Times* (July 1, 2008), 50% of AA-rated asset backed securities were held by banks, ABCP conduits and SIVs. As much as 30% was simply parceled out by banks to each other, while 20% sat in conduits and SIVs.

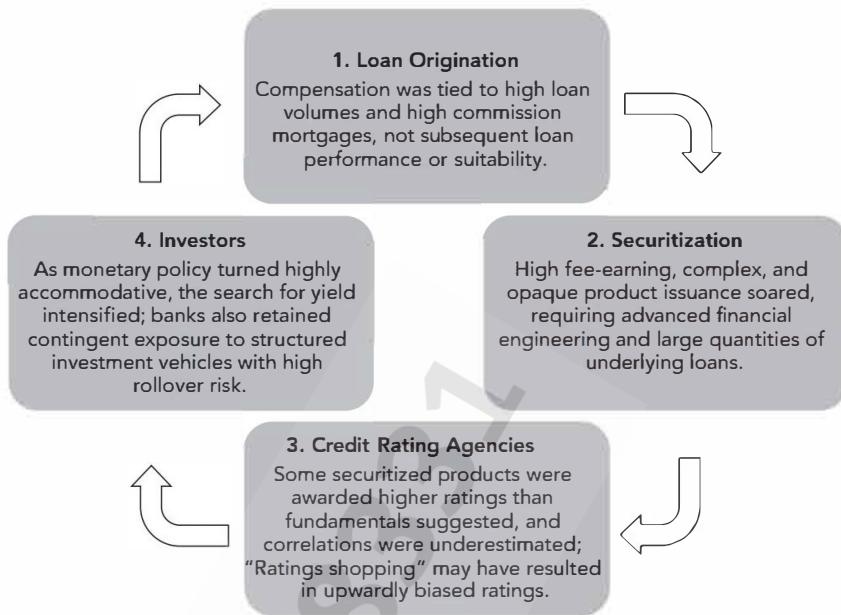
risk embedded in the securities they originated. Among the issues that needed to be addressed were the following.<sup>12</sup>

- There were misaligned incentives along the securitization chain, driven by the pursuit of short-term profits. This was the case among many originators, organizers, managers, and distributors. Investor oversight was weakened by complacency, as market growth beckoned many to “let the good times roll.” The complexity of these instruments and a lack of understanding among investors also served as barriers to market discipline and oversight.
- The risks embedded in securitized products were not transparent. Investors had difficulty assessing the quality of the underlying assets and the potential correlations between them.
- There was poor securitization risk management, particularly regarding the identification, assessment, handling and stress testing of market, liquidity, concentration, and pipeline risks.
- There was an overreliance on the accuracy and transparency of credit ratings. This was problematic because rating agencies failed to adequately review the granular data underlying securitized transactions and underestimated the risks of subprime CDO structuring.<sup>13</sup>

Figure 4.2 summarizes this self-reinforcing securitization chain that amplified systemic risk during the crisis by allowing massive leverage and risk concentration in the financial sector.

While operating at a fraction of its pre-crisis size, the securitization market is on the rebound. MBSs, particularly those issued by U.S. government agencies, continue to dominate the landscape in terms of the volume of outstanding securities, new issuances, and trading. The markets for other asset-backed securities, such as those related to consumer lending, have held their ground since the crisis and have grown in recent years.

Table 4.2 shows the global structured finance volumes from 2015 to 2018 and the projected 2019 forecast by Standard & Poor's for the U.S., Canada, Europe, and Asia-Pacific. As can be



**Figure 4.2** The self-reinforcing securitization chain.

Source: Used with permission of International Monetary Fund, from *Securitization: Lessons Learned and the Road Ahead*, Vol. 13 (2013); permission conveyed through Copyright Clearance Center, Inc.

seen, the projected global structured finance volume for 2019 was USD 1 trillion.

As of 2018, securitization issuance is near the level observed in 2003.

The dust has not entirely settled on the regulatory environment. Some measures are still being drafted, some are in various stages of implementation, and others are facing the possibility of repeal. This regulatory uncertainty serves as an obstacle to securitization’s comeback. It remains to be seen if, once implemented, these new measures will be enough to prevent the formation of a similar constellation of incentives, actors, and circumstances that plagued the securitization process before the crisis.

While it is important to be cognizant of the potential risks posed by credit derivatives, the case favoring a thriving market in these financial instruments is compelling. The paradigm of active credit management has not been replaced by a new paradigm. The demand for instruments that efficiently transfer credit risk and improve the effectiveness of risk management continues to prevail, and the OTD model of banking based on the transfer and dispersion of credit risk continues to carry the promise of furthering systemic financial stability.

<sup>12</sup> E. H. Neave, *Modern Financial Systems: Theory and Application*, Hoboken, NJ: John Wiley & Sons, 2010.

<sup>13</sup> See M. Crouhy, R. Jarrow, and S. Turnbull, “The Subprime Credit Crisis of 2007,” *Journal of Derivatives*, Fall 2008, pp. 84–86.

**Table 4.2** Global Structured Finance Volumes

	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019 forecast</b>
<b>U.S. (bil. \$)</b>					
ABS	183	191(i)	229(i)	239(i)	245(i)
CMBS	101	76	93	77	80
CLO	98	72	118	129	110(ii)
RMBS-related	54	34	70	86	100
<b>Total U.S. new issue</b>	<b>436</b>	<b>373</b>	<b>510</b>	<b>531</b>	<b>535</b>
U.S. CLO reset/refi	10	39	167	155	110
<b>Canada (bil. C\$)</b>	<b>15</b>	<b>18</b>	<b>20</b>	<b>24</b>	<b>21</b>
<b>Europe (bil. €)</b>	<b>77</b>	<b>81</b>	<b>82</b>	<b>106</b>	<b>95</b>
<b>Asia-Pacific (bil. \$)</b>					
China	97	116	220	292	310
Japan	38	53	48	55	58
Australia	24	17	36	23	26
<b>Total Asia-Pacific new issue</b>	<b>159</b>	<b>186</b>	<b>304</b>	<b>370</b>	<b>394</b>
<b>Latin America (bil. \$)</b>	<b>11</b>	<b>12</b>	<b>17</b>	<b>9</b>	<b>18</b>
<b>APPROXIMATE GLOBAL NEW ISSUE TOTAL (bil. \$)</b>	<b>700</b>	<b>670</b>	<b>930</b>	<b>1,040</b>	<b>1,050</b>

(i)U.S. auto loan ABS volume includes the U.S. dollar-denominated cross-border Canadian transactions. (ii)U.S. CLO resets/refis excluded.

ABS—Asset-backed securities. CMBS—Commercial mortgage-backed securities. CLO—Collateralized loan obligation. RMBS—Residential mortgage-backed securities. NPL—Nonperforming loan.

Source: Global Structured Finance 2019 Securitization Energized With \$1 T In Volume © 2019, reproduced with permission of S&P Global Market Intelligence LLC and Standard & Poor's Financial Services LLC. Standard & Poor's Financial Services LLC, provides independent financial information, analytical services, and credit ratings to the world's financial markets.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## QUESTIONS

### True/False Questions

- 4.1** The securitization mechanism underlying the subprime CDO market played a central role in bringing about the 2007–2009 global financial crisis (GFC).
- A. True  
B. False
- 4.2** In a securitization, the bond classes are issued by the loan originator and guaranteed by the special purpose vehicle.
- A. True  
B. False
- 4.3** Credit default swaps allow the transfer of credit risk without impacting funding or relationship management.
- A. True  
B. False
- 4.4** The originate-to-distribute (OTD) business model reduces the incentive for loan originators to monitor the creditworthiness of borrowers.
- A. True  
B. False
- 4.5** In a typical securitization, the sources of funds are mainly several classes of debt with different ratings and a relatively large equity tranche.
- A. True  
B. False

### Multiple Choice Questions

- 4.6** Which of the following cannot be used to transfer credit risk from a bank's balance sheet?
- A. Credit derivatives  
B. Credit default swaps  
C. Securitization  
D. US government bond futures
- 4.7** Credit default swaps helped transfer credit risk in the loan book, but also generated new \_\_\_ of a systemic nature.
- A. credit spread risk  
B. counterparty credit risk  
C. interest rate risk  
D. None of the above
- 4.8** Credit risk includes
- A. the risk of default.  
B. the risk of upgrades and downgrades.  
C. credit spread risk.  
D. All the above

### Short Concept Questions

- 4.9** Describe the securitization process.
- 4.10** How do the SEC's risk retention provisions force banks to have "skin in the game"?

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## ANSWERS

---

### 4.1 False

The crisis may have had more to do with failings of the pre-crisis securitization process than with the underlying principle of credit risk transfer.

### 4.2 False

In a securitization, the bond classes are issued by the special purpose vehicle and not the loan originator. Moreover, the SPV does not make any guarantees.

### 4.3 True

CDSs do not require funding per se, nor do they require any participation from the reference creditor.

### 4.4 True

With an OTD model there is typically little incentive for lenders to carefully underwrite and monitor the credits in the loan pool. Some regulations, such as the SEC's risk-retention provisions, have addressed this by requiring securitizers to retain some of the risk. However, the OTD model still reduces the incentive to monitor credit risk compared to the buy-and-hold model.

### 4.5 False

Equity tranches typically comprise less than 10% of total funding.

### 4.6 D. U.S. government bond futures

Government bond futures offer a mechanism to transfer interest rate risk, not credit risk.

### 4.7 B. Counterparty credit risk

Even prior to the 2007–2009 financial crisis, regulators were concerned about the relatively small number of liquidity providers in the credit derivatives markets. They feared this nascent market could face systemic disruption if any of the major participants were to experience distress (in isolation or in concert).

### 4.8 D. All the above

All of these are derived from the creditworthiness (or the perceived creditworthiness) of the borrower

### 4.9 Answer: See Section 4.3

### 4.10 The rules require securitizers to retain, without recourse to risk transfer or mitigation, at least 5% of the credit risk.





# 5

# Modern Portfolio Theory and Capital Asset Pricing Model

## ■ Learning Objectives

After completing this reading, you should be able to:

- Explain Modern Portfolio Theory and interpret the Markowitz efficient frontier.
- Understand the derivation and components of the CAPM.
- Describe the assumptions underlying the CAPM.
- Interpret and compare the capital market line and the security market line.
- Apply the CAPM in calculating the expected return on an asset.
- Interpret beta and calculate the beta of a single asset or portfolio.
- Calculate, compare, and interpret the following performance measures: the Sharpe performance index, the Treynor performance index, the Jensen performance index, the tracking error, information ratio, and Sortino ratio.

Anticipating changes in the financial markets is an important component of risk management. Because future market movements are inherently uncertain, one must rely on models to measure and quantify risks.

This chapter reviews two key theoretical models for market risk: modern portfolio theory and the capital asset pricing model. It also demonstrates how they are related (as well as their place in risk management).

Market risk has attracted a great deal of academic research since the 1950s due to the abundance of available data on traded securities. As a result, market risk models have been empirically tested in various global markets.

These models have several simplifying assumptions that allow them to deliver insights into the key factors and their interrelationships, without getting bogged down by excess complexity. In this sense, a “good” financial model is one that helps to separate the major explanatory variables from the noisy background.<sup>1</sup>

The stance taken herein aligns with Milton Friedman’s edict that predictive power is the sole criterion to gauge the success of a model.<sup>2</sup> To that end, even a very simple model can be “successful” if it provides reasonably accurate forecasts and adds value to the decision-making process. Despite the criticism directed at risk management models following the 2007–2009 financial crisis—which saw models fail due to errors in selection, implementation, and over-interpretation—models and their underlying theories are still essential to modern risk management. What the crisis taught is that, while models are important tools, what is even more important is how they are implemented.

## 5.1 MODERN PORTFOLIO THEORY

Harry Markowitz’s Ph.D. dissertation in 1952 put forth the foundation of modern risk analysis.<sup>3</sup> The theory developed by Markowitz, referred to as Modern Portfolio Theory (MPT),

<sup>1</sup> The Fed and OCC refer to a model as a “quantitative method system or approach that applies statistic, economic, financial or mathematical theories, techniques and assumptions to process input data into quantitative estimates.”

See United States, Board of Governors of the Federal Reserve System, Office of the Comptroller of the Currency. (2011, April 4). SR 11-7: Guidance on Model Risk Management. Retrieved from <https://www.federalreserve.gov/supervisionreg/srletters/sr1107.htm>

<sup>2</sup> M. Friedman, “The Methodology of Positive Economics,” in *Essays in Positive Economics* (Chicago: University of Chicago Press, 1953).

<sup>3</sup> H. M. Markowitz, “Portfolio Selection,” *Journal of Finance* 7, 1952, pp. 77–91. Markowitz would eventually win the Nobel Prize for Economics based upon this work.

asserts how investors *should* construct portfolios (or equivalently, how investors *should* select investments to include in a portfolio) based on certain assumptions about investor behavior and the properties of capital markets.

Markowitz demonstrated that a “rational investor” (i.e., an investor who is risk averse and seeks to maximize utility)<sup>4</sup> should evaluate potential portfolio allocations based upon the associated means and variances of the return distributions. Given two investments with the same expected return (as measured by the mean of the returns), a risk-averse investor will select the one with the lowest risk (as measured by the variance). Markowitz’s theory also makes the following assumptions:

- Capital markets are perfect, meaning that:
  - There are no taxes or transaction costs;
  - All traders have costless access to all available information; and
  - Perfect competition exists among all market participants
- Returns are normally distributed.

The assumption of normally distributed returns allows investors’ utility choices (as well as investment portfolios) to be stated simply in terms of the mean (i.e., performance) and variance (i.e., risk). With all else being equal, investors prefer a higher mean return and a lower variance.

Investors seek to reduce the variance of their portfolio returns by diversifying their investments. Diversification is accomplished by investing in a portfolio of assets whose constituents have values that do not move in lockstep with one another (i.e., they are not perfectly correlated). Specifically, diversification allows investors to offset specific risk exposures associated with individual assets.

According to Markowitz, the level of investment in a particular financial asset should be based upon that asset’s contribution to the distribution of the portfolio’s *overall* portfolio return (as measured by the mean and variance). An asset’s performance is not judged in isolation, but rather in relationship to the performance of the other portfolio assets. In other words, what matters is the covariability<sup>5</sup> of the asset’s return with respect to the return of the overall portfolio. Portfolio diversification enables

<sup>4</sup> Markowitz made specific reference to the Von Neumann-Morgenstern utility theorem, which postulates that under certain behavioral assumptions, an agent presented with a set of risky outcomes will seek to maximize the expected value of a given utility function defined across the range of potential outcomes.

<sup>5</sup> The overall variance is equal to the weighted sum (using the portfolio weights) of the covariances.

(at least in theory) the zero-cost reduction of risk exposures to individual assets.

Logically, a reduction in risk should result in lower expected returns. If the asset weights are appropriately selected, however, the resulting diversification can enable the optimization (i.e., maximization) of returns for any given level of risk. Plotting the optimal returns for each level of risk results in the *efficient frontier*, which is represented by the solid curve in Figure 5.1. Each point on this curve represents the portfolio of assets that is expected to offer the highest return for the given level of risk.

In Figure 5.1, portfolio P offers the best expected return for any portfolio with the same level of risk. Meanwhile, portfolio K can be categorized as being suboptimal because there are portfolios that will offer better expected returns for the same level of risk (i.e., all the portfolios that lie vertically between portfolio K and the efficient frontier). Along the efficient frontier, the only way to achieve a higher expected rate of return is by increasing the riskiness of the portfolio as measured by the standard deviation. Conversely, it is only by reducing the expected return that a less risky portfolio can be achieved. Note that the dotted line in the plot represents the most inefficient portfolios (e.g., portfolio L) where the investor achieves the lowest expected return for each level of risk.

A critical input to the mean-variance model developed by Markowitz is the estimated correlation between assets. One concern following the global financial crisis was the increase in correlations between returns of major asset classes, even during normal market conditions. A study by Craig Israelsen looked at how the 12-month rolling correlation of 11 major asset classes

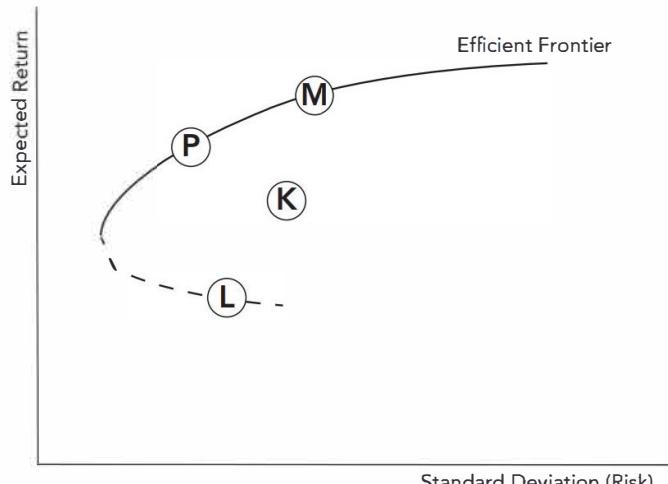
with large U.S. stocks changed in the two years before and after October 2008.<sup>6</sup>

He reported that prior to October 2008, the correlations between the large cap stocks and the other 11 major asset classes were generally lower than after that date. For example, the correlation between U.S. large cap stocks and U.S. bonds increased from 0.21 in October 2006 to 0.46 in October 2008. The instability of the correlation between these asset classes can be seen by looking at the correlation two years later in October 2010: the correlation decreased to -0.38.

For the equity asset classes, correlations were high prior to October 2008 and went even higher, as seen in Table 5.1.<sup>7</sup>

One commonly cited reason for this increase is the huge increase in basket trading via index-tracking mutual funds and exchange-traded funds (ETFs). Through these vehicles, large baskets of assets composed of benchmark indices are traded simultaneously and independently of analyst recommendations concerning the relative performance of these assets.

Quantitative asset management techniques have been proposed to adapt to this new environment. These techniques consist of identifying risk regimes and optimizing portfolio allocations for each specific risk regime. For example, there may be periods in which market participants are worried and uncertain about the future. Markets adjust quickly to these situations, resulting in higher stock market volatility and wider credit spreads in the bond market. These periods tend to be followed by quieter periods with lower stock market volatility and lower bond market credit spreads. An asset manager anticipating a high-risk regime can increase a portfolio's allocation toward



**Figure 5.1** The efficient frontier of Markowitz.

**Table 5.1**

Asset class	October 2006	October 2008	October 2010
Mid-cap U.S. stocks	0.84	0.98	0.96
Small-cap U.S. stocks	0.78	0.96	0.91
Non-U.S. stocks	0.63	0.92	0.90
Emerging market stocks	0.77	0.85	0.92

<sup>6</sup> C.L. Israelsen, "What a study of correlations reveals about diversification," *Financial Planning*, January 5, 2017. Available at <https://www.financial-planning.com/news/what-a-study-of-correlations-reveals-about-diversification/>

<sup>7</sup> Table created from data reported in the Israelsen study.

## BOX 5.1 SENSITIVITY OF MEAN-VARIANCE PORTFOLIOS

Several studies have investigated how errors in estimating the mean, variance, and covariance of stock returns affect the composition of optimal portfolios. What these studies find is that even small deviations in the input values of mean-variance analysis on the resulting portfolios produce notably large effects.<sup>a</sup> In other words, mean-variance efficient portfolios are highly sensitive to the inputs. Furthermore, among the inputs of the mean-variance model, errors in estimating expected returns are observed to cause the most concern.<sup>b</sup> Specifically, errors in estimating expected returns are found

to be at least 10 times more important than errors in estimating variances and covariances.

<sup>a</sup> The effect of a small increase in a single asset on portfolio weights is studied by M. J. Best and R. R. Grauer, "On the Sensitivity of Mean-Variance-Efficient Portfolios to Changes in Asset Means: Some Analytical and Computational Results," *Review of Financial Studies* 4, 2 (1991), pp. 315–342.

<sup>b</sup> V. K. Chopra and W. T. Ziemba, "The Effect of Errors in Means, Variances, and Covariances on Optimal Portfolio Choice," *Journal of Portfolio Management* 19, 2 (1993), pp. 6–11.

low-risk assets, such as money market funds. Conversely, a manager anticipating a low-risk regime can switch to a more aggressive asset allocation favoring equities, emerging markets, commodities, high-yield bonds, and so on. Each asset allocation is optimized to generate the highest return for the regime with which it is associated. These approaches combine risk management techniques with optimal portfolio selection to control the volatility of investment portfolio returns.

Although MPT was an important breakthrough in the theory of portfolio selection, there are major concerns about the unwarranted assumptions underlying the theory and the issues associated with applying the theory in practice.<sup>8</sup>

For example, the assumption that returns are normally distributed is a major concern. The preponderance of empirical evidence across different asset classes and countries fails to support the assumption that asset returns are normally distributed. These studies show that return distributions have fat tails (i.e., there are more observations in the tails of the distribution than a normal distribution) and are asymmetric. Another assumption that is challenged is that investors ignore skewness in selecting assets by only focusing only on the mean and the variance of returns. By ignoring the skewness of a return distribution, the estimated mean and variance of returns will be incorrect. Studies by Campbell Harvey<sup>9</sup> and Bekaert and Harvey<sup>10</sup> found that skewness of return distributions is important in asset pricing.

<sup>8</sup> For a more detailed discussion, see P. K. Kolm, R. Tütüncü, and F.J. Fabozzi, "60 Years of Portfolio Optimization: Practical Challenges and Current Trends," *European Journal of Operational Research*, 234 (April 2014), pp. 356–371.

<sup>9</sup> C.R. Harvey, "The Drivers of Expected Returns in International Markets," (July 25, 2000). Available at SSRN: <http://ssrn.com/abstract=795385>

<sup>10</sup> G. Bekaert and C.R. Harvey, "Research in Emerging Markets Finance: Looking to the Future," (September 11, 2002). Available at SSRN: <http://ssrn.com/abstract=795364>

The major implementation issue comes when estimating the parameters required to apply the model (i.e., the mean and the variance of returns, along with correlations between each asset in the portfolio). These parameters are typically estimated using historical data over a certain period of time. However, the theory does not identify which period should be used to estimate these parameters despite the fact that the resulting allocation can differ greatly depending on which historical data are used. (See Box 5.1). There are methodologies that have been used to deal with the problem of the uncertainty about these parameters. One popular method is to use a technique called robust portfolio optimization, which incorporates estimation error directly into the portfolio optimization process.<sup>11</sup>

## 5.2 THE CAPITAL ASSET PRICING MODEL

Economists William Sharpe, John Lintner, and Jan Mossin furthered MPT theory in the 1960s by incorporating overall capital market equilibrium.<sup>12</sup> The derived equilibrium model, popularly referred to as the capital asset pricing model (CAPM), shows the relationship between the risk and expected return of a risky asset.

Specifically, Sharpe, Lintner, and Mossin decomposed the total risk of a risky asset (as measured by the standard deviation of returns) into two components. The first component is called

<sup>11</sup> W.C. Kim, J.H. Kim, and F.J. Fabozzi *Robust Equity Portfolio Management* (John Wiley & Sons, 2016).

<sup>12</sup> W. F. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk," *Journal of Finance* 19, 1964, pp. 425–442. J. Lintner, "Security Prices, Risk and Maximal Gains from Diversification," *Journal of Finance* 20, 1965, pp. 587–615, and J. Mossin, "Equilibrium in a Capital Asset Market," *Econometrica* 34, 1966, pp. 768–783. Sharpe was awarded the Nobel Prize in 1990. One of the rules of the Nobel award is that the recipient must be alive. Lintner and Mossin had passed away by then, so by rule they could not receive the highest honor in economics.

systematic risk. According to the CAPM, this risk is market risk and (as will be explained) is proxied by the asset's beta. The second risk is one that is unique to that asset. In the case of a stock, it is the risk that is unique to the company. For example, this risk can include strikes, adverse consequences of regulatory change, or litigation in which the company is accused of some wrongdoing. This risk is also referred to as is idiosyncratic risk.

The CAPM demonstrates that by combining assets into a portfolio, each asset's unique risk can be eliminated. This leaves market risk as the portfolio's sole exposure. Because in a well-diversified portfolio the unique risk can be eliminated, unique risk is also referred to as *diversifiable* risk. Since systematic risk cannot be eliminated even in a well-diversified portfolio, systematic risk is also referred to as *non-diversifiable* risk.

The derivation of CAPM includes several crucial assumptions,<sup>13</sup> some of which are the same as those used by Markowitz in deriving the MPT:

- Access to information for all market participants, meaning that all information is freely available and instantly absorbed;
- All market participants have the same expectations;
- All market participants make their investment decisions based on the mean and variance of returns;
- No transaction costs, taxes, or other frictions;
- Allocations can be made in an investment of any partial amount (i.e., perfect divisibility);
- All participants can borrow and lend at a common risk-free interest rate;<sup>14</sup> and
- Any individual investor's allocation decision cannot change the market prices.

The CAPM model shows that market equilibrium is achieved when all investors hold portfolios consisting of the riskless asset and the market portfolio described earlier. Each investor's portfolio is just a combination of these two, with the proportional allocation between them being a function of the individual investor's risk appetite.

Accordingly, the expected return on a risky asset is determined by that asset's relative contribution to the market portfolio's total risk. In this case, the relevant measure of risk is the risk that cannot be diversified away (i.e., non-diversifiable risk or systematic risk). This means that investors should only

<sup>13</sup> These assumptions have all been relaxed by various researchers throughout the years.

<sup>14</sup> For example, it is generally assumed that one can earn a risk-free rate of interest by investing in US government obligations.

be compensated for the risk that cannot be eliminated by diversification.

Systematic risk is proxied by a measure called beta and is calculated as:

$$\beta_i = \frac{\text{cov}(R_i, R_M)}{\sigma_M^2} = \frac{\sigma_i}{\sigma_M} \rho_{i,M} \quad (5.1)$$

$R_i$  and  $R_M$  are (respectively) the returns on asset  $i$  and the market portfolio  $M$ , while  $\sigma_i$  and  $\sigma_M$  are their associated standard deviations. Meanwhile,  $\rho_{i,M}$  is the correlation between the returns on asset  $i$  and those on the market portfolio.<sup>15</sup>

An asset's contribution to the overall risk of the market portfolio is given by the ratio of the covariance of the rates of return for the asset and the market portfolio (i.e., the numerator) to the variance of the market portfolio's rate of return (i.e., the denominator). Note that the weighted sum across all covariances equals  $\sigma_M^2$  (i.e., the market portfolio's total risk)

$$\sum_{i=1}^N x_i \text{cov}(R_i, R_M) = \sigma_M^2 \quad (5.2)$$

In Equation (5.2), each asset's relative weight is given by  $x_i$ ,  $N$  is the total number of assets in the market portfolio, and

$$\sum_{i=1}^N x_i = 1.$$

Starting with Equation (5.2), dividing both sides of the equation by  $\sigma_M^2$ , and using the definition of  $\beta$  in (5.1), the following result is

$$\sum_{i=1}^N x_i \beta_i = 1$$

Note that beta measures the relative co-movement of the return of security  $i$  with that of the market, and therefore the weighted sum of the betas for all assets in the market portfolio equals one. In other words, the beta of the market portfolio is one by construction.

From an investor's perspective, beta represents the portion of an asset's total risk that cannot be diversified away and for which investors will expect compensation. Put more simply, the higher the beta, the higher the systematic risk (and therefore the higher the expected rate of return).<sup>16</sup>

<sup>15</sup> CAPM dictates that total risk  $\sigma_i^2$  can be disaggregated into the systematic,  $\sigma_i^2 \rho_{i,M}^2$  and the specific  $\sigma_i^2(1 - \rho_{i,M}^2)$  risk components. For example, if  $\rho_{i,M} = 0.5$  then the systematic risk component is 0.25  $\sigma_i^2$  and the specific risk component is 0.75  $\sigma_i^2$ .

<sup>16</sup> An unlevered beta is the beta of a company without taking debt into account. In other words, the unlevered beta removes the financial effects of leverage. Unlevered Beta = Levered (equity) Beta/[1 + (1 - tax rate) (Debt / Equity)].

Under this set of assumptions, the expected rate of return over a given holding period on a given asset  $i$  is the mathematical representation of the CAPM:

$$E(R_i) = r + \beta_i[E(R_M) - r] \quad (5.3)$$

Here,  $E(R_i)$  is the expected return of asset  $i$  over the holding period and  $r$  is the rate of return on the risk-free asset. The market risk premium is  $E(R_M) - r$  and  $\beta_i$  is the quantity of market risk. Therefore,  $\beta_i[E(R_M) - r]$  is the expected return premium above the risk-free rate (as required by investors according to the CAPM). A useful interpretation of Equation (5.3) is that if the assumptions of the CAPM hold, the expected return on asset  $i$  should be the return on the risk-free asset plus a risk premium. The risk premium has two components: the quantity of market risk and the unit price of market risk (i.e., how much the market compensates investors for taking on a unit of market risk).

As noted above, the market risk premium is the difference between the expected rate of return of the market portfolio and the risk-free rate:  $[E(R_M) - r]$ . According to the theory,  $E(R_M)$  represents the portfolio of all risky assets in the market. In practice, however, a "broad enough" index of traded shares is used as a proxy (e.g., the S&P 500). Note that broadness is subjective and there continues to be substantial debate among economists and investors alike over what is the exact market risk premium.<sup>17</sup> What is less controversial is the common estimate for the risk-free rate ( $r$ ), which is the three-month U.S. Treasury rate.

## 5.3 THE CAPITAL MARKET LINE AND THE SECURITY MARKET LINE

Look again at Figure 5.1 which shows the efficient frontier as given by the solid curve. Now let us introduce the risk-free rate  $r$ . The risk-free rate has no standard deviation, so it lies on vertical axis. In Figure 5.2, a line is drawn from the risk-free rate and becomes tangent to the efficient frontier at point  $M$  (i.e., portfolio  $M$ ), which is called the tangency portfolio. The line shows all portfolios that an investor can now create once we allow for a risk-free asset and is called the capital market line (CML).

Now, compare the portfolios on the CML with the portfolios on the efficient frontier. With the exception of portfolio  $M$ , the portfolios on the CML dominate the portfolios on the

efficient frontier. By dominate, we mean that the portfolios on the CML, with the exception of the tangency portfolio ( $M$ ), have a higher expected return for every level of risk as measured by the standard deviation. It has been demonstrated that the tangency portfolio is a portfolio that contains all assets held in proportion to their market value and for that reason is called the market portfolio (as we defined it for the CAPM).

The implication of the CML is that all investors should allocate to two investments: the risk-free asset and the market portfolio. This is referred to as the "two-fund separation theorem."

According to this theorem, the amount that should be allocated to the risk-free investment and the market portfolio depends on an investor's risk tolerance. Investors with little tolerance for risk will allocate most of their funds to the risk-free asset. Those who seek more risk will allocate a greater proportion of funds to the market portfolio.

The equation for the CML is

$$E(R_P) = r + \frac{E(R_M) - r}{\sigma_M} \sigma_P \quad (5.4)$$

where

$E(R_P)$  is expected portfolio return,  $r$  is risk-free rate,  $E(R_M)$  is expected market return,  $\sigma_M$  is standard deviation of market returns, and  $\sigma_P$  is standard deviation of the portfolio returns

From the CML another important relationship can be developed called the security market line (SML). The SML gives the relationship between the expected return for individual assets (not portfolios) and risk. However, in the SML the risk measure is systematic risk as proxied by beta, rather than the standard deviation (as in the CML).

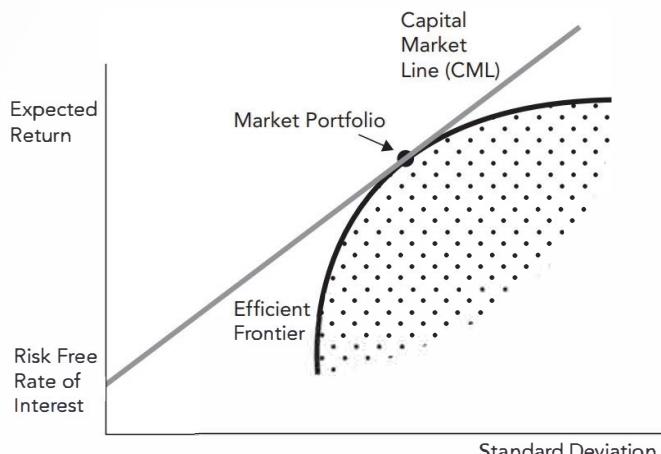


Figure 5.2 Capital market line.

<sup>17</sup> For an updated empirical estimation of the market risk premia of different countries, see the website of Professor Aswath Damodaran: [http://pages.stern.nyu.edu/~adamodar/New\\_Home\\_Page/datafile/ctryprem.html](http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html)

## 5.4 ESTIMATING BETA

In practice, beta analysis for any individual security is implicitly based upon that security's volatility (i.e., total risk) and the correlation of its returns with those of the market. Explicitly, beta is estimated by simple linear regression:<sup>18</sup>

$$R_{it} - r_t = a_i + b_i(R_{Mt} - r_t) + \varepsilon_{it} \quad (5.5)$$

where  $R_{it}$  and  $R_{Mt}$  are the respective rates of return for security  $i$  and the market portfolio,  $r_t$  is the short-term, risk-free rate, and  $\varepsilon_{it}$  is a residual value (all taken at some time  $t$ ). The regression parameters are  $a_i$  (i.e., the intercept) and  $b_i$  (i.e., the slope and the estimate of  $\beta_i$ ). Note that the empirical model (5.3) is referred to as the market model and is based on observations, whereas the CAPM described in (5.3) is based on expectations.

Figure 5.3 shows the estimated beta<sup>19</sup> for J.P. Morgan's stock, based on the monthly

rates of return for the period between June 2008 and May 2019. The beta is estimated as the slope coefficient for a regression line of the firm's excess return and that of the market.<sup>20</sup> The regression line points to a raw, unadjusted beta<sup>21</sup> of 0.36. This means that a 1% change in market excess returns return corresponds to a 0.36% in excess returns for J.P. Morgan's stock price.

Stocks with betas greater than 1 are considered aggressive (because they exhibit more systematic risk than the market), whereas those with betas lower than 1 are considered defensive (because they exhibit less systematic risk than the market). For example, many utility companies in the United States are extremely defensive and have betas of around 0.5. From the example above, JPMorgan would be considered a defensive stock.

Since its development, CAPM has become an important tool in understanding the behavior of prices in capital markets. Despite

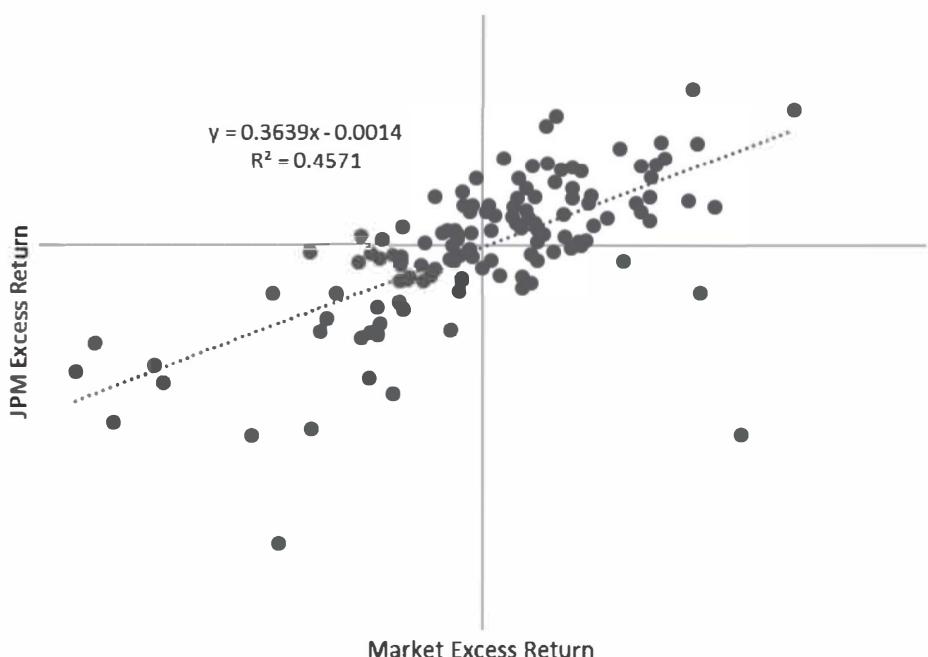
<sup>18</sup> Note that this is a simple reformulation of Equation (5.3) that subtracts the risk-free rate from both sides and thereby lowers the intercept but does not affect the slope of the regression line.

<sup>19</sup> The calculation is done without considering the effect of dividends; log returns were used for the equities and the one-year U.S. Treasury bill rate netted against those figures.

<sup>20</sup> The proxy for the market was the ETF SPY, which is designed to track the S&P 500.

<sup>21</sup> An unadjusted raw beta is calculated solely on the basis of historical data. If the historical beta is adjusted (say to reflect mean reversion properties) then it is called an adjusted beta.

J.P. Morgan versus SPY



**Figure 5.3** Raw beta computation for J.P. Morgan.

its critical role in financial theory, empirically there is little support for the CAPM. One of the findings that questions the validity of the CAPM is that there are other factors driving security returns in addition to the market factor. These other factors are explained in the next chapter.

Beta is also highly important to corporate managers focusing on creating shareholder value. For instance, many corporations require a minimum rate of return on the investment to assess the desirability of new ventures. This hurdle rate is often based on beta analyses, which are essentially how a firm understands the market's expectations for its relative return (or how the market would view the relative return of the proposed venture/project). A failure to properly understand investor expectations can lead to a hurdle rate set at the wrong level. Note that a hurdle rate set too high can result in missed investment opportunities by a company, whereas a rate set too low may result in sub-par investment decisions.

Lastly, note that the original CAPM was developed for discrete time intervals (e.g., one-year or one-month horizons). Subsequently, Merton extended the model to a continuous-time framework by assuming that trades are continuously executable and price changes are smooth (i.e., no jumps in prices).<sup>22</sup>

<sup>22</sup> R.C. Merton, "An Intertemporal Capital Asset Pricing Model," *Econometrica* 41, pp. 867–887. This is only one of many extensions of the CAPM.

## 5.5 PERFORMANCE MEASURES

In a world where the market is in equilibrium and is expected to remain in equilibrium, no investor can achieve an abnormal return (i.e., an expected return greater than that return predicted by the CAPM risk-return relationship). Each asset (or portfolio of assets) yields an identical risk-adjusted return. That is, all securities will lie on the SML and all portfolios on the CML.

Of course, this is not the case in the real world. First, it is not known exactly how expected values are determined. While they can be estimated, such estimations are always subject to measurement errors. Second, markets are rarely in equilibrium. And once they reach equilibrium, deviations from equilibrium are likely to occur almost instantaneously. In the real world, stocks and portfolios may yield a return in excess of, or below, the return with fair compensation for the risk exposure.

This is the reason why portfolio managers rely on indices to measure the performance of a given stock or portfolio relative to the CAPM equilibrium risk-return relationship.

This section compares several performance indices and illustrates how they are used. The focus is on the three traditional measures of portfolio performance based on CAPM: (1) the Sharpe reward-to-volatility ratio, (2) the Treynor reward-to-volatility ratio, and (3) the Jensen performance index. Also presented are some additional indices proposed in academic literature to measure performance. Regardless of the measure used, the overall idea is the same: To get higher average returns one must assume a greater amount of risk.

### Sharpe Performance Index

As previously discussed, the capital market line is given by:

$$E(R_P) = r + \frac{E(R_M) - r}{\sigma_M} \sigma_P$$

$E(R_P)$  and  $\sigma_P$  are the expected return and the standard deviation of the return, respectively, for an efficient portfolio  $P$ . Meanwhile,  $r$  is the risk-free rate and  $E(R_M)$  and  $\sigma_M$  are, respectively, the expected return and the standard deviation for the market portfolio.

The capital market line's slope  $\left( \frac{E(R_M) - r}{\sigma_M} \right)$  is the fair equilibrium compensation. As can be seen it measures expected excess return per unit of volatility.

The investment performance index proposed by Sharpe (SPI) is

$$SPI = \frac{E(R_l) - r}{\sigma_l}$$

where  $E(R_l)$  and  $\sigma_l$  are the expected return and the standard deviation, respectively, for the rates of return on any asset or portfolio  $l$ .

An SPI greater than the slope of the capital market line indicates a superior performance to what is expected in equilibrium. On the other hand, an SPI below the slope of the capital market line indicates an inferior performance.

### Treynor Performance Index

The Treynor performance index (TPI) is

$$TPI = \frac{E(R_l) - r}{\beta_l}$$

TPI is like SPI in the sense it measures the risk premium  $E(R_l) - r$  per unit of risk. However, the two measurements are calculated using different risk measures. Whereas SPI uses the standard deviation of the rates of return,  $\sigma_l$ , TPI uses the beta of the asset or portfolio  $l$ . For a well-diversified portfolio, beta is widely accepted as an appropriate measure of risk.

The derivation of TPI from CAPM is straightforward. According to CAPM:

$$E(R_l) = r + \beta_l [E(R_M) - r]$$

where  $E(R_l)$  is the expected return on the risky asset or portfolio  $l$ , and  $\beta_l$  is the asset's systematic risk measure. Then:

$$TPI = \frac{E(R_l) - r}{\beta_l} = E(R_M) - r$$

Thus, in equilibrium it is expected that this ratio will be constant across all risky assets and portfolios and equal to the excess expected return on the market portfolio  $E(R_M) - r$  (also called the alpha measure). Any TPI greater than  $E(R_M) - r$  is considered to have a positive alpha (indicating superior performance), while a TPI below  $E(R_M) - r$  would indicate a negative alpha and inferior performance.

### Jensen's Performance Index

Jensen's performance index (JPI) is like TPI, as both measures assume investors hold well-diversified portfolios.

By running a time-series regression of the portfolio excess rate of return ( $R_{lt} - r_t$ ) on the market portfolio's excess rate of return ( $R_{Mt} - r_t$ ), one can estimate the beta of portfolio  $l$ :

$$(R_{lt} - r_t) = \hat{\alpha}_l + \hat{\beta}_l (R_{Mt} - r_t) + e_{lt}$$

where  $\hat{\alpha}_l$  and  $\hat{\beta}_l$  are the regression coefficients and  $e_{lt}$  is the deviation of  $l$  from the regression line in period  $t$ . Taking the

mean on both sides, the residual disappears as the average deviation,  $\bar{e}_I$ , is always zero by construction:

$$\bar{R}_I - r = \hat{\alpha}_I + \hat{\beta}_I(\bar{R}_M - r)$$

According to CAPM, one expects  $\hat{\alpha}_I$  to be zero in equilibrium. Hence the JPI, also known as Jensen's Alpha, concentrates on the alpha of the regression.

If  $\hat{\alpha}_I$  is significantly different from zero and is positive, then the performance of  $I$  is considered superior, while it is considered inferior if  $\hat{\alpha}_I$  is negative.

## Link Between the Treynor and Jensen's Performance Measures

The JPI is given by  $\hat{\alpha}_I$ , the y-axis intercept of the regression line:

$$\bar{R}_I - r = \hat{\alpha}_I + \hat{\beta}_I(\bar{R}_M - r)$$

dividing through by  $\hat{\beta}_I$ :

$$\frac{\bar{R}_I - r}{\hat{\beta}_I} = \frac{\hat{\alpha}_I}{\hat{\beta}_I} + (\bar{R}_M - r)$$

The left-hand side of the equation is the TPI. Because superior performance implies  $TPI > (\bar{R}_M - r)$ , then  $\frac{\hat{\alpha}_I}{\hat{\beta}_I}$  must be positive.

Because  $\hat{\beta}_I > 0$  for virtually all assets, it follows that  $\hat{\alpha}_I > 0$ .

Therefore, as long as  $\hat{\beta}_I > 0$ , a superior performance as measured by TPI implies a superior performance by JPI, and vice versa. However, the relative ranking of portfolios by the two performance indices may differ.

## Sortino Ratio

The Sortino ratio (SR) is a modification of SPI. Both ratios measure the risk-adjusted return of an asset or portfolio. However, if the primary focus is on downside risk, then SR is considered to be an improvement over SPI:

$$SR = \frac{R_P - T}{\sqrt{\frac{1}{N} \sum_{t=1}^N \min(0, R_{Pt} - T)^2}}$$

The denominator is the downside deviation, as measured by the standard deviation of returns below the target.  $T$  is the target or required rate of return for the investment strategy, also known as the minimum accepted rate of return (MAR).  $T$  may be set to the risk-free rate or another hurdle rate.

Notice that the Sharpe and the Treynor ratios compare or adjust performance relative to the return on a risk-free asset. The Sortino ratio, in contrast, compares or adjusts performance based on some client-specified return. For that reason, portfolio managers will find it more useful in evaluating performance than the Sharpe and Treynor ratios.

## Information Ratio

Another performance measure that compares or adjusts performance relative to a benchmark is the information ratio. In order to understand this ratio, we have to introduce an important measure of risk called the tracking error.

Tracking error (TE) is the measure of the difference between a portfolio's returns and those of a benchmark it was meant to mimic or to beat. The first step to calculate TE is simply to calculate:

$$R_P - R_B$$

where  $R_P$  is the return on the portfolio under consideration and  $R_B$  is the return on the client-specified benchmark portfolio. This difference is referred to as the active return. Tracking error is then the standard deviation of the active returns over some time period.

An indexed portfolio (i.e., a portfolio constructed to mimic the benchmark) will have a tracking error close to zero. Active portfolio managers will have larger tracking errors that increase the more their portfolio deviates from the holdings of the benchmark.

Given the tracking error, the information ratio is calculated as the ratio of the active returns divided by the tracking error. That is,

$$IR = \frac{\text{Average active return}}{\text{Tracking error}}$$

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## QUESTIONS

- 5.1** Is the market portfolio the only efficient portfolio that can be formed?
- 5.2** What does beta measure?
- A. The volatility of the security
  - B. The joint volatility of any two securities in a portfolio
  - C. The volatility of a security divided by the volatility of the market index
  - D. The relative co-movement of a security with the market portfolio
- 5.3** In the CAPM, what is the expected return for a stock with a beta of 1?
- A.  $E(R_i)$
  - B.  $E(R_M) - r$
  - C.  $r + (E(R_M) - r)$
  - D.  $E(R_M)$
- 5.4** The betas for three stocks are given below. Considering only the stock's beta, which company's stock would be considered the most aggressive?
- |                        |      |
|------------------------|------|
| 3M                     | 1.14 |
| IRobot Corporation     | 1.49 |
| Applied Materials Inc. | 1.64 |
- 5.5** The risk-free rate of interest is  $r = 5\%$  and the market portfolio is characterized by  $E(R_M) = 13\%$ . The betas for stocks A, B, and C are 0.5, 1.0, and 2.0, respectively. According to the CAPM, what are the expected returns of the three stocks?
- A.  $E(R_A) = 5\%, E(R_B) = 11\%, E(R_C) = 21\%$
  - B.  $E(R_A) = 9\%, E(R_B) = 13\%, E(R_C) = 21\%$
  - C.  $E(R_A) = 14\%, E(R_B) = 22\%, E(R_C) = 26\%$
  - D. None of the above
- 5.6** The Sharpe ratio and the Treynor ratio evaluate performance relative to a customized benchmark.
- A. True
  - B. False
- 5.7** The Capital Market Line dominates the efficient frontier once a risk-free asset is introduced.
- A. True
  - B. False
- 5.8** The realized rate of return on stock A and stock B will be the same each month if they have the same beta.
- A. True
  - B. False
- 5.9** If  $r = 4\%$  and  $E(R_M) = 10\%$ , then a stock with a beta of 1.3 is expected to return
- A. 10.0%.
  - B. 6.0%.
  - C. 7.8%.
  - D. 11.8%.
- 5.10** The approximate tracking error for a fund that is indexed is equal to
- A. -12%
  - B. 0%
  - C. 4%
  - D. Greater than 20%
- 5.11** What are the major assumptions needed to establish CAPM (as made by Sharpe, Lintner, and Mossin)?
- 5.12** What is the two-fund separation theorem?
- 5.13** What is the relationship between CAPM and the market model?
- 5.14** What is the difference between the Capital Market Line and the Security Market Line?
- 5.15** Define systematic risk and nonsystematic risk.
- 5.16** According to CAPM, the higher the variance of a security, the higher its expected return.
- A. True
  - B. False
- 5.17** In the Sortino ratio, is performance compared to the performance of a risk-free asset or a client-designated benchmark?
- 5.18** The beta of a security estimated from historical returns is equal to the true beta of the security. True or false? Discuss.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## ANSWERS

---

**5.1** No

**5.2** D. The relative co-movement of a security with the market portfolio

**5.3** C.  $r + E(R_M) - r$

According to the CAPM, the expected return is  
 $r + \beta[E(R_M) - r]$ .

Since the question says that the stock has a beta of 1, substituting 1 for beta gives the answer above.

**5.4** The most aggressive stock is the one with the largest beta, Applied Materials, Inc.

**5.5** B.  $E(R_A) = 9\%$ ,  $E(R_B) = 13\%$ ,  $E(R_C) = 21\%$

In equilibrium, all three stocks are on the same security market line:

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

**5.6** False

**5.7** True

**5.8** False

The realized return is random. CAPM predicts that the expected rates of return for stocks A and B should be the same.

**5.9** D. 11.8%

**5.10** B.

**5.11**

- Investments are perfectly divisible;
- There are no transaction costs and/or taxes;
- Full and costless information is available to all investors;
- The lending and borrowing rates are equal, and are the same for all investors; and
- Each investor can borrow or lend any amount at the market rate.

**5.12** According to capital market theory, all investors will invest in two assets: the risk-free asset and the market portfolio.

**5.13** These models are frequently confused because they both demonstrate a relationship between every asset and the market portfolio.

The market model is an empirical model based on realized rates of return, whereas CAPM is based on expected and unobserved variables. The market model also provides a method of decomposing asset returns into two components: a systematic (or market) component and a residual (or non-market) component:

$$r_P = a_P + b_P r_M + \varepsilon_P$$

where  $r_P = R_P - r$  (or the excess return of the portfolio return  $R_P$  over the risk-free rate  $r$ ), and  $r_M = R_M - r$  (or the excess return of the market portfolio  $R_M$  over the risk-free rate  $r$ ).

The residual component  $\varepsilon_P$  is uncorrelated with the market excess return  $r_M$ . The systematic component is beta multiplied by the market excess return. The market model thus appears to be a natural framework for estimating beta.

CAPM is an equilibrium pricing model, which suggests that each asset is priced so that its expected return compensates for its contribution to the risk of the market portfolio. The asset's expected return is thus found to be proportional to its beta. For a well-diversified portfolio, an asset's risk contribution will approximate its risk contribution to the market portfolio.

**5.14** The CML shows the relationship between expected returns on an efficient portfolio and its standard deviation (See Figure 5.2). Another important relationship can be developed from the CML called the security market line (SML). The SML gives the relationship between the expected return for individual assets (not portfolios) and risk. However, in the SML the risk measure is systematic risk as proxied by beta, not by standard deviation as in the CML.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

**5.15** Systematic, or undiversifiable, risk is that portion of the risk that is associated with market fluctuations and therefore cannot be reduced by diversification.

Non-systematic, or diversifiable, risk is that portion of risk that can be eliminated by combining the security in question with others in a diversified portfolio.

**5.16** False:

A security may have a higher variance of returns but still have a lower expected return because of its low beta.

**5.17** The Sortino ratio compares a portfolio's performance to that of a client-designated benchmark which is a minimum return that the client specifies.

**5.18** This statement is false. The beta of a security obtained from past data is only an estimate of the true beta, which is unknown. The estimate is subject to statistical estimation errors and the true beta, at best, can be said to fall within a confidence interval with a given probability (the confidence level).



# 6

# The Arbitrage Pricing Theory and Multifactor Models of Risk and Return

## ■ Learning Objectives

After completing this reading, you should be able to:

- Explain the Arbitrage Pricing Theory (APT), describe its assumptions, and compare the APT to the CAPM.
- Describe the inputs, including factor betas, to a multifactor model and explain the challenges of using multifactor models in hedging.
- Calculate the expected return of an asset using a single-factor and a multifactor model.
- Explain how to construct a portfolio to hedge exposure to multiple factors.
- Describe and apply the Fama-French three-factor model in estimating asset returns.

As explained in Chapter 5, the capital asset pricing model (CAPM) is a single-factor model that describes an asset's expected rate of return as a linear function of the market's risk premium above a risk-free rate. Beta is the coefficient (i.e., the slope) of this relationship.

The Arbitrage Pricing Theory (APT) is another theory that seeks to explain the relationship between expected returns and risk. However, unlike the CAPM, the APT considers more than just market risk. According to the APT, an asset's expected rate of return is a linear function of several factors. However, the APT does not specify what the risks are. The task of identifying the risks is based on economic logic and empirical analysis. Moreover, the single factor in CAPM (i.e., the market's expected risk premium) is derived from a theoretical model with assumptions about investor behavior. In contrast, APT only assumes that there are no arbitrage opportunities.

## 6.1 THE ARBITRAGE PRICING THEORY

The APT suggests that multiple factors can help explain the expected rate of return on a risky asset. One of these factors is the market in general, just as in the case of the CAPM. Other factors include macroeconomic and fundamental company attributes. However, the model does not say which of these factors adds to the explanatory power of the relationship.

The APT was initially proposed in 1976 by Professor Stephen Ross.<sup>1</sup> Unlike CAPM, APT does not assume investors hold efficient portfolios (as defined within the mean-variance framework) and does not assume risk aversion. Instead, APT has three underlying assumptions.

1. Asset returns can be explained by systematic factors that affect all securities.<sup>2</sup>
2. By using diversification, investors can eliminate specific (or idiosyncratic) risk from their portfolios.
3. There are no arbitrage opportunities among well-diversified portfolios. If any arbitrage opportunities were to exist, investors would exploit them away.

According to APT, the return on a security is given by:

$$R_i = E(R_i) + \beta_{i1}[I_1 - E(I_1)] + \dots + \beta_{iK}[I_K - E(I_K)] + e_i \quad (6.1)$$

where:<sup>3</sup>

$R_i$  is the rate of return on security  $i$  ( $i = 1, 2, \dots, N$ ) with expected return  $E(R_i)$ ;

<sup>1</sup> S. Ross, "The Arbitrage Theory of Capital Asset Pricing," *Journal of Economic Theory* 13 (3), 1976, 341–360.

<sup>2</sup> Note that APT does not assume that asset returns are normally distributed.

<sup>3</sup>  $N$  being the number of securities.

$I_k - E(I_k)$  is the difference between the observed and expected values in factor  $k$  (it is also known as the surprise factor);  
 $\beta_{ik}$  is a coefficient measuring the effect of changes in factor  $I_k$  on the rate of return of security  $i$ ; and  
 $e_i$  is the noise factor (i.e., the idiosyncratic factor).

The basic premise of APT is that investors can create a zero-beta portfolio with zero net investment. If such a portfolio yields a positive return, however, then a sure profit can be realized through arbitrage. The fundamental result, as proved by Professor Ross, is that the absence of arbitrage opportunities requires the expected return on all well-diversified portfolios to satisfy

$$E(R_P) = E(R_Z) + \beta_{P1}[E(I_1) - E(R_Z)] + \dots + \beta_{PK}[E(I_K) - E(R_Z)] \quad (6.2)$$

where

$R_P$  is the return on a well-diversified portfolio with expected return  $E(R_P)$ ;

$\beta_{Pk}$  is the factor loading for the portfolio  $P$  related to factor  $k$ ;

$E(R_Z)$  is the expected rate of return on the zero-beta portfolio (i.e., the risk-free rate) such that  $\text{Cov}(I_k, R_Z) = 0$ , for  $k = 1, \dots, K$ ; and

$E(I_k) - E(R_Z)$  is the risk premium associated with factor  $k$ .

Although both the APT and CAPM refer to the expected rate of return on security  $I$ , because the expected rate of return is unobservable, one must use the realized historical average instead. As introduced in Chapter 5, the empirical proxy to CAPM is shown in Equation 5.5 in Chapter 5.

Many empirical works prefer to use the APT approach rather than that of CAPM because the latter is a special case of the former. Note that CAPM is a one-factor model and thus the market index is the only variable used to explain the expected return for any security. On the other hand, the APT is a multi-factor model where several different factors can be used to explain the variation in expected rates of return. APT is often used to decompose the factors' respective contributions to the expected return.

## 6.2 DIFFERENT TYPES OF FACTOR MODELS

Gregory Conner describes the three different types of factor models in practice: macroeconomic factor models, fundamental factor models, and statistical factor models.<sup>4</sup>

<sup>4</sup> G. Connor, "The Three Types of Factor Models: A Comparison of Their Explanatory Power," *Financial Analysts Journal* 51(3), 1995, 42–57.

## Macroeconomic Factor Models

As their name suggests, macroeconomic factor models seek to explain returns using macroeconomic variables. Chen, Roll, and Ross introduced the first macroeconomic factor model in the 1980s.<sup>5</sup> They found that the following set of macroeconomic factors were important in explaining the realized average rates of return on stocks traded on the New York Stock Exchange (NYSE):

- The spread between long-term and short-term interest rates (reflecting shifts in time preferences);
- Expected and unexpected inflation;
- Industrial production (reflecting changes in cash flow expectations); and
- The spread between high-risk and low-risk corporate bond yields (reflecting changes in risk preferences).

Later, Roll and Ross joined Burmeister and Ibbotson to develop a proprietary factor model that includes the following macroeconomic factors: investor confidence (confidence risk), interest rates (time horizon risk), inflation (inflation risk), real business activity (business cycle risk), and market index (market timing risk).<sup>6</sup>

## Fundamental Factor Models

A fundamental factor is an attribute of a company or an industry. A company's price/earnings ratio, book/price ratio, estimated revenue growth, and market capitalization are examples of fundamental factors.

Probably the most well-known factor model that uses fundamental factors is the three-factor model proposed by Eugene Fama and Kenneth French.<sup>7</sup> Their model extends CAPM by adding two fundamental factors:

1. Small Minus Big (SMB) (i.e., the difference between returns from small stocks and those from large stocks); and
2. High Minus Low (HML) (i.e., the difference between the returns on stocks with high book-to-market values and those of stocks that have low book-to-market values).<sup>8</sup>

<sup>5</sup> N. Chen, R. Roll, and S. Ross, "Economic Forces and the Stock Market," *Journal of Business* 59 (3), 1986, 383–403.

<sup>6</sup> E. Burmeister, R. Ibbotson, R.R. Roll, and S. A. Ross, "Using Macroeconomic Factors to Control Portfolio Risk," unpublished paper.

<sup>7</sup> E.F. Fama and K.R. French, "Common Risk Factors in the Returns on Stocks and Bonds," *Journal of Financial Economics* 33 (1993), pp. 3–56.

<sup>8</sup> For example, a book to market value ratio above one is preferred by value managers because that means a firm is trading cheaply when compared to its book value.

The three-factor model proposed by Fama and French is

$$E(R_P) - r = \alpha_P + \beta_{P,PM}E(R_M) - r] + \beta_{P,SMB}E(SMB) + \beta_{P,HML}E(HML) \quad (6.3)$$

where

- $E(R_P)$  is the expected return on portfolio  $P$ ;
- $r$  is the risk-free interest rate;
- $E(R_M) - r$ ,  $E(SMB)$ , and  $E(HML)$  are the expected premiums; and
- The factor sensitivities  $\beta_{P,PM}$ ,  $\beta_{P,SMB}$ , and  $\beta_{P,HML}$  are the coefficients for the time-series regression:

$$R_P - r = \alpha_P + \beta_{P,PM}(R_M - r) + \beta_{P,SMB}SMB + \beta_{P,HML}HML + \varepsilon_P \quad (6.4)$$

According to Fama and French, the slope of HML is a proxy of relative distress: Strong firms with consistently high earnings have negative HML slopes (while weak firms with consistently low earnings have positive HML slopes) because stronger firms typically have a higher market value relative to their book value. They also show that the SMB factor captures the covariation in returns on small stocks (i.e., the small firm effect).

Fama and French extended the model in 2015 by suggesting two additional fundamental factors:<sup>9</sup>

1. Robust Minus Weak (RMW), which is the difference between the returns of companies with high (robust) and low (weak) operating profitability, and
2. Conservative Minus Aggressive (CMA), which is the difference between the returns of companies that invest conservatively and those that invest aggressively.

When these two factors are added, Fama and French showed that the HML factor is redundant.<sup>10</sup>

Other versions of this model (e.g., Carhart (1997)) include a momentum factor (MOM), which is the difference between stocks that have risen in value over the prior month (i.e., winners) versus those that have fallen in value (i.e., losers).<sup>11</sup> See Boxes 6.1, 6.2, and 6.3.

<sup>9</sup> E.F. Fama and K.R. French, "A Five-Factor Asset Pricing Model," *Journal of Financial Economics* 116(2015), pp. 1–22.

<sup>10</sup> Most notably CMA, which had a -0.7 correlation with HML.

<sup>11</sup> M. Carhart, 1997, "On Persistence of Mutual Fund Performance," *Journal of Finance* 52(1), 57–82. N. Jegadeesh and S. Titman, 1993, "Returns to Buying Winners and Selling Losers: Implication for Stock Market Efficiency," *The Journal of Finance* 48(1), 65–90; and N. Jegadeesh and S. Titman, 2001, "Profitability of Momentum Strategies: An Evaluation of Alternative Explanations," *Journal of Finance* 56(2), 699–720.

### Box Example 6.1:

Consider two companies: Coca-Cola and J.P. Morgan. Using monthly returns from January 2011 through April 2019, the estimated coefficients for the three-factor Fama-French model are shown below.<sup>a</sup>

**Table 6.1**

Monthly Data from January 1990 to April 2019				
	Coca-Cola		J.P. Morgan	
	Value	p-Value	Value	p-Value
Alpha	0.08	0.82	0.16	0.71
Beta	<b>0.53</b>	0.00	<b>1.45</b>	0.00
SMB	<b>-0.74</b>	0.00	-0.14	0.47
HML	-0.10	0.51	<b>1.29</b>	0.00

<sup>a</sup> Data sourced from Yahoo Finance and K. Fama's website: [http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data\\_library.html](http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html) and regression performed in Excel.

The p-values suggest that while the alphas are insignificant, the betas are significant at most of the typical confidence levels utilized for inference (i.e., 90% through 99.9%). For Coca-Cola, the SMB factor is significant and negative, indicating that when small companies outperform large ones, the value of Coca-Cola's equity will probably be negatively impacted (because Coca-Cola is a large company). On the other hand, J.P. Morgan does not have a significant dependence upon the SMB factor, suggesting that the health of small companies is not highly important to a large, broad-based commercial bank. However, J.P. Morgan does have a strong dependence on the HML factor.

### Box Example 6.2:

An analyst believes that a firm's Fama-French dependencies are

	Value
Beta	0.25
SMB	<b>1.25</b>
HML	<b>-0.75</b>

Further, the analyst believes that the firm can generate an extra 3.0% return annually because it has an advantage over its competitors.

Accordingly, if the market forecast is

- A 12.5% return on equities over the next year;
- An SMB of 3.5%;

- An HML of 0.0%; and
- A risk-free rate of 1.5%

The expected return for the company would be

$$\begin{aligned}E(R_c) - r &= \alpha + \beta_{c,M}[E(R_M) - r] + \beta_{c,SMB}E(SMB) \\&\quad + \beta_{c,HML}E(HML) \\E(R_c) - 1.5\% &= 3.0 + 0.25[12.5 - 1.5] + 1.25 * 3.5 - 0.75 * 0.0 \\E(R_c) &= 11.63\%\end{aligned}$$

### Box Example 6.3:

State Street Global Advisors has formulated several tradable baskets of equities, made from subsets of the S&P 500, that are designed to track specific indices. These equities are part of the Standard and Poor's Depository Receipts (SPDR) Exchange Traded Fund (ETF) family and can be traded in the same way as regular equities.

These tradable ETFs can be used in an explanatory multi-factor return model (in the same way as CAPM uses a broad market index or Fama-French relies upon the broad market and two relative return indices). The fact that the SPDR ETFs are tradeable makes this modeling avenue compelling because it offers a clear way to take specific risk-mitigating actions (e.g., by trading these indices against the target equity). SPDRs are fairly liquid and there is also an active market in their derivatives.

The nine sector SPDRs are in Table 6.2.

**Table 6.2**

Symbol	Sector
XLB	Materials
XLE	Energy
XLF	Financials
XLI	Industrials
XLK	Technology
XLP	Consumer Staples
XLU	Utilities
XLV	Health Care
XLY	Consumer Discretionary

This model is

$$E(r_s - r_f) = \alpha_s + \sum_{i=1}^9 \beta_i E(r_i - r_f)$$

To look at a specific example, consider the stock for J.P. Morgan. The model is fit such that all the coefficients were significant (i.e., can be statistically distinguished from zero at the 95% confidence

level). The fit was estimated using the five-day excess returns over the US Treasury one-week rate from December 1998 to June 2019.

**Table 6.3**

		J.P. Morgan
Alpha		
Betas	XLB	
	XLE	
	XLF	1.000
	XLI	
	XLK	0.223
	XLP	-0.212
	XLU	
	XLV	
	XLY	

To see how this might be used, consider an analyst that forecasts the excess returns over the next week as:

- XLF = 5%,
- XLK = -4.0%, and
- XLP = 2.0%.

This would translate into an expected return of 3.68% ( $= 1.000 \times 5.0 + 0.223 \times (-4.0) - 0.212 \times (2.0)$ ) for a position in J.P. Morgan.

Determining portfolio risk using all the stocks in the S&P 500 (in various portions) would require the calculation of about 125,000 different variances. By using these nine factors, that number falls to less than 5,019. The latter is much more feasible and in practice should offer results that perform just as well (given the error margins).

## Statistical Factor Models

In a statistical factor model, historical and cross-sectional data on stock returns are used in the model. The statistical technique of principal components analysis is used to explain the observed stock returns with "factors" that are linear return combinations and uncorrelated with each other.

For example, suppose that the monthly returns for 2,000 companies for 10 years are computed. The goal of principal components analysis is to produce factors that best explain the observed variance in the stock returns. Now suppose that five factors explain most of the variation in the returns of the 2,000 stocks over the 10-year periods. These factors are statistical artifacts. The task then becomes to determine the economic meaning of each of these factors.

## 6.3 FACTOR ANALYSIS IN HEDGING EXPOSURE

While idiosyncratic (i.e., specific) risk can theoretically be eliminated through diversification, the same is not true for systematic risk. However, factor betas can be used to construct a hedging strategy to eliminate systematic risk.

Each factor can be regarded as a fundamental security and can therefore be used to hedge the same factor that is reflected in a given security. For example, a countervailing factor exposure in portfolio H can be used to hedge a specific type of risk in portfolio P.

If the goal is to hedge out all the factor risks and create a zero-beta portfolio, then we can take the opposite positions in each of the factors so that the combined portfolio contains no factor exposures. If the goal is to leave a portfolio exposed to certain types of systematic risks, then not all factor exposures need to be neutralized.

A parsimonious choice in the number of factors is essential, as each needs to serve an institution's risk-adjusted return objectives. The selection of the appropriate systematic factors depends (in part) on judgment and there is no single perfect set of factors for all investors.

A key challenge is determining how often a hedge needs to be adjusted. Note that there is a tradeoff between the cost of hedging and the need to keep the hedge aligned to the portfolio. If the hedging strategy is not implemented on a continuous basis, then tracking errors will appear. If the hedging strategy is updated too frequently, trading costs will be high and drag down overall performance.

Another challenge is model risk, which includes both factor model errors and the potential for errors in implementation. Factor model errors occur when a model contains mathematical errors or is based on misleading/inappropriate assumptions. For example, a hedging strategy that is based on linear factor models that fail to capture nonlinear relationships among the factors will be flawed.

Another common error in model building is to assume stationarity in the underlying asset distribution, as often such distributions can evolve over time. Additionally, assumptions built into models may fail to hold in certain conditions, such as during stressed markets. During the 2007–2009 financial crisis, for example, many market-neutral hedge funds performed poorly.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## QUESTIONS

---

- 6.1** While APT demonstrates that there are other factors in addition to the market factor that impact security returns, it fails to identify what those factors are.
- A. True  
B. False
- 6.2** APT assumes asset returns are normally distributed.
- A. True  
B. False
- 6.3** APT requires that investors make decisions based on mean and variance.
- A. True  
B. False
- 6.4** What is the basic idea of the APT?
- 6.5** What are the three key assumptions of the APT?
- 6.6** Chen, Roll, and Ross (1986) tested the APT model and found several explanatory variables for the average rate of return on stocks traded on the NYSE. Which of the following is not an explanatory variable in their empirical test?
- A. Expected and unexpected inflation  
B. The yield spread between high and low risk corporate bonds  
C. The yield spread between long and short maturity bonds  
D. The change in money supply in the economy
- 6.7** Unlike the CAPM, the APT rewards investors for accepting specific risk.
- A. True  
B. False
- 6.8** In a statistical factor model, are the macroeconomic and fundamental factors clearly identified using principal component analysis?
- 6.9** Roll noted that well-diversified portfolios are nonetheless highly correlated if the holdings are concentrated within the same asset class. True or false? Explain.
- 6.10** The Fama-French three-factor model adds two risk factors beyond the market index to explain past average rates of return. Which of the following ratios is a risk factor in the Fama-French empirical model?
- A. EBITDA to total sales  
B. Current assets to current liabilities  
C. Net profit to total assets  
D. Book-to-market values
- 6.11** The Fama-French five factor model added two more factors. Which of the following is a basis for one of these new risk factors?
- A. Operating profitability  
B. Current assets to current liabilities  
C. Net profit to total assets  
D. Last month performance
- 6.12** Factor betas in a well-diversified portfolio provide a means for constructing a hedging strategy to reduce systematic risk. True or False? Discuss.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## ANSWERS

---

**6.1** True

Although APT asserts there are multiple factors, it does not identify those factors.

**6.2** False

**6.3** False

**6.4** The basic idea of APT is that investors can create a zero-beta portfolio with zero net investment. If such a portfolio yields positive return, then a sure profit can be realized by arbitraging. In the real world, any existing arbitrages would be exploited away.

**6.5** APT has three underlying assumptions.

1. Asset returns can be explained by systematic factors.
2. By using diversification, investors can eliminate specific risk from their portfolios.
3. There are no arbitrage opportunities among well-diversified portfolios. If any arbitrage opportunities were to exist, investors would exploit them away.

**6.6** D. The change in money supply in the economy

The explanatory variables were

- The spread between long-term and short-term interest rates (reflecting shifts in time preferences);
- Expected and unexpected inflation;
- Industrial production (reflecting changes in cash flow expectations); and
- The spread between high-risk and low-risk corporate bond yields (reflecting changes in risk preferences).

**6.7** Neither the APT nor the CAPM find that investors should be rewarded for accepting specific risk.

**6.8** In a statistical factor model, principal component analysis provides factors that best explain the observed variance in returns of the stocks being analyzed. These factors are statistically derived and are not identified as specific macroeconomic or fundamental factors.

**6.9** True

Roll noted that well-diversified portfolios exhibit high correlations when constrained to the same asset class, whereas there is much less correlation when portfolios are diversified across multiple asset classes.

**6.10** D. Book-to-market values

HML is the difference between the returns on stocks with high book-to-market values and those of stocks that have low book-to-market values.

**6.11** A. Operating profitability

Fama and French extended the model in 2015 by suggesting two additional factors:

1. RMW, which is the difference between the returns of companies with high (robust) and low (weak) operating profitability; and
2. CMA, which is the difference between the returns of companies that invest conservatively and those that invest aggressively.

**6.12** True

Each factor can be used to hedge the same factor exposure that is reflected in a given security. For example, to hedge a positive exposure to a factor, another security with a negative factor beta to that factor can be purchased (or one with a positive factor beta could be shorted).





# 7

# Principles for Effective Data Aggregation and Risk Reporting

## ■ Learning Objectives

After completing this reading, you should be able to:

- Explain the potential benefits of having effective risk data aggregation and reporting.
- Explain challenges to the implementation of a strong risk data aggregation and reporting process and the potential impacts of using poor-quality data.
- Describe key governance principles related to risk data aggregation and risk reporting.
- Describe characteristics of effective data architecture, IT infrastructure, and risk-reporting practices.

## 7.1 INTRODUCTION

Effective risk analysis requires sufficient and high-quality data. This makes data a major asset in today's world, and it should be treated as such.

Risk analyses can be made using the internal data of an organization (e.g., transaction data within a financial institution or the specific costs of raw materials for a manufacturing company). The major concern with this type of data is whether it is kept in an organized way so that it can be used for analysis. Statistical techniques for analyzing this data are wide ranging and can include tools such as machine learning and artificial intelligence (AI).

Data can also come from outside the organization (e.g., external data on the economy or on a specific industry). Financial institutions need data on past inflation rates, changes in money supply, major interest rates, exchange rates, and so on. Some external data can be collected from public sources, whereas other types of data may have to be purchased from traditional and non-traditional sources. Non-traditional sources of information are referred to as alternative data and includes data gathered by third parties such as information from scrapping the web, mobile devices, and sensors.

### BOX 7.1 DATA IN MODEL RISK

Data acquisition plays an important role in model risk. Financial institutions rely on models to guide their day-to-day operations and to analyze their risk exposures. As a result, even the smallest of model errors can have dire consequences.

Model risk can be decomposed into four components:<sup>\*</sup> input risk, estimation risk, valuation risk, and hedging risk. Note that data acquisition is especially pertinent when considering input risk. Models depend on the quality of data because it is used to create statistical estimators of their parameters. As the adage goes: "garbage-in, garbage-out".

\*M. Crouhy, D. Galai, and R. Mark, *Risk Management*, McGraw Hill, 2002, p. 586.

For many years, financial firms collected data on either a departmental or business activity basis. Generally, these efforts were not well coordinated or managed. Different departments often used different data sources, resulting in duplication in some cases. A lot of data was neglected and even destroyed (e.g., data loss can occur when moving from one computer system to another). In the 1960s and 1970s, data were stored on paper cards or computer tapes. Later storage devices included floppy

disks and hard disk drives, neither of which were compatible with the older generation of systems.

A special committee of the Basel Committee on Banking Supervision (BCBS) examined bank data collection, data storage, and data analysis practices. That committee uncovered many problems within the industry and subsequently published a special report on risk data management. It concluded that data quality in the banking industry was inadequate to aggregate and report risk exposures across business lines, legal entities, and at the bank group level.

In recognition of these inadequacies, the BCBS published a set of 14 principles to guide banks as they overhauled their risk data aggregation and reporting capabilities (BCBS 239).<sup>1</sup> The BCBS defines risk data aggregation as the "process of defining, gathering, and processing risk data according to [a firm's] risk reporting requirements to enable the bank to measure its performance against its risk tolerance/appetite."

The principles and supervisory expectations outlined in BCBS 239 apply to risk management data and models. These principles cover governance/infrastructure issues, risk data aggregation procedures and needs, reporting, and considerations for supervising authorities.

Banks have struggled to comply with BCBS 239 and the original timeline to achieve full compliance was not met by any bank. This is largely due to the highly complex nature of the IT reengineering involved in bringing the various systems into compliance as well as the dynamic nature of the principles.<sup>2</sup> The exponential increase in the application of AI techniques on large data sets has also made compliance with BCBS 239 more challenging.

Section 7.2 explains how effective risk data aggregation and reporting can allow organizations to measure risk across an enterprise.<sup>3</sup> Section 7.3 describes the key BCBS governance principles.<sup>4</sup> Section 7.4 identifies the data and IT infrastructure features that contribute to effective data aggregation and reporting. Section 7.5 describes specific characteristics of a strong risk aggregation capability as well as the interactions between those characteristics. Finally, section 7.6 describes the characteristics of effective risk reporting practices and the need for forward looking capabilities to give preemptive signals of potential risk exceedances.

<sup>1</sup> Principles for effective risk data aggregation and risk reporting (Rep.). (2013, January). Retrieved <https://www.bis.org/publ/bcbs239.pdf>

<sup>2</sup> See Basel Committee on Banking Supervision, June 2018, Progress in adopting the Principles for effective risk data aggregation and risk reporting (RDARR): <https://www.bis.org/publ/bcbs443.pdf>

<sup>3</sup> The specific costs and benefits of enterprise risk management (ERM) will be discussed in Chapter 8.

<sup>4</sup> Best practices in corporate governance were discussed in Chapter 2.

## 7.2 BENEFITS OF EFFECTIVE RISK DATA AGGREGATION AND REPORTING

If a firm fully adheres to the BCBS principles, its risk managers will have less uncertainty regarding the accuracy, integrity, completeness, timeliness, and adaptability of the data they use. Simply put, risk management benefits from having high-quality risk data at all levels of the organization.

Designing and implementing an effective risk data aggregation and reporting capability enhances tactical and strategic decision-making processes. This reduces the chance of losses and improves risk-adjusted returns.

Banks need to leverage the relevant risk information and carefully consider what data can be obtained (and at what cost). It can be challenging for risk managers to process and refine fast moving big data<sup>5</sup> into usable risk information. It is essential that decision-makers have confidence in the quality of the underlying data. If the information is inaccurate or incomplete, management may not be able to make sound risk decisions.

Advances in data analytics (e.g., machine learning) are being used to collect, analyze, and convert large volumes of unstructured data<sup>6</sup> into usable information. This makes it easier for organizations to avoid information overload and enables them to turn vast amounts of data into a strong competitive advantage.<sup>7</sup>

Rigorous model validation also plays a critical role in risk management.<sup>8</sup> In the United States, model developers must comply with regulatory guidance on model vetting. The Federal Reserve provides comprehensive guidance for banks on effective model risk management.<sup>9</sup> This guidance calls for a "rigorous assessment of data quality . . . as well as the proper documentation."<sup>10</sup> Model developers need to demonstrate that the data

<sup>5</sup> Big data is data that are so big and complex that traditional data processing techniques are inadequate.

<sup>6</sup> This is data without a pre-defined data model or otherwise lacking a pre-defined approach to organization.

<sup>7</sup> COSO, "Enterprise Risk Management: Integrating Strategy with Performance," June 2017. (See Principle 18: Leverages Information and Technology.)

<sup>8</sup> M. Crouhy, D. Galai, and R. Mark, *The Essentials of Risk Management* (2<sup>nd</sup> edition), Chapter 15, McGraw Hill, 2014, offers a more complete discussion on model risk management.

<sup>9</sup> United States, Board of Governors of the Federal Reserve System, Office of the Comptroller of the Currency (2011), "Supervisory Guidance on Model Risk Management (SR 11-7)." Retrieved from <https://www.federalreserve.gov/supervisionreg/srletters/sr1107a1.pdf>

<sup>10</sup> Basel Committee on Banking Supervision, January 2013, "Principles for effective risk data aggregation and risk reporting."

they use are suitable as well as consistent with both the theory behind the model and the chosen methodology.

BCBS 239 was a major driver in the rise of the chief data officer (CDO) function. The CDO is typically responsible for standardizing a firm's approach to data management. Note that data standardization efforts have grown well beyond reference data to include financial products data and accounting data.<sup>11</sup> If independent departmental applications and methodologies are based on consistent standards, the data that flows up through an organization's structure will provide a reliable, accurate, and manageable view of the institution's total risk profile.

If this is not the case, however, important connections among different dimensions of an organization's business will not be transparent. An example of such data risk is the case where customers with credit products in different business lines (e.g., mortgage loans and a credit card) are not recognized as the same customer due to the absence of standardized customer identification codes.

An operational process that allows flawed data to enter the system may eventually cause failures in the aggregate. An example of such a failure can be seen in the role of erroneous/fraudulent mortgage application data in precipitating the 2007–2008 collapse of the U.S. housing market. Note that this flawed data, which concerned loan suitability, was submitted by individuals one application at a time yet at an unusually high frequency.

## 7.3 KEY GOVERNANCE PRINCIPLES

### BOX 7.2 PRINCIPLE 1\*

**Governance**—A firm's risk data aggregation capabilities and risk reporting practices should be subject to strong governance arrangements consistent with other principles and guidance established by the Basel Committee.

\*Basel Committee on Banking Supervision, January 2013, "Principles for effective risk data aggregation and risk reporting."

A strong governance framework (see Principle 1 in Box 7.2) combined with a well-designed risk data and IT infrastructure<sup>12</sup>

<sup>11</sup> The Financial products Markup Language (FpML) is one such example. FpML defines a taxonomy and structure of financial derivative products using the eXtensible Markup Language (XML) standards. For example, FpML includes structural definitions not only for derivatives, but also for the underlying financial instruments and assets to which financial derivatives contracts must necessarily refer.

<sup>12</sup> Infrastructure describes the actual components of a system. Architecture describes the design of the components and their relationships. For example, a system is built on an infrastructure that has a specific architecture.

(see Principle 2 in Box 7.3) is necessary to ensure BCBS 239 compliance. Furthermore, independent validation is necessary to ensure risk data aggregation and risk reporting (RDARR) capabilities “are functioning as intended and are appropriate for the [firm’s] risk profile.”<sup>13</sup>

As of mid-2019, most banks are still finding it difficult to implement the BCBS 239 principles. It is therefore critical that the board and senior management understand the limitations preventing effective RDARR and remedy any shortcomings. If risk data are the blood of a financial enterprise, then data integration<sup>14</sup> constitutes its circulatory system. A bank with a limited ability to integrate data will have difficulties in satisfying the Basel principles.

A key challenge is collecting data from the various internal and external sources and feeding it into risk analytics systems. Typically, risk management applications do not access these data sources directly. Instead, the information is copied, extracted, translated, and loaded into a financial data warehouse. This approach prevents the execution of computationally intensive analytical processes from degrading the performance and response times of operational systems.

Effective (i.e., fully or largely compliant) risk data governance is achieved by implementing policies that set “out a clear delineation of roles, incentive schemes, and responsibilities for risk data management (including dedicated staff responsible for defining risk data expectations).”<sup>15</sup>

Conversely, a hallmark of ineffective (i.e., non-compliant) risk governance is “a lack of structured policies and frameworks to consistently assess and report risk data activities to the board and senior management.”<sup>16</sup>

The board has an important governance role related to RDARR. It should, in addition to reviewing and approving a bank’s RDARR, ensure that the appropriate resources are available. RDARR policies should be reviewed, and revised if necessary, after major acquisitions or changes in strategy.

## 7.4 DATA ARCHITECTURE AND IT INFRASTRUCTURE

### BOX 7.3 PRINCIPLE 2\*

**Data architecture and IT infrastructure**—A bank should design, build, and maintain data architecture and IT infrastructure which fully supports its *risk data aggregation capabilities* and *risk reporting practices* not only in normal times but also during times of stress or crisis, while still meeting the other Principles.

\*Basel Committee on Banking Supervision, January 2013, “Principles for effective risk data aggregation and risk reporting.”

Firms should establish integrated risk data architectures. Roles should be clearly specified, including the responsibilities for ensuring “adequate controls throughout the lifecycle of the data and for all aspects of the technology infrastructure.”<sup>17</sup>

There is no uniform blueprint in place for a BCBS 239-compliant infrastructure and solutions are specific to each institution. The optimal approach ensures that all people and systems within the banking group are working with the same data, the same models, and the same assumptions.<sup>18</sup>

Firms should create information on data characteristics. This could be in the form of various data models. The four primary types of data models include: semantic data, conceptual data, logical data, and physical data.

Semantic data models address the agreed-upon meaning of elements in the model.<sup>19</sup> Conceptual models confirm human understanding of the system and its objectives.<sup>20</sup> Physical data

<sup>17</sup> Basel Committee on Banking Supervision, January 2013, “Principles for effective risk data aggregation and risk reporting.”

<sup>18</sup> S. Ludwig and M. Gujer (2016), “The Art of Adaptable Architecture—Implementing BCBS 239.”

<sup>19</sup> Semantic model standardization initiatives improve the efficiency and quality of enterprise financial risk management as well as support industry-wide and global financial data standards. Usually accompanying a semantic model is a documented understanding of the behavior of elements acting on other elements.

<sup>20</sup> Conceptual models take on a high-level design of the groupings of informational elements, structures, and processes that interact with each other.

<sup>13</sup> Basel Committee on Banking Supervision, January 2013, “Principles for effective risk data aggregation and risk reporting.”

<sup>14</sup> Data integration involves the extracting, translating, associating, merging, constructing, and loading of data from physical data sources into a data store based on a given set of logical and physical models.

<sup>15</sup> Basel Committee on Banking Supervision, June 2018, “Progress in adopting the Principles for effective risk data aggregation and risk reporting (RDARR).”

<sup>16</sup> Ibid.

models translate the data requirements and properties expressed in the logical model into a specific implementation on an IT hardware/software vendor system platform.<sup>21</sup>

In summary, banks with effective (i.e., fully or largely compliant) data architecture and IT infrastructure have consolidated their “data categorization approaches and structures as well as integrated data taxonomies.”<sup>22</sup>

Conversely, banks with ineffective (i.e., non-compliant) data architecture and IT infrastructure lack the “appropriate processes and controls to ensure that the risk reference data is updated following changes in business activities.”<sup>23</sup>

## 7.5 CHARACTERISTICS OF A STRONG RISK DATA AGGREGATION CAPABILITY

Firms need to monitor their data on an ongoing basis to ensure its accuracy and integrity (see Principles 3 and 4 in Box 7.4). Risk data should be complete, reconciled with sources, and include all material risk disclosures at a granular level. Classifications and categorizations are necessary to present complete and manageable information to executive management. If classifications are too broad, however, information loss and data distortion can occur.

Banks should also be “able to produce aggregate risk information on a timely basis”<sup>24</sup> (see Principle 5 in Box 7.4). The degree of timeliness required depends on the risk area being monitored. For example, data used to measure risk on the trading floor will need to generate risk information on a time-lier basis when compared to risk information on a corporate loan. Information systems dedicated to trading rooms must

accommodate a wide variety of specific and potentially complex financial instruments. These risks need to be evaluated quickly and frequently for the purposes of managing a trading book or a portfolio.

Trading systems apply sophisticated analytical valuation and pricing algorithms to portfolio positions. They typically use data structures, customized either by vendors or designed by in-house development teams, to record the details of financial instrument contracts. Compromises in timeliness are often made due to the need to extract and map data from different trading systems into other systems that can integrate, summarize, and report on the consolidated data.

Furthermore, risk data aggregation practices need to be adaptable (see Principle 6 in Box 7.4). An example of adaptability would be the ability to integrate a hypothetical stress scenario with other parts of the portfolio to produce an aggregated enterprise risk measure. Adaptability would also include the capability to incorporate changes in an upcoming regulatory framework (e.g., an update to Basel capital regulatory rules) and the ability to combine that with historical data to produce an overall risk measure.

The BCBS notes that an effective (i.e., fully or largely compliant) capability to aggregate risk data features “appropriate data element certification, data quality documentation, data quality assurance mechanisms, assessment of data quality per risk type, and documented and effective controls for manual processes.”<sup>25</sup>

Conversely, ineffective (i.e., with compliance gaps) risk data aggregation capabilities may feature “deficiencies in data quality controls . . . ; [lack of properly established] data quality rules such as minimum standards for data quality reporting thresholds; absence of a designated authority [oversight] . . . ; lack of an effective escalation model . . . ; and weaknesses in [quality control]” as well as “. . . overreliance on manual . . . processes without proper documentation [and policy] . . . , lack of reconciliation for certain key reports . . . and no variance analysis . . . , inability to promptly [also without automation] source risk data from foreign subsidiaries . . . , lack of standardization of reference data.”<sup>26</sup>

<sup>21</sup> A physical data model can generate the specific operations, procedures, and data loads to create a functioning database instance of the logical data model.

<sup>22</sup> Basel Committee on Banking Supervision, June 2018, “Progress in adopting the Principles for effective risk data aggregation and risk reporting (RDARR).” This report also mentions as an example “a data dictionary and a single data repository or data warehouse for each risk type identified and constructed”

<sup>23</sup> Ibid. The report also mentions as an example of this “a lack of a formalized escalation process to communicate poor data quality to senior management”.

<sup>24</sup> Basel Committee on Banking Supervision, January 2013, “Principles for effective risk data aggregation and risk reporting.”

<sup>25</sup> Basel Committee on Banking Supervision, June 2018, “Progress in adopting the Principles for effective risk data aggregation and risk reporting (RDARR).”

<sup>26</sup> ibid.

## BOX 7.4 PRINCIPLES 3 TO 6\*

### Principle 3:

**Accuracy and Integrity**—A bank should be able to generate accurate and reliable risk data to meet normal and stress/crisis reporting accuracy requirements. Data should be aggregated on a largely automated basis to minimize the probability of errors.

### Principle 4:

**Completeness**—A bank should be able to capture and aggregate all material risk data across the banking group. Data should be available by business line, legal entity, asset type, industry, region, and other groupings, as relevant for the risk in question, that permit identifying and reporting risk exposures, concentrations, and emerging risks.

### Principle 5:

**Timeliness**—A bank should be able to generate aggregated and up-to-date risk data in a timely manner while also meeting the principles relating to accuracy and integrity, completeness, and adaptability. The precise timing will depend upon the nature and potential volatility of the risk being measured as well as how critical it is to the overall risk profile of the bank. The precise timing will also depend on the bank-specific frequency requirements for risk management reporting, under both normal and stress/crisis situations, set based on the characteristics and overall risk profile of the bank.

### Principle 6:

**Adaptability**—A bank should be able to generate aggregate risk data to meet a broad range of on-demand, ad hoc risk management reporting requests, including requests during stress/crisis situations, requests due to changing internal needs, and requests to meet supervisory queries.

\*Basel Committee on Banking Supervision, January 2013, "Principles for effective risk data aggregation and risk reporting."

to make critical decisions about risk"<sup>27</sup> (see Principle 7 in Box 7.5).

For instance, the ability to use models to aggregate risk depends upon having those models be fully vetted to ensure that the results are accurate within a given level of specificity. Banks should also establish accuracy and precision requirements for their risk reports that reflect the criticality of decisions made using risk information.

Risk reports also need to be comprehensive and cover all risk types (see Principle 8 in Box 7.5). These risks include the Pillar 1 and Pillar 2 risks.<sup>28</sup>

Risk reports need to be clear and useful as well as meet the needs of their users (see Principle 9 in Box 7.5). The BCBS notes that "reports should include an appropriate balance between risk data, analysis and interpretation, and qualitative explanations."<sup>29</sup> These reports should be purposeful, in the sense that they should be tailored towards a specific audience (e.g., a trading unit or a lending unit). For example, risk reports for a board of directors should not be difficult to interpret at an aggregate level.

Risk reporting frequency is a function of the risk type and purpose of each risk report (see Principle 10 in Box 7.5). During times of stress, report frequency may increase to keep pace with unusually fast-moving markets. Additionally, there may be situations where rapid risk analyses are required to facilitate decision-making. In short, all these situations should be planned for ahead of time (to the extent such preparation is possible).

However, there may be unavoidable limits on reporting frequency. For example, in cases where forward-looking stochastic cash flow simulations are used, the volume of data produced can be significantly larger than that of the input data. Having too much output data can negatively impact a firm's ability to perform the necessary quality checks.

The generation of many scenario iterations can also affect the frequency of risk reports.<sup>30</sup> Combining multiple analyses and model iterations requires consistent contexts and synchronized

<sup>27</sup> ibid.

<sup>28</sup> Pillar 1 risks include market risk, credit risk, and operational risk. Pillar 2 risks include business risk, reputation risk, and strategic risk. Chapter 1 describes and differentiates among the key classes of risks.

<sup>29</sup> Basel Committee on Banking Supervision, January 2013, "Principles for effective risk data aggregation and risk reporting."

<sup>30</sup> The cycle of sample, process, and review and act upon results repeats itself, often daily, producing yet more results datasets. In addition to the need to manage these results datasets, there is a need for the annotation and attribution of scenario assumptions corresponding to the data in the results data repository.

## 7.6 CHARACTERISTICS OF EFFECTIVE RISK REPORTING PRACTICES

Banks also have significant progress to make when it comes to the BCBS 239 principles on effective risk reporting practices.

The BCBS notes that "risk management reports should be accurate and precise to ensure a bank's board and senior management can rely with confidence on the aggregated information

## BOX 7.5 PRINCIPLES 7 TO 11\*

### Principle 7:

**Accuracy**—Risk management reports should accurately and precisely convey aggregated risk data and reflect risk in an exact manner. Reports should be reconciled and validated.

### Principle 8:

**Comprehensiveness**—Risk management reports should cover all material risk areas within the organization. The depth and scope of these reports should be consistent with the size and complexity of the bank's operations and risk profile, as well as the requirements of the recipients.

### Principle 9:

**Clarity and usefulness**—Risk management reports should communicate information in a clear and concise manner. Reports should be easy to understand yet comprehensive enough to facilitate informed decision-making. Reports should include meaningful information tailored to the needs of the recipients.

### Principle 10:

**Frequency**—The board and senior management (or other recipients as appropriate) should set the frequency of risk management report production and distribution. Frequency requirements should reflect the needs of the recipients, the nature of the risk reported, and the speed at which the risk can change, as well as the importance of reports in contributing to sound risk management and effective and efficient decision-making across the bank. The frequency of reports should be increased during times of stress/crisis.

### Principle 11:

**Distribution**—Risk management reports should be distributed to the relevant parties while ensuring that confidentiality is maintained.

\*Basel Committee on Banking Supervision, January 2013, "Principles for effective risk data aggregation and risk reporting."

scenario parameters that are easily applied to independent model runs. Lack of such scenario consistency will result in important aspects of the diversification across scenarios being lost. In turn, this can destroy a model's ability to determine the volatility of the aggregate results.

Another key requirement is creating an agreed-upon set of report distribution lists, with an eye toward making sure that

reports are provided to all relevant decision-makers (see Principle 11 in Box 7.4). A distribution list also needs to recognize the degree of confidentiality of the information contained within specific sections of the overall report.

In summary, effective reporting capabilities feature routine risk reports having useful information and providing preemptive analyses and dynamic features. A drill down of risk data from these reports can enable rigorous analyses across different risks and be accessed with an easy-to-use interface.

Conversely, ineffective risk reporting capability would have the opposite features (not all are required and this list is far from comprehensive): static/inflexible, lacking ability to answer even simple drill down questions, and difficult to understand.

## CONCLUSION

The original goal of the Basel Committee was to ensure that firms developed strategies to meet the BCBS 239 principles by 2016. However, we still have a long way to go.

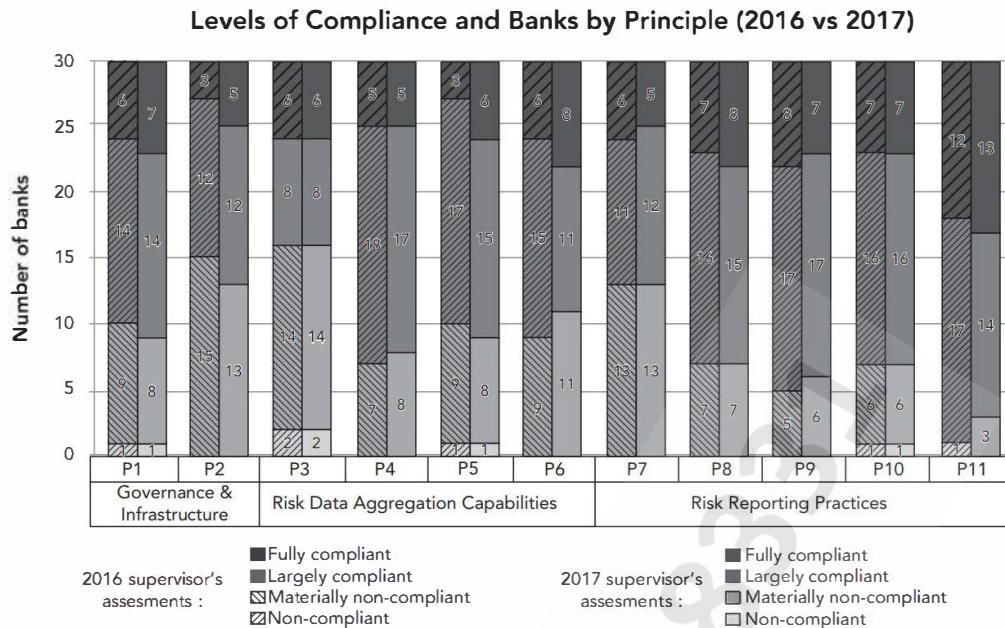
The Risk Data Network (RDN) periodically releases progress reports on implementation of the BCBS 239 principles.<sup>31</sup> In these reports, supervisors rate firms' current performance on achieving compliance with the RDARR principles (see the appendix for details). These ratings are affirmed by a 2016 survey conducted by McKinsey & Company and the Institute of International Finance (IIF)—which revealed that despite significant investments, banks are still struggling to comply with the principles.<sup>32</sup>

A study from PwC showed higher performance for compliance with Principles 7–11 (risk reporting) compared to Principles 3–6 (data aggregation). Meanwhile, Principles 1 (governance) and 2 (data architecture and infrastructure) have poor compliance rates.

Although these principles are focused on internal risk reporting, some supervisors have indicated regulatory and stress-testing results would also help to inform the process when assessing bank compliance. More recently, the European Central Bank has stated that financial and regulatory reporting is part of BCBS 239 compliance. Though many banks have asked, regulators have not come forward with clearer guidelines for compliance.

<sup>31</sup> The Working Group on SIB Supervision (WGSS) was transformed into the RDN in early 2016 with a stronger focus on supervisory evaluations.

<sup>32</sup> H. Harreis, A. Tavakoli, T. Ho, J. Machado, K. Rowshankish, and P. Merrath, (2017, May). "Living with BCBS 239." Retrieved from <https://www.mckinsey.com/business-functions/risk/our-insights/living-with-bcbs-239>



**Figure 7.1** Levels of compliance with RDARR principles.

Source: Progress in Adopting the Principles for Effective Risk Data Aggregation and Risk Reporting, June 2018, Basel Committee on Banking Supervision. Reprinted by permission of the Bank for International Settlements.

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
<b>2017</b>	2.90	2.73	2.60	2.90	2.87	2.90	2.73	3.03	3.03	2.97	3.33
<b>2016</b>	2.83	2.60	2.60	2.93	2.73	2.90	2.77	3.00	3.10	2.97	3.37
<b>Change</b>	0.07	0.13	0	-0.03	0.13	0	-0.03	0.03	-0.07	0	-0.03

**Figure 7.2** Internal bank gap analysis.

## BOX 7.6 PRINCIPLES 12 TO 14\*

### Principle 12:

**Review**—Supervisors should periodically review and evaluate a bank's compliance with the eleven Principles above.

### Principle 13:

**Remedial actions and supervisory measures**—Supervisors should have and use the appropriate tools and resources to require effective and timely remedial action by a bank to address deficiencies in its risk data aggregation capabilities and risk reporting.

### Principle 14:

**Home/host cooperation**—Supervisors should cooperate with relevant supervisors in other jurisdictions regarding the supervision and review of the Principles, and the implementation of any remedial action if necessary.

\*Basel Committee on Banking Supervision, January 2013,  
"Principles for effective risk data aggregation and risk reporting."

The regulators continue to emphasize that ascertaining compliance with BCBS 239 is a subjective exercise and that the standards for each bank are accordingly bespoke.

## APPENDIX

### Compliance Levels of 30 Banks

In Figure 7.1, the small changes in the average compliance ratings (on scale of 1 to 4) with BCBS 239 between 2016 and 2017 illustrate the minimal progress observed in the Principles' implementation. The scale ranges from being "fully compliant" (a rating of 4) to "non-compliant" (a rating of 1). The scores for the  $i$ th Principle are shown in Figure 7.2. For example, Principle 1 was rated 2.83 in 2016 and 2.90 in 2017.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## QUESTIONS

---

**7.1** BCBS 239 concerns

- A. conducting scenario analysis.
- B. liquidity requirements in banks.
- C. how to deal with data in a bank.
- D. details of how to implement the Graham-Dodd Act

**7.2** Is the following statement True or False?

The original timeline to achieve full compliance with BCBS 239 was not met by any bank.

- A. True
- B. False

**7.3** Is the following statement True or False?

There is a uniform blueprint in place for BCBS 239 compliant infrastructures.

- A. True
- B. False

**7.4** Is the following statement True or False?

An additional requirement that has emerged since the original BCSBS 239 principles were published is the expectation that BCBS 239 principles should also apply to banks' regulatory reporting.

- A. True
- B. False

**7.5** Please provide an example of compliant risk data governance in BCBS 239.

**7.6** Please provide an example of effective risk reporting in BCBS 239.

**7.7** Why was the original timeline to achieve full compliance with BCBS 239 not met by any bank?

**7.8** What are the characteristics of a strong risk data aggregation capability?

**7.9** Explain how model risk is affected by data quality.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## ANSWERS

### 7.1 C. how to deal with data in a bank.

The principles and supervisory expectations outlined in BCBS 239 apply to risk management data and models. These principles cover governance/infrastructure issues, risk data aggregation procedures and needs, reporting, and considerations for supervising authorities.

### 7.2 True

Banks have struggled to comply with BCBS 239 and the original timeline to achieve full compliance was not met by any bank.

### 7.3 False

Solutions are specific to the individual institution.

### 7.4 True

The European Central Bank has stated that financial and regulatory reporting is part of BCBS 239 compliance.

### 7.5 Policies are in place that set "out a clear delineation of roles, incentive schemes, and responsibilities for risk data management (including dedicated staff responsible for defining risk data expectations)."<sup>33</sup>

### 7.6 Effective reporting capabilities feature routine risk reports having useful information and providing

preemptive analyses and dynamic features. A drill down of risk data from these reports can enable rigorous analyses across different risks and be accessed with an easy-to-use interface.

### 7.7

- The underestimation of the compliance efforts required due to the complexity of the problems,
- The exponential increase in the application of AI techniques on large data sets, and
- Cost considerations.

### 7.8

- To ensure accurate and reliable risk data,
- To capture and aggregate all material risk data (completeness),
- To Produce aggregate risk information on a timely basis (timeliness), and
- To Generate ad hoc reports on data and risk analyses in response to management needs (adaptability).

### 7.9

The quality of any model is heavily dependent on the accuracy of the input data. If the quality of data that feeds the model is garbage, then the adage garbage-in, garbage-out applies. Data errors can significantly alter estimated model parameters.

<sup>33</sup> Basel Committee on Banking Supervision, January 2013, "Principles for effective risk data aggregation and risk reporting."



# 8

# Enterprise Risk Management and Future Trends

## ■ Learning Objectives

After completing this reading, you should be able to:

- Describe Enterprise Risk Management (ERM) and compare an ERM program with a traditional silo-based risk management program.
- Describe the motivations for a firm to adopt an ERM initiative.
- Explain best practices for the governance and implementation of an ERM program.
- Describe risk culture, explain the characteristics of a strong corporate risk culture, and describe challenges to the establishment of a strong risk culture at a firm.
- Explain the role of scenario analysis in the implementation of an ERM program and describe its advantages and disadvantages.
- Explain the use of scenario analysis in stress testing programs and capital planning.

## 8.1 ERM: WHAT IS IT AND WHY DO FIRMS NEED IT?

Earlier chapters of this book have focused on specific risk types (e.g., credit risk, market risk, or operational risk). This approach has also been adopted by banking regulators, who require banks to hold minimum capital against credit, market, and operational risk (e.g., Pillar I of Basel III).<sup>1</sup> Looking at risk within risk types and specific business portfolios makes it easier to:

- Define and measure risk (e.g., most financial models deal with specific risks),
- Aggregate risk within business lines, and
- Determine whether to retain risk or partially/fully hedge risk
- Use derivative instruments (if hedging risk), which tend to be risk specific.

However, it is also important to compare exposures to one another. Doing so allows firms to prioritize risk management and understand how risk-type and business line exposures add up to their total exposure. At the enterprise level, risks may negate each other (e.g., through netting<sup>2</sup> and diversification) or exacerbate each other (e.g., through risk concentrations, contagion, and cross-over risks).

### BOX 8.1 CROSS-OVER RISKS—THE NORTHERN ROCK EXAMPLE

A perceived weakness in one risk management area (e.g., credit risk) can reveal weakness in another area (e.g., funding liquidity). Northern Rock discovered this to its detriment during the initial stages of the 2007–2009 global financial crisis.

The fast-growing bank had developed a strategy that left it highly dependent on investors and wholesale markets—rather than customers' deposits—for its funding. It tried to manage this funding concentration risk by diversifying geographically beyond its home market in the United Kingdom by tapping funding markets in continental Europe and the United States.

However, that approach left the institution vulnerable to the global storm in funding markets that erupted when investors began shunning banks perceived as having risky lending strategies (as we discussed in Chapter 5). Northern Rock officials later claimed that this kind of global funding market shutdown was "unforeseeable."

Source: House of Commons, Treasury Committee, "The Run on the Rock," January 2008, p. 16.

Enterprise risk management (ERM) applies the perspective and resources at the top of the enterprise to manage the entire portfolio of risks and account for them in strategic decisions.<sup>3</sup> ERM improves the traditional risk management approach, popularly referred to as silo-based risk management or stove-pipe risk management, by giving senior management an integrated, enterprise-level view of risk. Under silo-based risk management, the risks of an organization are managed at the business unit level. ERM offers an important supplement to the more limited perspective available from specific business lines or risk-type functions. It also focuses attention on the largest threats to a firm's survival and core functionality.

Another important feature of ERM is that it supports a consistent approach to enterprise risks throughout a firm, from the boardroom to the business line. This consistency can be achieved through a robust risk culture and an adherence to enterprise risk appetites and governance. Firms that lack this consistency may see one business unit reject an opportunity due to its risk, while similar opportunity is embraced by another unit.

This chapter explains how ERM evolved to help firms manage risk efficiently, identify overlooked enterprise risks, manage risk concentrations, and understand how different risk types interact (Figure 8.1). It also introduces the key ERM dimensions

1. Helps firms define and adhere to enterprise risk appetites
2. Focuses oversight on most threatening risks
3. Identifies enterprise-scale risks generated at business line level
4. Manages risk concentrations across the enterprise
5. Manages emerging enterprise risks (e.g., cyber risk, AML (anti-money laundering) risk, reputation risk)
6. Supports regulatory compliance and stakeholder reassurance
7. Helps firms to understand risk-type correlations and cross-over risks
8. Optimizes risk transfer expenses in line with risk scale and total cost
9. Incorporates stress scenario capital costs into pricing and business decisions
10. Incorporates risk into business model selection and strategic decisions

**Figure 8.1** Top ten benefits of ERM.

<sup>1</sup> Regulators are also concerned with many other risks facing a bank and try to make sure banks consider them by applying Pillar II, the supervisory review process.

<sup>2</sup> For example, a global financial institution will have inflows and/or outflows denominated in some foreign currency. Currency risk in this case is the net exposure from the inflows and outflow.

<sup>3</sup> Enterprise risks, meanwhile, are those risks large enough to make enterprise outcomes fall materially short of enterprise goals.

and tools, including risk culture indicators and enterprise-wide stress testing.

## 8.2 ERM—A BRIEF HISTORY

The need for ERM's holistic approach to risk seems almost self-evident, so why is it still a work in progress? The answer lies in the difficulty of the task and in how risk management has evolved at the firm and industry levels.

Risk management is usually fully integrated within small firms, even if it is not necessarily well developed. But as firms grow, they create specialist risk functions to improve their management of specific risks. (This is what was discussed in earlier chapters.)

These risk types may initially be managed independently of one other, with some firms operating separate risk management functions across their lines of business. Over time, firms may try to move beyond this siloed risk management structure. For example, they may bring their risk managers together to improve risk management skills, ensure all key risks are covered, and increase purchasing power in the risk transfer markets.<sup>4</sup>

This kind of enterprise-level rationalization became more urgent after a wave of financial market liberalization in the 1970s increased price volatilities and created new derivative instruments across interest rate, commodities, foreign exchange, and other markets. By the 1990s, financial institutions realized that they needed to manage their derivatives portfolios and underlying economic exposures in a more integrated fashion.

First banks, and then large corporations, began to build global risk management divisions. They appointed chief risk officers (CROs)—responsible for all types of risk—and began to use universal risk metrics (e.g., Value-at-Risk (VaR)) to compare and aggregate risks across the firm.

<sup>4</sup> A precursor example is the growth of the specialist insurance purchaser in US corporations and the evolution of this role into a more integrated enterprise-level insurance “risk manager” during the 1950s and 1960s. During this period, large U.S. corporations began to centralize and rationalize insurance purchases, hitherto spread over many business divisions and activities. Pooling risk with other entities through an insurer can be an expensive way to transfer risk for firms with good claims records. The “top-of-the-firm” perspective made it clearer that larger firms could choose between transferring an insurable risk to an external insurer or using their own capital to cover a portion of the risk through the use of self-insurance, captive insurance companies, and similar mechanisms. Setting up a captive to retain risk meant understanding—rather than outsourcing—the risk and incentivized firms to capture risk data. This in turn spawned new ideas about how to mitigate risk at the business line level. The term “risk manager” first began to be used in relation to this widened role of the corporate insurance purchaser. Though insurance risk managers had a very different role to that of today’s bank risk manager, there is one striking parallel: integrating risk management at the enterprise level changed how the firm saw and managed risk.

In the mid-1990s, derivatives disasters (e.g., Barings Bank) showed how institutions lacking robust risk management frameworks could be destroyed by one out-of-control individual. At the same time, banks expanded the scope of credit risk management from a focus on the credit ratings of obligors to the active management of enterprise credit portfolios (e.g., through the use of credit derivatives).

By the late 1990s, banks had begun to track and measure operational risks. At the same time, some institutions began trading new types of transferable risk (e.g., weather risk and political risk). In the same way that VaR had helped firms build an overall perspective of market risk, new global risk committees and risk transfer tools helped firms to build an overarching perspective of enterprise risk across business lines and risk types.

In the early days of global risk management, many firms had trouble setting up integrated ERM programs across large enterprises. Then, as now, firms preferred to devolve responsibility for risk to the business line (where risk can be controlled at the source). However, firms keep coming back to ERM because managing risk demands a portfolio management perspective.

By the early 2000s, some of the benefits of an ERM view were beginning to be realized (Table 8.1). However, the global financial crisis of 2007–2009 revealed many weaknesses in risk management practices. Among these included

- A failure to properly apply aggregate risk measures,
- An inability to identify enterprise risk concentrations across business lines, and
- An inability to see risks within certain business models.

The years following the crisis saw a greater regulatory emphasis on ERM tools such as risk appetite and risk capacity (Chapters 2 and 3), data aggregation and reporting (Chapter 7), enterprise-level scenario analysis, and risk culture (the latter two being key topics in this chapter).

A 2018 survey of 94 financial institutions by Deloitte found that 83% had an ERM program in place, up from 73% in 2016.<sup>5</sup> During that same timeframe, the percentage of financial institutions with a CRO rose to 95%. Despite the increase in the number of CROs, those surveyed felt that there was room for improvement in the reporting relationship and that the CRO should report to both the CEO and to the board. The survey found that 25% of the respondents indicated that the CRO did

<sup>5</sup> Deloitte, *Global Risk Management Survey, 11<sup>th</sup> Edition*, Deloitte Insights.

**Table 8.1** ERM versus Traditional Silo-based Risk Management

Traditional Risk Management	ERM View
Risk viewed in business line, risk-type, and functional silos	Risk viewed across business lines, functions, and risk types, looking at diversification and concentration
Risk managers work in isolation	Risk team integrated using global risk management committee and chief risk officer
Many different risk metrics that cannot be compared (apples to oranges)	Development of rational risk management frameworks and cross-risk universal metrics (e.g., VaR and scenario analysis) to integrate risk view (i.e., apples to apples)
Risk aggregated, if at all, within business lines and risk types. Difficulty seeing the aggregate risk picture	Tools and integrated frameworks make it possible to more accurately measure and track enterprise risk. Potentially, risk is aggregated across multiple risk types.
Each risk type managed using risk-specific transfer instruments	Possibility of cutting risk transfer costs firm-wide and integrated (e.g., multi-trigger) instruments
Each risk management approach (e.g., avoid/retain/mitigate/transfer) often treated separately, with strategy rarely being optimized.	Each risk management approach is viewed as one component of a total cost of risk, ideally measured in a single currency. Component choice is optimized as far as possible in risk/reward and cost/benefit terms expressed in that currency.
Impossible to integrate the management and transfer of risk with balance sheet management and financing strategies	Risk management is increasingly integrated with balance sheet management, capital management, and financing strategies.

not report to the CEO and about half said the CRO did not report to the board of directors or even a sub-set of the board.

In addition to data and IT system issues, the three issues that more than half the respondents cited as being extremely urgent or a high priority for their institution's ERM program were: (1) managing increasing regulatory requirements and expectations, (2) collaboration between the business units and the risk management function, and (3) establishing and embedding the risk culture across the enterprise.<sup>6</sup>

### 8.3 ERM: FROM VISION TO ACTION

So far, this chapter has covered ERM's evolution and basic goals. But how is ERM organized in practice?<sup>7</sup> This depends a lot on the size and type of firm, but it helps to think of ERM practices across five dimensions (Table 8.2).

1. **Targets:** These include the enterprise's risk appetite and how it relates to its strategic goals (discussed in Chapter 2).

<sup>6</sup> Ibid., p. 8.

<sup>7</sup> In organizational terms, ERM programs are often implemented through the senior management risk committee. Other risk committees, such as the Credit Risk committee, may adopt ERM initiatives. Meanwhile, some non-financial firms that lack elaborate risk committee structures may set up ERM committees that help coordinate ERM activities with their respective business lines.

**Table 8.2** Five Key ERM Dimensions

ERM Dimension	Examples
<b>Targets</b>	Enterprise goals: Enterprise risk appetite, enterprise limit frameworks, risk-sensitive business goals and strategy formulation
<b>Structure</b>	How we organize ERM: Board risk oversight, global risk committee Risk Officer; ERM subcommittee; reporting lines for ERM; reporting structures
<b>Metrics</b>	How we measure enterprise risk: Enterprise-level risk metrics, enterprise stress testing, aggregate risk measures (Value-at-Risk, Cash-Flow-at-Risk, Earnings-at-Risk, etc.), "total cost of risk" approaches, enterprise level risk mapping and flagging, choice of enterprise-level risk limit metrics
<b>ERM Strategies</b>	How we manage ERM: Enterprise level risk transfer strategies, enterprise risk transfer instruments, enterprise monitoring of business line management of enterprise-scale risks
<b>Culture</b>	How we do things: "tone at the top", accountability for key enterprise risks, openness and effective challenge, risk-aligned compensation, staff risk literacy, whistle-blowing mechanisms

Risk appetite is linked to operational mechanisms, such as global limit frameworks and incentive compensation schemes. One goal of ERM is to set the right targets and make sure they are not in conflict with other strategic goals.

- 2. Structure:** The organizational structure of an ERM program includes the role of the board, the global risk committee and other risk committees, the CRO, and the corporate governance framework described in Chapter 3. The goal of ERM is to make each structure sensitive to the enterprise-scale risks faced by the firm, including indirect losses.
- 3. Identification & Metrics:** No amount of thoughtful target setting or ERM reorganization will help if a firm cannot identify enterprise-scale risks and measure their severity, impact, and (ideally) frequency. This chapter discusses key ERM metrics such as enterprise-level scenario analysis and stress testing. Other metrics include aggregate risk measures such as VaR, total-cost-of-risk methodologies, risk-specific metrics, and whole-of-firm risk mapping and flagging mechanisms. Here, the goal of ERM is to make sure the firm has the right family of metrics to capture enterprise risks.
- 4. ERM strategies:** Firms also need to articulate specific strategies for managing enterprise-scale risks at either the enterprise level or through the business lines. This includes the fundamental decisions to avoid, mitigate, or transfer risks, along with the choice of enterprise risk transfer instruments.
- 5. Culture:** If targets, structure, and metrics are the bones of the ERM strategy, then culture is the flesh and blood. In short, a strong risk culture is built from a pervasive sense of common goals, practices, and behaviors.

It is tempting to rank a firm's commitment to ERM in terms of identifiable ERM attributes across these five dimensions.

However, the success of ERM is governed by the how these five dimensions interact with each other. For example, appointing a CRO might either lead to important improvements in enterprise stress testing or be a cynical re-badging exercise that changes nothing. Meanwhile, an improvement in stress testing and other risk metrics might not lead to improvements in risk management if a firm lacks a healthy risk culture.

Furthermore, many ERM programs that look well established may not be comprehensive. For example, surveys suggest that only around half of CROs review the impact of compensation plans on a firm's risk appetite and culture—arguably a critical ERM function.<sup>8</sup>

The true test for ERM is whether its growing adoption leads to a decrease in negative surprises and mishaps. So far, empirical

<sup>8</sup> Deloitte, *Global Risk Management Survey*, 10<sup>th</sup> edition; p. 6 and p. 18. The Deloitte survey is available at <https://www2.deloitte.com/insights/us/en/topics/risk-management/global-risk-management-survey.html>

research has yielded ambiguous results. Some researchers have identified positive results from adopting ERM (e.g., in terms of bank default swap spreads),<sup>9</sup> while others have so far failed to find evidence of tangible benefits.

The ambiguity in the research data probably stems from the difficulty in identifying empirical markers of successful ERM adoption and the relatively short time series available to researchers. In addition, ERM is continually evolving. For example, there has been a much greater emphasis placed on risk culture in the years since the crisis.

In the years ahead, the financial industry will continue to gather data and refine its methodology for back-testing the results of ERM adoption.

## 8.4 WHY MIGHT ENTERPRISE RISK DEMAND ERM: FOUR KEY REASONS

Perhaps the most important argument for ERM is that an enterprise-level perspective is the best way to prioritize risks and optimize risk management.<sup>10</sup> A risk that looks minimal at the business line level can develop into a threat to the whole enterprise. Conversely, a risk that looks threatening at a business line level might look trivial in the context of the diversified enterprise risk portfolio.

### Top to Bottom—Vertical Vision

Large risks often begin their life a long way from the board room. As an example, consider the case of a car manufacturer. Suppose that a poor design or sourcing decision is made, and a potentially dangerous car part is installed. The risk is engineered into countless cars and therefore threatens the enterprise, its suppliers, and their insurers through recall and compensation costs, lost sales, and reputational harm.

We can see something similar happening in the "product factories" of financial institutions. For example, misconduct issues have plagued large financial firms in recent years. In these firms, selling a poor investment product may not seem like a critical threat at the business line level when the business is young. As the business grows, however, that threat can rise dramatically over time.

<sup>9</sup> S. A. Lundqvist and A. Wilhelmsson, "Enterprise Risk Management and Default Risk: Evidence from the Banking Industry," *Journal of Risk and Insurance* 85 (1), 2018, 127–157, with a discussion of the literature around ERM and value creation on pp. 130–132. See also M. K. McShane, A. Nair, and E. Rustambekov, "Does Enterprise Risk Management Increase Firm Value?" *Journal of Accounting, Auditing and Finance*, 26, 2011, 641–658.

<sup>10</sup> See B. W. Nocco and R. M. Stulz, "Enterprise Risk Management: Theory and Practice," *Journal of Applied Corporate Finance* 18 (4), 2006, 8–20.

For both financial and non-financial firms, the remedy might be something simple (e.g., tweaking the design or spending marginal amounts on better components) or something painful (e.g., closing a product line and firing the line manager). It might also mean recognizing that the risk is being driven by poor target setting by senior management. Whatever the remedy, ERM is the process of:

- Recognizing the potential threat to the whole enterprise arising from the risky design/production decision, and
- Picking up on early signs that things are going wrong to reduce the leveraging effect of time.

ERM brings risk decisions, across time and space, in line with the enterprise's stated risk appetite.<sup>11</sup>

During the global financial crisis of 2007–2009, many firms found themselves with concentrations of mortgage risk in both specific geographies and risky product types (e.g., negative amortizing mortgages).

Firms cannot always avoid concentrations. For example, insurers and bankers have been wary of concentrating their key systems, infrastructure, and data with cloud computing providers. However, large security investments made by cloud providers mean that going to the cloud could offer one way to manage cyber risk and strategic technology risk. Firms must manage such risk tradeoffs.

Ultimately, ERM includes the recognition and management of concentration risks according to a firm's risk appetite.

## Are There Potentially Dangerous Concentrations of Risk within the Firm?

Line managers look after specific business lines and therefore it can be difficult for them to spot risk concentrations across the enterprise. Credit concentrations, for example, are the big red lever of the credit portfolio. If a bank loans too much to one person (i.e., name concentration), the bank risks a significant loss. If too many borrowers belong to the same industry, a sector downturn could wreak havoc to the loan portfolio.

Hidden concentrations often build up across many different businesses because line managers cannot see the connections. In banking, for example, an institution may lend to one firm in its corporate loan division and then create a counterparty exposure with the same firm in its derivatives division. Many kinds of concentration risk can creep across enterprises. Examples include the following.

- *Geographical and industry concentrations.* Examples include where a manufacturer's production facilities or a bank's core IT is located within a given region, or where a financial firm is over-exposed to default risk in a local economy or type of industry.
- *Product concentrations.* For example, a derivative or retail product might be mispriced in multiple divisions.
- *Supplier concentrations.* An example would be a firm that has too great of a dependency on a link in its global supply chain or, in the case of financial institutions, on technology suppliers or data/risk analysis providers.

## Thinking Beyond Silos

Conversely, there are major diversification benefits that can only be understood at the enterprise level, particularly in terms of risk type.

Acknowledging risk-type diversification reduces the aggregate risk capital a firm needs to hold. It also helps to transform "badly behaved" risk portfolios, including many kinds of operational risk, into loss distributions closer to that of a normal distribution (Figure 8.2).

At the same time, thinking beyond silo-based risk management helps firms to understand how risk types can interact to worsen enterprise threats. For example, enhanced consumer protection in the United States since the global financial crisis has created significant cross-over risks between credit risk, legal risk, and reputational risk. As a result, banks are under growing pressure to make sure they are not deceiving or misleading customers or engaging in abusive acts.

Likewise, ERM can help firms understand how risk can cross over between risk types during times of stress (as noted in Box 8.1).

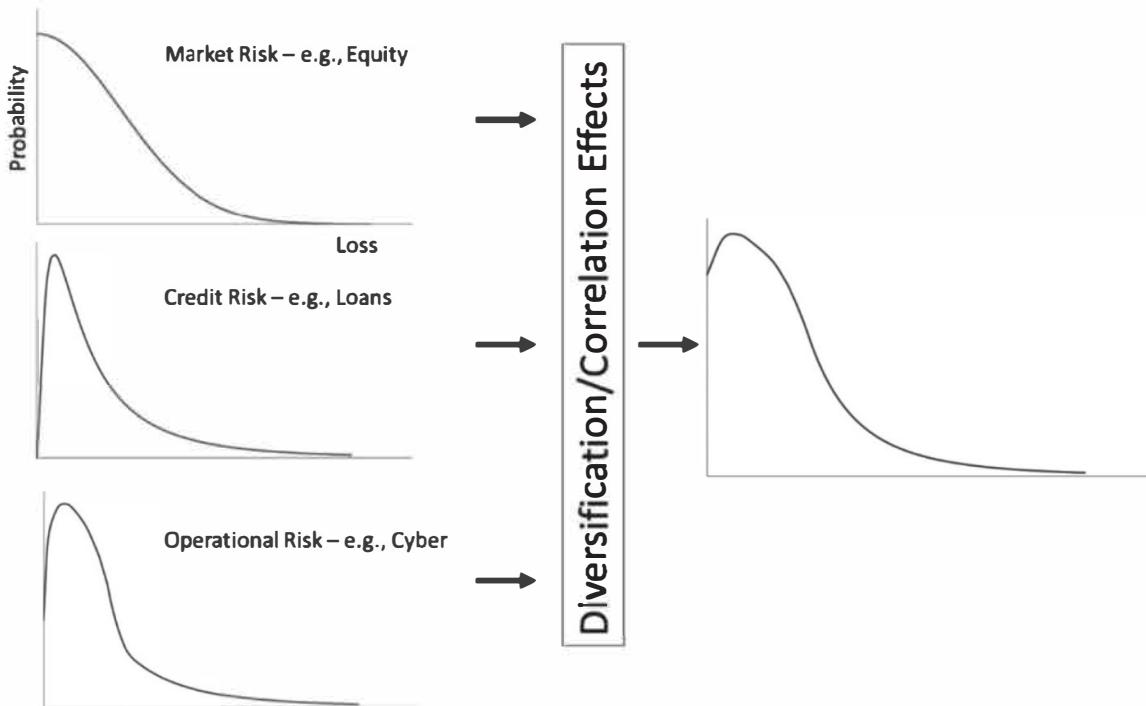
## Risk Retention Decisions: Self-Insurance and Captive Insurance

Consumers are nearly always right to turn down offers of insurance for inexpensive goods. For example, if a kettle catches fire, it is the home insurance they need to worry about and not the replacement cost of the kettle.

Firms have been applying the same logic at the enterprise level since the 1960s by using mechanisms such as selfinsurance and captive insurance<sup>12</sup> to retain portions of property, liability, and

<sup>11</sup> One complication is that business line short-term priorities are often set at the top of the firm. For example, the business line might be trying to save money on product components to boost its reported profit margin. It might be trying to make headquarters' sales targets, through whatever means. ERM is therefore also about managing agency risk and the firm's risk culture, including how to build structures within the firm that balance the need for aggressive short-term goals against the need to stay in line with long-term risk appetite.

<sup>12</sup> A captive insurance company (or simply captive insurer) is an insurance company that is wholly owned and controlled by its insured(s), which is/are one or more non-insurance firms. Captive insurance is an alternative to self-insurance.



**Figure 8.2** The enterprise risk portfolio generates diversification benefits.

other risks. Note that around 20% of firms with between USD 1 billion and USD 5 billion in revenue have a captive insurance unit; that percentage rises to over 50% for firms with at least USD 10 billion in revenue.<sup>13</sup> Risk retention decisions are best made at the enterprise level, where the aggregate level of risk exposure can be understood.

The process of understanding an enterprise risk and then managing a portion of it in-house is happening again today with cyber risk. So far, only around 12% of firms using captives employ them to provide cyber coverage. However, 23% of them plan to do so by 2020.<sup>14</sup> This growth will be driven by firms improving their understanding of cyber risk, such as through enterprise risk assessments of cyber dependencies and vulnerabilities, and then applying quantitative metrics to assess the financial impact of cyber events.

This demonstrates a general truth: firms that understand enterprise risk can translate this understanding into dollar savings (Figure 8.3). The process is most obvious in the case of insurable risks,<sup>15</sup> but it is true for financial risks as well. As firms

understand their true exposures (i.e., considering enterprise netting and diversification effects) they can retain the right level of exposure and target resources towards the real, enterprise-threatening risks.

## 8.5 THE CRITICAL IMPORTANCE OF RISK CULTURE

Risk culture can be thought of as the set of goals, values, beliefs, procedures, customs, and conventions that influence how staff create, identify, manage, and think about risk within an enterprise, including implicit and explicit beliefs. Another well-known definition is that “risk culture can be defined as the norms and traditions of behavior of individuals and of groups within an organization that determine the way in which they identify, understand, discuss, and act on the risks the organization confronts and the risks it takes.”<sup>16</sup>

Risk culture sounds intangible, but a strong risk culture is a firm’s surest handle on ERM<sup>17</sup> in the same way that

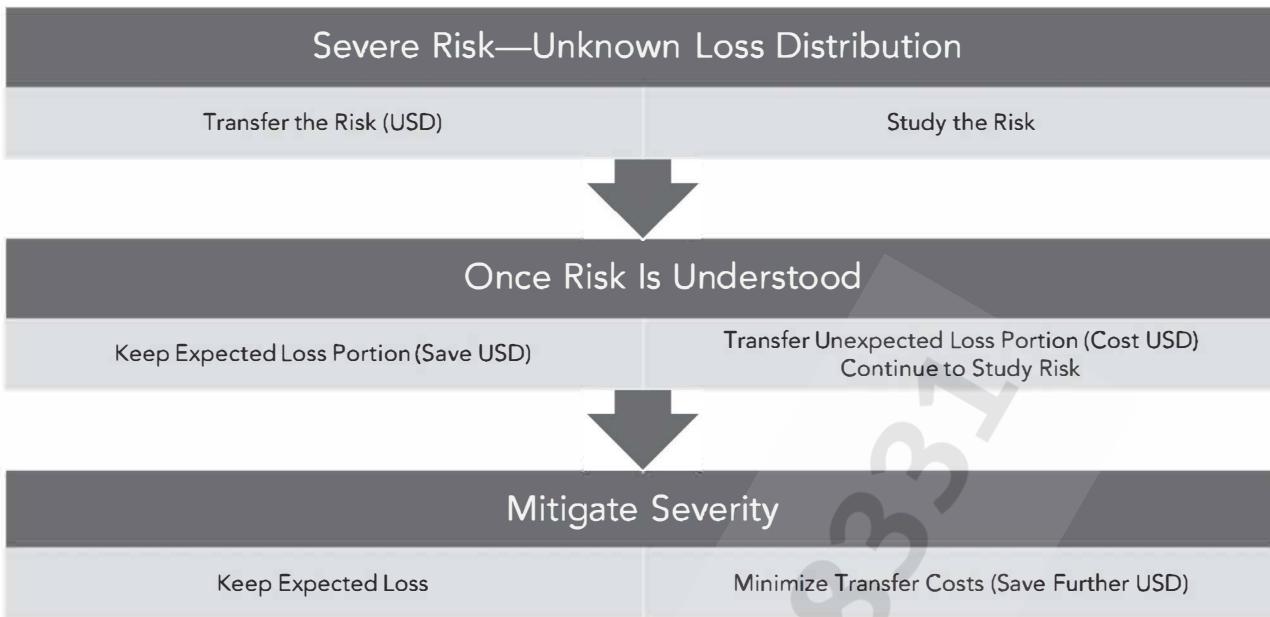
<sup>13</sup> Aon Risk Solutions, *Global Risk Management Survey 2017*, p. 92. Captives also help firms to centrally gather information about their risks, check their risk taking against their risk appetite, and to build more effective risk management across multiple business lines and activities.

<sup>14</sup> Aon Risk Solutions, *Global Risk Management Survey 2017*, p. 89.

<sup>15</sup> An insurable risk is a risk where the insurer can calculate the potential future losses or claims. A risk where the insurer cannot calculate the potential losses or claims is a non-insurable risk.

<sup>16</sup> See IIF, Reform in the Financial Services Industry: Strengthening Practices for a More Stable System, December 2009, Appendix III. Various definitions by unnamed banks are provided in APRA, “Risk Culture,” Information Paper, October 2016, p. 15.

<sup>17</sup> O. Karlsson et al., “Are CEOs Less Ethical Than in the Past?,” *Strategy+Business*, issue 87, May 15, 2017: <https://www.strategy-business.com/feature/Are-CEOs-Less-Ethical-Than-in-the-Past?gko=50774>



**Figure 8.3** Understanding enterprise risk saves money—and enterprises.

a strong safety climate minimizes accidents in physical industries.<sup>18</sup>

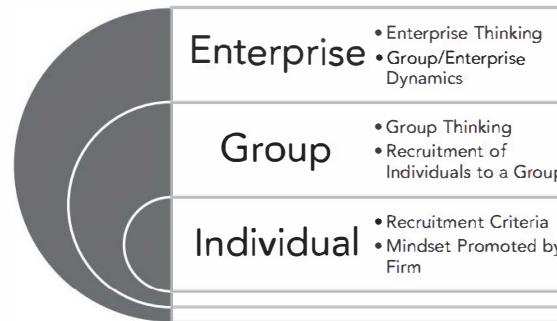
In the aftermath of the global financial crisis of 2007–2009, supervisory reports focused on risk culture as a driver of risk management failure in large financial institutions. Other culture-driven scandals emerged in the post-crisis years, including the mis-selling of consumer financial products (e.g., the UK payment protection insurance scandal), the manipulation of financial markets (e.g., Libor manipulation), money laundering, and embargo breaches.

The banks involved in these scandals paid massive penalties and suffered discounting on their share prices while litigation continued.<sup>19</sup> It is therefore not surprising that around 70% of surveyed financial institutions say that establishing and embedding risk culture across the organization is a high priority.<sup>20</sup>

Risk culture is a difficult to address because it is multilayered (Figure 8.4). Individuals arrive at an enterprise with their own

risk mindsets that are driven by their personalities, demographics, professional standards, personal experiences, and so on. They then absorb many of the risk-related behaviors and practices of their local group (e.g., business line sales targets) and make risk decisions as part of that local social environment.

In turn, this can lead to a gap between the stated targets of the organization (e.g., risk appetite and values) and behavior by its employees. This behavior may be driven by short-term or self-centered goals, with rules being broken or side-stepped. Furthermore, it is not easy to improve risk culture across the whole enterprise if a firm has no way to assess its progress.



**Figure 8.4** Risk culture is a series of overlapping layers.

**Table 8.3** Risk Culture—Illustrative Key Risk Culture Indicators

Indicator	Trend Tracking
Leadership Tone	Does board and executive compensation support the firm's core values? Do management's actions support or undermine the risk message? Can the board be shown to monitor and communicate how business strategy fits with risk appetite?
Accountability and Risk Monitoring	Are there clear expectations on monitoring and accountability for key risks? Are escalation processes used?
Openness and Effective Challenge	Is there evidence that opposing views from individuals are valued? Are there regular assessments of "openness to dissent"? Is risk management given stature?
Risk-Aligned Compensation	Are compensation and performance metrics supportive of the firm's risk appetite and desired culture?
Risk Appetite Knowledge	Do key staff members know the firm's enterprise risk appetite? Can they answer straightforward questions about its application to business decisions?
Risk Literacy/Common Language	Do staff use a common language to describe risk and its effects? Are training programs available and attended?
Risk Information Flows	Can the firm see information flowing up and across the firm in a way that captures and highlights enterprise-scale risks? And is there a clear link to specific discussions and decisions?
Risk/Reward Decisions	Has the firm tested whether senior executives respond to benchmark risk/reward questions consistently with each other and with the firm's risk appetite?
Risk Stature	Do the key ERM staff have the right stature and direct communication with the Board? Who hires and fires them?
Escalation and Whistle Blowing	Do key staff members understand when and how they can escalate a suspected enterprise risk? When were escalation procedures last used? Is there a whistle-blowing mechanism and is it used?
Board Risk Priorities	Can the board name the top ten enterprise risks faced by the firm? Can it name the key industry disasters associated with these risks?
Action Against Risk Offenders	Has the firm disciplined employees who have acted against its risk appetite and ethical stance? Does the staff believe action will be taken even if a risk violation leads to a profit rather than a loss?
Risk Incident and Near Miss Responses	Can the firm show how it has identified culture issues in risk incidents and the measures taken in response?

### Measuring a Mindset

Financial firms are increasingly expected to be able to form a view of risk culture within their institutions and of the degree to which their risk culture helps them adhere to their risk appetites.<sup>21</sup> One approach is to identify what are called *key risk culture indicators*.

In an effort to reduce the risk posed by systemically important financial institutions, the Financial Stability Board (FSB) has specified<sup>22</sup> four key risk culture indicators:

1. Accountability,
2. Effective communication and challenge,
3. Incentives, and
4. Tone from the top.

Table 8.3 builds on this to offer a longer series of indicators for discussion purposes. Some of these are informal and clearly cultural (e.g., encouraging openness in risk dialogue). Others are really part of a firm's organizational structure, but still signal a healthy environment (e.g., a whistle blower needs a way to blow the whistle).

Note that this is a short illustrative list and does not reflect any regulatory checklist. For consistency, the first four items follow (in the broadest terms only) the indicators set out by the FSB.

While firms focus on *internal* culture indicators, the firm's wider environment is also important. Environmental factors driving

<sup>21</sup> See APRA, Risk Culture, Information Paper, October 2016, p. 5, and FSB, Guidance on Supervisory Interaction with Financial Institutions on Risk Culture, 7 April 2014, p. 5.

<sup>22</sup> These are not meant to be exhaustive. FSB, Guidance on Supervisory Interaction with Financial Institutions on Risk Culture, 7 April 2014, p. 5.

**Table 8.4** External Risk Culture Drivers

External Drivers—Examples
Economic cycles (e.g., credit cycle, industry cycle)
Industry practices/guidelines
Professional standards
Regulatory standards
Country risk/corruption indices

risk culture may include industry norms, professional norms, and even phenomena such as credit cycles (Table 8.4).

Many firms have begun systematically assessing culture using risk culture indicators and other internal evidence (e.g., surveys, interviews, and focus groups with staff).<sup>23</sup> For example, surveys may ask staff how they rate the risk culture of their business line with regard to certain key characteristics, and how they and their colleagues behave in regard to risk/control decisions.

There are methodologies for transforming questionnaire results and other sets of quantitative key risk culture indicators into an overall risk culture score. However, while these indicators track changes in the quality of risk culture, they do not quantify the size of the losses associated with risk culture failings.

Some supervisors are digging deeper. For example, the Netherlands' DNB has conducted a series of detailed assessments of individual financial institutions on topics related to risk culture using insights from organizational psychologists, among other experts. The exercise brought to light "fundamental risks . . . in behavior and culture" in 34 of 54 assessments between 2010 and 2015.<sup>24</sup>

<sup>23</sup> One example of the application of questionnaires and focus groups to gauge key characteristics related to risk culture can be found in the activities of the UK's Banking Standards Board, a private sector subscription-funded body created to promote high standards of behavior.

A further detailed example of a researcher-driven survey of business line risk culture in three large banks can be found in E. Sheedy and B. Griffin, Empirical Analysis of Risk Culture in Financial Institutions: Interim Report, Risk Culture Project: Macquarie University, version: November 2014.

<sup>24</sup> DeNederlandseBank (DNB), Behaviour and Culture in the Dutch Financial Sector.

A brief survey of how regulators around the world are approaching risk culture can be found in S. Chaly, J. Hennessy, L. Menand, K. Stiroh, and J. Tracy, "Misconduct Risk, Culture, and Supervision, Federal Reserve Bank of New York, December 2017, pp. 12–16.

## Discussion—Five Culture Clashes

There are several problems standing in the way of a robust risk culture.

- 1. Risk indicator or risk lever?** The industry desperately wants to identify risk indicators that can be used to prove it is steadily improving risk culture. But if indicators are used as levers to change behavior (e.g., if survey results affect the performance assessments of senior managers), could the indicators themselves become compromised? It's a lot easier to manage (or manipulate) an indicator than it is to manage risk culture.
- 2. Education for everyone?** Firms can and should create common enterprise languages of risk by defining risk management terms, concepts, and common procedures as well as key ERM roles (e.g., the Board, CRO, and business line leaders).<sup>25</sup> One large financial institution went so far as to create a fictional character in a web-based game to bring risk-taking decisions to life and improve risk communication (which apparently provoked "mixed responses").<sup>26</sup> But so-called education for everyone includes the board. At the end of the day, can the board list the top ten enterprise risks and explain how these relate to the firm's risk appetite?
- 3. Time and space:** Do the same cultural attitudes exist in all parts of the firm and how do they change over time?
  - Empirical evidence suggests risk culture is mainly formed in the local business lines, rather than at enterprise level.<sup>27</sup> It's easy for business lines to develop distinct risk cultures under the example of local team leaders.
  - Conversely, if signs emerge from multiple business lines that something is wrong, (e.g., similar "near misses" in terms of conduct issues), does the firm have mechanisms to pick up these signals? Or are they all dealt with individually?
- 4. Culture cycle:** Arguably, it is only during times of stress that the enterprise's *real* risk culture becomes visible. As a result, risk cultures that look robust today may not survive real-life crises. While regulators want risk managers to carry real weight within firms to withstand this kind of buffeting,

<sup>25</sup> For example, see IFC (World Bank Group), *Risk Culture, Risk Governance, and Balanced Incentives: Recommendations for Strengthening Risk Management in Emerging Market Banks*, 2015, p. 13.

<sup>26</sup> T. Palermo, M. Power, and S. Ashby, "Navigating Institutional Complexity: The Production of Risk Culture in the Financial Sector," *Journal of Management Studies*, 54 (2), 2017, p. 167.

<sup>27</sup> E. Sheedy and B. Griffin, "Empirical Analysis of Risk Culture in Financial Institutions: Interim Report, Risk Culture Project," Macquarie University, version: November 2014, pp. 16–17.

**Table 8.5** Scenario Analysis: Advantages and Disadvantages

Advantages	Disadvantages
No need to consider risk frequency beyond “plausibility”	Difficult to gauge probability of events; does not lead to the quantification of risk
Scenarios can take the form of transparent and intuitive narratives.	Unfolding scenarios can become complex with many choices.
Challenges firms to imagine the worst and gauge the effects	Firms may not stretch their imaginations (e.g., scenarios might underestimate the impact of an extreme loss event or omit important risk exposures).
Can allow firms to focus on their key exposures, key risk types, and the ways in which risk develops over time	Only a limited number of scenarios can be fully developed—are they the right ones?
Allows firms to identify warning signals and build contingency plans	Are they the right warnings and plans, given the scenario selection challenge?
Does not depend on historical data; can be based around either historical events or forward-looking hypothetical events	The scenarios chosen are often prompted by the last major crisis; imaginative future scenarios may be dismissed as improbable.
Firms can make scenario analysis as sophisticated or straightforward as they like, outside regulator defined programs.	Scenario analyses vary in terms of quality and sophistication. Their credibility and assumptions can be difficult to assess.
Stress test results can influence risk appetite, risk limits, and capital adequacy.	Usefulness depends on accuracy, comprehensiveness, and the forward-looking qualities of the firm’s stress test program.

history suggests this weight lessens as memories of the last crisis fade into the past.

**5. Curse of data:** In the years ahead, firms will be able to gather massive amounts of data about risk culture from survey/focus group evidence, risk culture indicator scores, and human resources data (e.g., the number of sick days<sup>28</sup> taken). They can then combine this data with a wider set of risk data to spot patterns. However, managers may need to deploy machine learning technologies to hunt down insights and warning signs in such large data sets.

While scenario analysis may be entirely qualitative, firms are building increasingly sophisticated quantitative models to assess the impact of each scenario on their portfolios and businesses.

Scenario analysis, along with stress and sensitivity testing, have risen to become the preeminent risk identification tools for many ERM programs. This is a result of the weaknesses in probabilistic risk metrics (e.g., VaR) that were revealed by the global financial crisis of 2007–2008.<sup>29</sup>

When markets begin to behave abnormally, risk factor relationships break down to produce market movements and loss levels that seem inconceivable based on VaR calculations. For example, amid market turmoil in August 2007, Goldman Sachs’ chief financial officer David Viniar said that his firm was “seeing things that were 25-standard deviation moves, several days in a row.”<sup>30</sup>

This is where scenario analysis comes in. It helps firms think through the enterprise impact of abnormal events and events for which there is no historical data. But it also has its own set of advantages and disadvantages (Table 8.5).

## 8.6 SCENARIO ANALYSIS: ERM’S SHARPEST BLADE?

Sensitivity testing involves changing one parameter or variable in a risk model to see how sensitive the model result is to the alteration (and thereby identifying key variables). On the other hand, stress testing includes changing one or more key variables to explore risk model results under stressful conditions.

Scenario analysis involves imagining a whole scenario, developing a coherent narrative that explains why the variables change, and assessing the effects of this on the firm’s risk portfolios.

<sup>28</sup> “Sick days” or “sick leave” is time off from work that employees can utilize to address illness or various health issues without losing pay.

<sup>29</sup> See Chapter 1. Moreover, unlike most scenario analysis, it can be difficult to understand why the VaR calculation comes up with a particular VaR number.

<sup>30</sup> P. T. Larsen, “Goldman Pays the Price of Being Big,” August 13, 2007, available at: <https://www.ft.com/content/d2121cb6-49cb-11dc-9ffe-0000779fd2ac>

**Table 8.6** Historical Credit Scenarios—Examples

Historical Credit Scenarios—Examples
1997—Asian crisis
1998—Russian debt moratorium
2001—9/11 market effects
2007—US subprime debt crisis
2008—Lehman Brothers counterparty crisis
2010—European sovereign debt crisis

## Scenario Analysis Before the Global Financial Crisis

Scenario analysis has been a significant risk management tool in banking since well before the global financial crisis. Pre-crisis, banks tended to pick their own short selection of historical and hypothetical scenarios from a list of events (e.g., those listed in Table 8.6) to run against their portfolios.

Judgments are inevitable when building scenarios. For each historical scenario, the bank considers which key variables to apply to its own current portfolios and how far to pursue the narrative. For example, should a simulation of the 1998 Russian debt default event (noted in Table 8.6) also include the related near-collapse of Long-Term Capital Management?<sup>31</sup>

After the crisis, it became apparent that banks often failed to consider factors such as the cumulative exposures across multiple business lines, how different risks interacted with one another, and how the behavior of market participants might change under stress. Regulators also pointed to the mildness of many of the hypothetical scenarios.

## Post-Crisis Trends in Scenario Building

Since the global financial crisis, regulators around the world<sup>32</sup> have begun to insist that larger, systemically important banks demonstrate that they can withstand more severe, dynamic, and realistic scenarios. Regulators in the United States, for example, oblige larger banks to apply regulator-defined macroeconomic stress scenarios—specified in terms of variables such as drops in GDP, employment, equity markets, and housing prices—across their enterprise exposures.

<sup>31</sup> As well as credit scenarios, banks develop scenarios that demonstrate risk across interest rate, equity, foreign exchange, and commodity markets as well as key operational risk events such as cyber attacks, natural catastrophes, or even the effects of a flu pandemic.

<sup>32</sup> For example, the U.S. Federal Reserve and the Bank of England.

The US stress tests began with an initial Supervisory Capital Assessment Program (SCAP), which was conducted in May 2009 as part of the healing process toward the end of the global financial crisis.<sup>33</sup> The results from SCAP helped reassure markets about the stability of the banking system. From 2011 onward, as part of the Dodd-Frank Act, the Federal Reserve began conducting two separate annual stress test exercises:

- Dodd-Frank Act stress tests (DFAST), which are conducted in the middle of the year for all banks with assets above USD 10 billion; and
- Comprehensive Capital Analysis and Reviews (CCAR), which are conducted at the end of the year for banks with assets above USD 50 billion.<sup>34</sup>

DFAST and CCAR apply the same supervisor-devised scenarios. However, DFAST is more prescriptive, applies more limited capital action assumptions, and is less demanding in terms of reporting. Both DFAST and CCAR also oblige banks to generate their own scenarios to complement the supervisory scenarios.

The Federal Reserve generates three supervisor-devised macroeconomic scenarios, that are differentiated by what they are designed to mimic:

- **Baseline:** Corresponds to the consensus forecast among major bank economists,
- **Adverse:** A moderately declining economy, and
- **Severely Adverse:** Severe, broad global recession/depression and an associated decline in demand for long-term fixed-income investment.

CCAR obliges banks to project how these scenarios drive their income statements and balance sheets over a nine-quarter horizon. This complex process requires the dynamic projection of revenues, provisions, credit losses related to defaults and downgrades, management rules for new loan issuances, regulatory ratios, and so on. CCAR firms must also submit detailed capital plans that include:

- Assessments of expected sourcing and use of capital over the planning horizon,

<sup>33</sup> Macroeconomic stress testing first tended to focus on market and credit risk impacts. Banks and other financial institutions are now also often expected to conduct liquidity stress testing and to meet key standards (e.g., the Basel III liquidity coverage ratio).

<sup>34</sup> More precisely CCAR is mandatory for firms designated as either subject to Large Institution Supervision Coordinating Committee Oversight (selected based upon the Fed's judgement that such firms potentially pose "elevated risks" to the US banking system) or "large and complex" firms—the latter defined as (per the US code of Federal Regulations, part 225 section 8) firms that "(1) have USD 250 billion or more in total consolidated assets, (2) have average total nonbank assets of USD 75 billion or more, or (3) are U.S. global systemically important bank holding companies." Altogether, 18 firms participated in the 2018 CCAR exercise.

- Descriptions of the firm's process and methodology to gauge capital adequacy,
- Capital policy, and
- Discussions of any expected business plan changes that are likely to materially impact capital adequacy/liquidity.

For each scenario, banks must show that they maintain minimum capital ratios (Figure 8.5), how they will raise capital if necessary, and their intentions in terms of dividend distribution, share buy-backs, and so forth. For example, one way to hedge potential capital shortages over the planning horizon is to issue contingent convertible bonds (CoCos), which are described in detail in Box 8.2.

- Common equity Tier 1 capital ratio: 4.5%
- Tier 1 risk-based capital ratio: 6%
- Total risk-based capital ratio: 8%
- Tier 1 leverage ratio: 4%

**Figure 8.5 Minimum capital ratios (2018).**

Source: Federal Deposit Insurance Corporation. Regulatory Capital Rules: Regulatory Capital, Implementation of Basel III, Capital Adequacy, Transition Provisions, Prompt Corrective Action, Standardized Approach for Risk weighted Assets, Market Discipline and Disclosure Requirements, Advanced Approaches Risk-Based Capital Rule, and Market Risk Capital Rule.

## BOX 8.2 WHERE DOES ERM END AND CAPITAL PLANNING BEGIN?

This can be a difficult line to draw, as illustrated by contingent convertible bonds (CoCos).

CoCos are bonds issued by a financial institution that are written down or convert into common equity if the firm gets into trouble. The idea is that CoCos ease the bank's obligations and cash outflows when it is in a tight spot. Most existing CoCos focus on accounting triggers (e.g., the level of Tier 1 capital). However, the trigger mechanism could also be some market-based event (e.g., a drop in an institution's share price).

Since the global financial crisis of 2007–2009, regulators have favored CoCos as a shock-absorbing funding instrument. Note that CoCos are effectively a form of insurance (i.e., ERM risk transfer) that can be triggered by a multiplicity of underlying risk events (e.g., credit, operational, and systemic risks). Furthermore, because CoCos become less valuable after a major shock, they can help banks structure risk-sensitive bonuses that increase executive exposure to the downside and therefore potentially lead to an improvement in risk culture. One great advantage of this kind of enterprise risk transfer is that the source of the risk does not need to be defined in advance.

1. CCAR macroeconomic scenarios unfold over several quarters (rather than being simply point-in-time shocks).
2. The scenarios drive a series of interlinked factors covering a variety of risks (e.g., credit risk, market risk, and operational risk).
3. The risk variables are not held static. Therefore, all sorts of underlying risk factors (e.g., probability of default and loss given default) and market impacts (e.g., credit spreads and margining) need to be adjusted as the scenario unfolds.
4. In turn, banks can allow for their capital planning as the scenario unfolds.
5. Importantly, imposing a standard set of scenarios on the largest banks allows regulators to see systemic effects and compare bank risk exposures.

**Figure 8.6 Five key improvements driven by CCAR.**

If a bank cannot show it satisfies minimum capital ratios under stressed conditions, it must review the business plans of its various units and lower its risk appetite.

The complexity of the CCAR exercise dwarfs most banks' historic stress testing programs. In the 2018 exercise, for example, the 28 variables used by the regulators to describe the three scenarios included changes in gross domestic product, the unemployment rate, housing and commercial real estate price indices, stock market volatility (i.e., the VIX), and various interest rate measures (e.g., the three-month Treasury bill rate and BBB corporate bond yields).<sup>35</sup>

For each scenario, banks project the behavior of all risk factors affecting their portfolios over a nine-quarter horizon. These additional risk factors (e.g., the slope of the interest-rate term structure and commodity prices) can number in the hundreds!

It has not been easy for banks in the United States to build scenario analysis programs that meet supervisor objectives. However, the exercises have driven five key ERM improvements (outlined in Figure 8.6). From a regulatory point of view, reactions to each scenario can now be assessed at an industry level to improve the stability of the financial system.

CCAR has also transformed internal bank-driven stress testing. Specifically, banks have had to invest in building an

<sup>35</sup> Federal Reserve, "2018 Supervisory Scenarios for Annual Stress Tests Required under the Dodd-Frank Act Stress Testing Rules and the Capital Plan Rule," February 2018: <https://www.federalreserve.gov/newsreleases/files/bcreg20180201a1.pdf>

infrastructure to generate dynamic projections (e.g., revenue, income, losses from defaults) and to track changes in their balance sheets, key capital ratios, and liquidity ratios. Critically, these exercises have obliged banks to bring many business functions together to discuss and enable the implementation of these tests (which is a key ERM exercise in itself).

## Stress Testing in Europe: Future Directions

Regulators around the world have also developed their own stress testing programs. Some, such as the European Banking Authority (EBA), have seen less immediate success than the authorities in the United States.<sup>36</sup> Compared to the CCAR, the EBA's testing program is more static, less sophisticated, and allows for less latitude in terms of altering risk and business strategies as scenarios unfold. This is because the EBA applies stress tests to a wider range of banks than CCAR.

The big improvements in European stress testing may be driven not by the EBA's supervisor-led stress tests, but by new approaches to bank supervision under the European Central Bank's Supervisory Review and Evaluation Process (SREP). These new approaches will examine how banks explore the sustainability of their business models under stress, including capital and liquidity adequacy, using industry best practices as a guide. Stress testing and scenario analysis will be key tools in this process.

In the years ahead, banks are likely to move away from a limited number of rather deterministic scenario tests toward a much more dynamic-stochastic approach. This approach will apply simulation techniques to explore many different scenarios playing out over time, including macroeconomic and geopolitical shocks.

For example, we can imagine a bank setting out its own core range of macro/geopolitical shocks (e.g., a sharp slowdown in the Chinese economy or a fall in oil prices). These shocks act on risk drivers such as interest rates and credit default swap (CDS) spreads.

The relationship between the scenario and the risk factors can be specified in a variety of ways. For example, the relationship between a shock to oil prices (part of the scenario) and GDP growth rate (a risk factor) might be based on the judgment of business leaders or on statistical analysis of the historical record.

Generating thousands of scenarios will allow each bank to produce a full distribution of outcomes for key performance indicators (KPIs) such as expected profits, regulatory capital, RWAs,

and credit losses. For some purposes, a bank might focus on the average outcome across the simulations (perhaps taken to be the base case scenario). Meanwhile, others might focus on the worst or very worst outcomes (i.e., adverse and severely adverse scenarios).

These simulation results also help banks to conduct reverse stress testing. Specifically, they can identify the full range of worst outcomes (i.e., the tail of the distribution) in terms of bank KPIs. Then they can look at the scenarios that gave rise to these worst-case tail risks and how the shocks turned into losses. This process shines a light on the business lines and portfolios that contribute to a worst-case loss and highlights the risk factors that matter most.

A firm can also identify the worst business environments for specific business lines and look at the sensitivity of various KPIs (e.g., loan losses) to the family of risk drivers.

Many banks around the world continue to regard stress testing as a largely regulatory compliance function. They do not use the results in their day-to-day planning processes.

However, a new generation of stress testing technologies offers banks advantages beyond compliance. Specifically, they can use the results to:

- Specify their risk appetites and limit frameworks,
- Perform a "reasonableness check" on business and capital planning,
- Develop early warning signals, and
- Put in place contingencies to manage credit, funding, and liquidity shocks.

## 8.7 ERM AND STRATEGIC DECISIONS

Enterprise risk managers need to be involved in strategy formulation. The banking industry can provide many examples where business strategies (e.g., increased lending volume through lowered standards or rapid growth through successive acquisitions) did not take ERM into account.

The latest industry thinking encourages firms to apply ERM to forge a stronger link between risk and reward in corporate planning and strategy.<sup>37</sup>

The latest stochastic stress testing techniques offer a practical tool for thinking through a strategy's ERM implications. For example, a bank can explore the risk effects of growing a portfolio of lending to a given industry sector. The bank could learn

<sup>36</sup> The first 2010 stress tests were much criticized.

<sup>37</sup> "COSO Enterprise Risk Management: Integrating with Strategy and Performance," June 2017, section 3, pp. 13–16.

that the plan helps to diversify its risk and absorb shocks. Alternatively, the strategy may add to risk concentrations or increase dependence on a key macroeconomic driver.

Meanwhile, scenario simulation technology makes it potentially much easier to explore positive scenarios. For example, a bank may find that it would benefit from a decline in oil prices because it had previously reduced lending to oil producers in favor of manufacturers who stand to benefit from lower input costs.

In this way, macroeconomic stress test results are set to become part of general business planning activities (e.g., growth plans, strategic risk management, and balance sheet and capital management). But could new approaches to ERM help shape other kinds of strategic decisions?

Macroeconomic factors are not the only drivers of strategic risk. Banks, and all kinds of firms, need to assess strategic risks arising from changes in factors such as technology, social behavior, and new kinds of competition. These kinds of strategic risk are very challenging because, by definition, they do not have historical parallels (as opposed to something like a fall in GDP).

However, new approaches to scenario building could help. For example, they can offer firms a way to model the impact of strategic shocks across the corporate balance sheet and offer better ways to turn expert judgments into a rigorous scenario selection process.

Strengthening a wider set of corporate strategic decisions is vitally important. A study examining loss of enterprise value in public companies in the United States between 2002 and 2012 showed: "strategic blunders were the primary culprit a remarkable 81 percent of the time."<sup>38</sup> As destroyers of shareholder value, strategic errors far outranked the classic risk management problems (e.g., major operational mishaps, fraud, corporate governance failures) as well as external shocks (e.g., natural catastrophes and political and regulatory upheavals).

## 8.8 CONCLUSION: RISK MANAGEMENT AND THE FUTURE

Risk management is a relatively young discipline. Chapter 1 noted that the global financial crisis of 2007–2009 had accelerated recognition by risk managers of the multi-dimensional nature of risk, the connections between risk types, and (especially) the need to integrate the application of statistical science

<sup>38</sup> C. Dann et al., "The Lesson of Lost Value," *Strategy + Business*, November 2012, available at: <https://www.strategy-business.com/article/00146?gko=f2c51>

with business judgment. These three themes also point to where risk management is heading in the future.

### 1. Risk is multidimensional and requires holistic thinking

Risk managers now recognize the need to deploy a range of risk metrics to capture the many dimensions of risk. So far, the key advance has been in developing new forms of scenario analysis and stress testing to supplement summary statistics (e.g., VaR).

However, scenario analysis has its own deficiencies. In the future, there will be more emphasis on overcoming these shortcomings through the development of better simulation technologies and more rigorous scenario selection methodologies. Future stress testing will also be more dynamic, stretching over periods of one to three years, and it will be incorporated into a firm's capital planning process. The results will help determine risk appetite and ensure that business models are sustainable and can survive severely adverse scenarios.

Holistic thinking on risk requires a sophisticated approach to uncertainty. Almost a century ago, economists explored whether risk and uncertainty are the same concept. The debate focused on how certain we can be about our statistical estimators and predictive capabilities. New research is emerging on how we can measure uncertainty about the risk factors and probabilities that generate risk, a dimension researchers call ambiguity.<sup>39</sup> Decision makers may be averse to ambiguity when they expect good returns and therefore demand a premium—potentially measurable in the financial markets—for accepting ambiguous risks.<sup>40</sup> Into the future, a more rigorous approach to characterizing statistical risk, uncertainty, and ambiguity (and measuring their effects) should improve decision making right up to board level.

Moving to a more holistic approach has also led banks to embrace the importance of risk culture. The way an institution thinks and talks about risk drives enterprise behavior. It also affects how the results of enterprise-wide stress testing are interpreted at the board level, including whether a bank is capable of "thinking the unthinkable" and dealing rationally with ambiguous decisions.

<sup>39</sup> For example, see M. Brenner and Y. Izhakian, "Asset Pricing and Ambiguity: Empirical Evidence," *Journal of Financial Economics*, 130, 2018, 503–531. For a more general introduction to this research area see J. Etner et al., "Decision Theory Under Uncertainty," *Documents de Travail du Centre d'Economie de la Sorbonne*, November 2009.

<sup>40</sup> Conversely, they might favor the ambiguity associated with estimates of losses. However, the empirical research into decisions under ambiguity is ongoing.

### BOX 8.3 BEHAVIORAL CONCEPTS—A SELECTION\*

In recent decades, behavioral science has introduced many concepts that help explain why risk decisions may not always be rational and efficient. These concepts include the following.

**Anchoring and referencing:** This is the use of mental reference points to contextualize a decision (e.g., such as using an existing price point to determine whether a new price point is attractive or not). The anchor may influence the decision-making process in an irrational way. Furthermore, the various reference points in a collection of related decisions may lack coherence.

**Feedback effects:** The presence or absence of frequent, positive feedback can irrationally influence the ability of decision makers to stick to a decision.

**Framing:** How a choice is framed can push a decision maker toward one decision or another. For example, a consumer may be willing to hunt for a 50% savings on a phone case (saving themselves USD 10) but be unwilling to make the same effort to save the USD 10 when buying a USD 200 phone (because it represents a smaller percentage of the purchase price).

**Groupthink:** This describes the tendency of individuals within groups to overcome their doubts about a risky decision (or keep quiet) in favor of the group consensus. The consensus may itself have been shaped by a dominant individual, poorly set targets, or selective reading of ambiguous evidence.

**Herding:** Herding is the tendency of investors to copy the actions of others, both when investing and when reducing losses in a volatile market. Herding effects in risk management can lead to too many investors using the same risk metrics or setting the same stop-losses, leading to sharp market sell-offs.

**Home bias:** This describes the tendency of investors to invest in domestic securities rather than building a globally

diversified portfolio, perhaps because of the uncertainties attached to foreign markets.

**Loss aversion:** Experiments show that for most people the potential for losses outweighs potential gains of similar magnitude. This can lead a decision maker to favor a result that is presented as certain, while foregoing the chance of larger but riskier wins. Loss aversion does not always lead to conservative risk decisions. It can also encourage decision makers to take irrationally risky decisions to preserve some chance of avoiding a loss. (Whether a decision is framed as a loss or as a potential gain is also therefore important.)

**Mental accounting:** People seem to account for money within separate categories that are treated differently, as if the money was not completely fungible across accounts. For example, consumers might spend more if they use a credit card compared to using cash. Investors might invest the money from an inheritance differently than money from a gambling win. They may also be reluctant to “close” a mental account if it involves declaring a loss or mistake. Loss aversion and other behavioral phenomena, such as the treatment of “sunk” costs, often further distort mental accounting.

**Ostrich effect:** This describes the irrational tendency to avoid observing bad news that might precipitate uncomfortable decisions or actions. For example, an investor might pay more attention to booming stock markets than flat or falling markets. (Conversely, an investor that pays too much attention to each individual loss can suffer from irrational loss aversion.)

\*Many of these points are covered in more detail in R. H. Thaler, “Mental Accounting Matters,” *Journal of Behavioral Decision Making*, 12: 1999, 183–206.

Holistic thinking about risk and risk management is the way forward. It would be wrong, however, to set up a direct opposition between silo-based risk management and holistic ERM. The new emphasis on ERM supplements continuing efforts to improve our quantitative, granular understanding of specific risks.

## 2. Risk jumps across risk types in business models and markets

Scenario stress testing is helping banks to understand how risk develops over an extended period (i.e., a year or more) while jumping across risk types. This kind of thinking must also be incorporated into business strategy formulation.

Prior to the global financial crisis of 2007–2009, too many institutions pursued growth using business models based on high leverage or naïve assumptions about the robustness of third-party credit assessments. Many times, growth plans

were formulated without input from the risk function or the chief risk officer. The future risk function must play a critical role in setting a firm’s risk appetite, analyzing the risks of each business model (often with the help of worst-case scenario simulations), explaining how risks may interact, and planning for contingencies. Firms need to decide in advance on the key warning indicators and the actions that will then be considered.

This may prove particularly important with the growth of digital businesses that are driven by machine learning and new data streams, or those using cognitive technologies to offer risk-related services to customers.

## 3. Numbers and judgment

The revolution in computing power and data science, seen through the rise of cloud-based on-demand analytical resources and machine learning technologies, seems likely

to transform risk analysis. For the moment, progress seems relatively slow compared to the customer-facing digital revolution. However, that is partly a function of legacy systems and the difficulty in changing the ways of doing things. In the years ahead, risk managers will be able to command new streams of integrated enterprise data and use machine learning technologies to identify patterns and correlations in large diverse bodies of data that presently seem intractable. It will also become easier to collect information live during business processes, improving vigilance and predictive analytics (as well as classic risk models). The key challenge here will be to keep the risk decisions transparent, even when they are largely automated, and subject to human review. Without this transparency, machine learning and automated decision making simply offer a pumped-up version of model risk.

Meanwhile, behavioral science, a relatively new field, has begun to explain why investors (and risk managers)

sometimes deviate from the seemingly rational decisions assumed by traditional economists. Its findings include the herding effect (where investors seem to follow each other like a herd of sheep) and home bias (where investors prefer investing in their home country rather than building diversified global portfolios) (See Box 8.3). These phenomena need to be incorporated more rigorously into risk management, alongside a better understanding of how people react to risk events.

It follows that the risk managers of the future will operate at the intersection of risk, data science, new understandings of human behavior, and business judgment. Risk managers will need to think holistically and apply new approaches to shape their firm's business strategy. They will also need to make sure their firms react to risk signals even when the signals are ambiguous and the risk metrics uncertain. This implies a need for many new skills and capabilities, alongside a new standing within enterprises. It is an exciting, if sometimes daunting, vision.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## QUESTIONS

- 8.1** What are advantages and disadvantages of scenario analysis?
- 8.2** What are three types of US Federal Reserve generated supervisory devised macroeconomic scenarios?
- 8.3** What is CCAR (Comprehensive Capital Analysis and Review)?
- 8.4** What are some of the key improvements driven by CCAR over standard stress testing?
- 8.5** What are contingent convertible bonds (CoCos)?
- 8.6** Define what is meant by risk culture?
- 8.7** Provide examples of key benefits of enterprise risk management (ERM).
- 8.8** Provide examples of the kinds of concentration risk that can creep across enterprises.
- 8.9** Provide examples that compare ERM with traditional silo-based risk management.
- 8.10** Provide examples of ERM dimensions.
- 8.11** Provide examples of key risk culture indicators (KRCIs).
- 8.12** Provide examples of external risk culture drivers.
- 8.13** Define and explain each of the following terms:
- Anchoring and referencing
  - Feedback effects.
  - Framing
  - Groupthink
  - Herding
  - Home bias
  - Loss aversion
  - Mental accounting
  - Ostrich effect
- 8.14** Risk that looks threatening at the business line level might look trivial in the context of the diversified enterprise risk portfolio.  
**A.** True  
**B.** False
- 8.15** Risk retention decisions are best made at the enterprise level, where the aggregate level of risk exposure can be understood.  
**A.** True  
**B.** False
- 8.16** CCAR does not oblige banks to generate their own scenarios to complement the supervisory scenarios.  
**A.** True  
**B.** False
- 8.17** For each scenario, Banks project CCAR scenarios over a five-quarter horizon.  
**A.** True  
**B.** False
- 8.18** CoCos focus solely on accounting triggers, such as the level of Tier 1 capital.  
**A.** True  
**B.** False
- 8.19** Reverse stress testing calls for identifying the full range of “worst outcomes” then picking the scenarios that gave rise to these worst tail risks and how the shocks turned into losses.  
**A.** True  
**B.** False
- 8.20** Northern Rock was the victim of poor trading liquidity risk management.  
**A.** True  
**B.** False
- 8.21** The ostrich effect describes the tendency of investors to invest in domestic securities.  
**A.** True  
**B.** False
- 8.22** CCAR is  
**A.** requiring all banks to engage in sensitivity testing.  
**B.** required of all relevant banks over an asset threshold.  
**C.** requiring all commercial banks to perform scenario analysis.  
**D.** relevant to investment banks only.
- 8.23** ERM looks at an integrated view of  
**A.** market and credit risks only.  
**B.** all the risks covered by Basel III.  
**C.** all the risks, including business risk, strategic risk, and liquidity risk.
- 8.24** External risk culture drivers include  
**A.** economic cycles.  
**B.** industry practices.  
**C.** professional standards.  
**D.** regulatory standards.  
**E.** country risk.  
**F.** all of the above.  
**G.** none of the above.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## ANSWERS

---

**8.1** See Table 8.5 for a list of the advantages and disadvantages.

**8.2**

1. Baseline: representing a consensus economic forecast/outlook;
2. Adverse: corresponding to a declining economy; and
3. Severely Adverse: severe global recession along with decline in demand for long-term fixed income assets.

Note: The adverse and severely adverse scenarios describe hypothetical macroeconomic environments that test bank resilience.

**8.3** From 2011 onward, as part of the Dodd-Frank Act, the Federal Reserve began conducting annual stress test exercises. CCAR is a specific annual stress test exercise required for large banks.

**8.4**

1. CCAR macroeconomic scenarios unfold over several quarters (rather than simply a point-in-time shock).
2. The scenarios drive a series of interlinked factors covering a variety of risks such as credit risk, market risk, operational risk, and so on.
3. The risk variables are not held static and all sorts of underlying risk factors (probability of default, loss given default) and market impacts (credit spreads, margining, etc.) need to be adjusted as the scenario unfolds.
4. In turn, the bank can allow for its capital planning as the scenario unfolds.
5. Importantly, imposing a standard set of scenarios on the largest banks allows regulators to see systemic effects and compare bank risk exposures.

**8.5** CoCos are bonds issued by a financial institution that are written down or convert into common equity if the firm gets into a precarious position.

**8.6** Risk culture can be thought of as the values and norms of behavior that surround risk taking and risk management. It includes the tendency within the firm to comply with best-practice risk management.

**8.7**

- Identifies enterprise-scale risks generated at business line level
- Focuses oversight on most threatening risks

• Manages:

- Risk concentrations across the enterprise, and
- Emerging enterprise risks (e.g., cyber risk)
- Supports regulatory compliance and stakeholder reassurance
- Helps firms to understand risk-type correlations and cross-over risks
- Optimizes risk transfer expenses in line with risk scale and total cost
- Incorporates:
- Stress scenario capital costs into pricing, and
- Risk into business model selection and strategic decisions.

**8.8**

- Geographical concentrations,
- Industry concentrations,
- Product concentrations, and
- Supplier concentrations

**8.9** See Table 8.1: ERM versus traditional silo-based risk management.

**8.10** See Table 8.2

**8.11** See Table 8.3

**8.12**

- Economic cycles (e.g., credit cycles),
- Industry practices/guidelines,
- Professional standards,
- Regulatory standards, and
- Country risk/corruption indices

**8.13** See Box 8.3.

**8.14** True

Diversification at the enterprise level can reduce overall risk so long as the constituent pieces are not strongly correlated.

**8.15** True

Otherwise situations could arise where business lines are offsetting risks that might already be offset by other businesses.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

**8.16** False

Both DFAST and CCAR also oblige banks to generate their own scenarios to complement the supervisory scenarios.

**8.17** False

CCAR obliges banks to project how these scenarios drive their income statements and balance sheets over a nine-quarter horizon.

**8.18** False

The trigger mechanism could also be some market-based event (e.g., a drop in an institution's share price).

**8.19** True

The purpose of reverse stress testing is to force management to visualize potential scenarios that could generate critical levels of losses.

**8.20** False

The Northern Rock collapse arose from a failure to manage funding liquidity risk.

**8.21** False

It describes the irrational tendency to avoid observing bad news that might precipitate uncomfortable decisions or actions.

**8.22** B. required of all relevant banks over an asset threshold.

CCAR is conducted at the end of the year for banks with assets above USD 50 billion.

**8.23** C. all the risks, including business risk, strategic risk, and liquidity risk.

Enterprise risk management (ERM) applies the perspective and resources at the top of the enterprise to manage the entire portfolio of risks and account for them in strategic decisions.

**8.24** F. all of the above

See Table 8.4.



# 9

# Learning from Financial Disasters

## ■ Learning Objectives

After completing this reading, you should be able to:

- Analyze the following factors that contributed to the given case studies of financial disasters and examine the key lessons learned from these case studies:
  - Interest rate risk, including the 1980s savings and loan crisis in the US.
  - Funding liquidity risk, including Lehman Brothers, Continental Illinois, and Northern Rock.
  - Constructing and implementing a hedging strategy, including the Metallgesellschaft case.
  - Model risk, including the Niederhoffer case, Long Term Capital Management, and the London Whale case.
  - Rogue trading and misleading reporting, including the Barings case.
  - Financial engineering, including Bankers Trust, the Orange County case, and Sachsen Landesbank.
  - Reputation risk, including the Volkswagen case.
  - Corporate governance, including the Enron case.
  - Cyber risk, including the SWIFT case.

This chapter briefly examines case studies of famous financial disasters. The purpose of these case studies is to show how various risk factors can materialize and, when ignored, escalate into major disasters. These cases are classified by the risk factors involved. In each case, however, multiple risk factors simultaneously caused and exacerbated the crisis, leading to major losses.

The first section focuses on how interest rate risk led to the U.S. savings and loan (S&L) crisis in the mid-1980s. Section 9.2 analyzes a couple of cases involving funding liquidity risk. Sections 9.3 and 9.4 cover strategic risk and model risk, respectively.

Rogue trading, discussed in Section 9.5, can cause major financial institutions to collapse (as seen in the case of Barings Bank). Section 9.6 deals with the hidden risks of financial engineering and the complexity of financial structures. Section 9.7 illustrates the damages that can arise from reputation risk, and Section 9.8 focuses on one of the most notorious cases of corporate governance failure (i.e., Enron). Finally, cyber risk is discussed in Section 9.9.

## 9.1 INTEREST RATE RISK

Over the last century, interest rate risk has caused the failure of individual firms as well as entire industries within the financial services sector. One notable example can be found in the collapse of the U.S. S&L industry in the 1980s.

To mitigate interest rate risk, firms must manage their balance sheet structure such that the effect of any interest rate movement on assets remains highly correlated with the effect on liabilities. This must be the case even in volatile interest rate environments. Such a correlation can be partially achieved using classical duration matching tools. More sophisticated methods involve the use of interest rate derivative products such as futures, forwards, swaps, caps, and floors.

### The Savings and Loan Crisis

The U.S. S&L industry prospered throughout most of the twentieth century thanks to regulations governing interest paid on deposits (i.e., Regulation Q)<sup>1</sup> and an upward-sloping yield curve. In particular, the upward-sloping yield curve meant that the interest rate borrowers paid on a ten-year residential mortgage (a

typical product offered by S&Ls) exceeded the rates on the short-maturity savings and time deposits that were an S&L's main source of funding. The mortgage design at the time was a fixed-rate mortgage. For example, an S&L would originate a 30-year fixed rate mortgage and retain it in its investment portfolio while borrowing funds on a short-term basis (i.e., a classic example of lending long and borrowing short). In the banking industry's vocabulary, S&Ls were simply "riding the yield curve" and earning a positive spread between their lending and borrowing rates.

However, rising inflation in the late 1970s prompted the Fed to implement a restrictive monetary policy, which led to a significant increase in short-term interest rates. The regulation that restricted the ceiling on what S&Ls paid on their deposits was removed, forcing S&Ls to compete for funds with the newly created money market fund industry by paying market interest rates. The resulting increase in short-term rates pushed up funding costs for S&Ls, wiping out the interest rate spread they depended on for their profit margin. The spike in their short-term funding costs (which were needed to finance long-term fixed-interest rate mortgages) meant that S&Ls generated negative net interest margins on many of their long-term residential mortgage portfolios.

The failure of the S&Ls to manage their interest rate risk helped to spark a long-running crisis in the United States, which gathered force through the 1980s as S&Ls desperately sought to repair their balance sheets with new business activities and higher-margin (but riskier) lending. However, these efforts resulted in the industry losing even more money through poorly controlled credit and business risks. Between 1986 and 1995, 1,043 out of 3,234 S&Ls in the United States failed or were taken over. The number of remaining S&Ls eventually fell to fewer than 2,200 and the crisis necessitated what was (at the time) one of the world's most expensive banking system bailouts: USD 160 billion. This bailout was funded by the American taxpayers.

It was during this period that S&Ls learned to manage their exposure to interest rate risk (as well as credit risk) from their mortgage portfolios by issuing mortgage-backed securities. These products, first issued in 1969 and backed by government agencies, did not eliminate the problem of borrowing short and lending long. However, they did provide liquidity for S&L mortgage portfolios.

## 9.2 FUNDING LIQUIDITY RISK

Funding liquidity risk can stem from external market conditions (e.g., during a financial crisis) or from structural problems within a bank's balance sheet. Most often, however, it stems from a combination of both. The collapse of Bear Stearns and Lehman Brothers at the height of the 2007–2009 financial crisis, along with the collapse of Long Term Capital Management (LTCM) a decade earlier, offer examples of funding liquidity crises that

were prompted by unexpected external conditions and exposed vulnerabilities inherent in the institutions' business models.

## Liquidity Crisis at Lehman Brothers

During the late 1990s and early 2000s, investment bank Lehman Brothers invested heavily in the securitized U.S. real estate market. The 150-year-old institution pioneered an integrated business model in which it sold mortgages to residential customers,<sup>2</sup> turned portfolios of these loans into highly rated securities, and then sold these securities to investors. Unlike securities backed by government-backed and prime mortgage loans, these securities were often backed by subprime mortgage loans.

The real estate market in the United States started to sour in 2006 and housing prices started falling following a long boom. During this time, however, Lehman continued to build up its real estate securitization business. Critically, the bank also continued to increase the amount of mortgage-related assets it held as longer-term investments for its own account (rather than simply acting as a middleman during the securitization process).<sup>3</sup>

As part of this aggressive growth strategy, Lehman also began to make outsized bets on U.S. commercial real estate. But if the firm's business model came to look like a risky bet on the U.S. housing market, it was ultimately Lehman's leverage ratio and funding strategy that threatened to turn this investment position into a disaster.

Banks are naturally highly leveraged entities (i.e., they take on a large amount of debt rather than issue equity to fund their activities). In the run up to the crisis, however, Lehman (like other investment banks in the boom years) pursued leverage to excess. By 2007, the bank had an assets-to-equity ratio of approximately 31:1. Meanwhile, the bank's funding strategy (i.e., the way it borrowed money to grow its operations) introduced a fatal element of fragility. Specifically, Lehman began borrowing huge amounts of money on a short-term basis (e.g., borrowing daily from the repo markets) to fund relatively illiquid long-term real estate assets. This meant that the firm had to depend heavily on the confidence of its funders and counterparties if it was to continue to borrow the funds necessary to stay in business.<sup>4</sup>

<sup>2</sup> To this end, in the early years of the millennium, Lehman had acquired several mortgage lenders, including subprime lender BNC Mortgage.

<sup>3</sup> "Mortgage-related assets on Lehman's books increased from USD 67 billion in 2006 to USD 111 billion in 2007," *The Financial Crisis Inquiry Report*, Financial Crisis Inquiry Commission, January 2011, p. 177.

<sup>4</sup> When investment banks came under close regulatory scrutiny in 2007–2008, they found it tempting to play down their leverage: "According to the bankruptcy examiner, Lehman understated its leverage through 'Repo 105' transactions—an accounting maneuver to temporarily remove assets from the balance sheet before each reporting period." *The Financial Crisis Inquiry Report*, Financial Crisis Inquiry Commission, January 2011, p. 177.

During the second half of 2007, it became evident that the U.S. housing bubble had burst and that the subprime mortgage market was in deep trouble. As a result, confidence began to erode in firms heavily invested in subprime securities. In July of that year, Bear Stearns (another highly leveraged subprime-linked firm) had to support two of its hedge funds following steep losses caused by their subprime mortgage exposures. In March 2008, these weaknesses caused Bear Stearns to collapse after its repo lenders and bank counterparties lost confidence in the firm's ability to repay its debts. J.P. Morgan then bought the fallen firm at a fraction of its prior market value.

Next investors turned their attention to Lehman. Specifically, they began to question how accurately the firm had valued its real estate-based assets. Market confidence, so critical to the firm's funding strategy (and therefore its liquidity), was ebbing fast. As the crisis mounted, many of Lehman's major counterparties began to demand more collateral for funding transactions, others began reducing their exposure, and some institutions simply refused to deal with the firm. Attempts to organize an industry rescue or to sell the firm to another large bank ultimately failed. In the early hours of September 15, 2008, Lehman Brothers was forced to file for bankruptcy, inciting months of panic and uncertainty in the global financial markets.<sup>5</sup>

## Liquidity Crisis at Continental Illinois

The case of Continental Illinois Bank is an example of how internal credit portfolio problems can precipitate a funding liquidity crisis. In this case, these problems were exacerbated by weaknesses in the institution's funding strategy.

Continental Illinois was once the largest bank in Chicago. Starting in the late 1970s, the bank began pursuing an aggressive growth strategy that saw its commercial and industrial lending jump from USD 5 billion to over USD 14 billion in the five years prior to 1981. During that time, the bank's total assets grew from USD 21.5 billion to USD 45 billion.

The first sign of Continental's problems surfaced with the closing of Oklahoma-based Penn Square Bank. This smaller bank had issued loans to oil and natural gas companies in Oklahoma during the boom of the late 1970s. If a loan was too large for it to service, Penn Square would pass it on to a larger institution such as Continental Illinois. But as oil and natural gas prices fell after 1981, some firms began to default on their debt. In 1982, Penn Square became insolvent and regulators stepped in to close the bank.

By then, Continental held more than USD 1 billion in loans to Penn Square's oil and gas customers, and therefore suffered heavy losses as defaults rose. While many other banks also

<sup>5</sup> Report of Anton Valukas, "Examiner to the United States Bankruptcy Court, Re Lehman Brothers Holdings Inc.," March 11, 2010.

suffered credit losses during this period, Continental was unusual in that it had only a tiny retail banking operation and a relatively small amount of core deposits. Therefore, it relied primarily on federal funds and floating large issues of certificates of deposit (CDs) to fund its lending business.<sup>6</sup>

When Penn Square failed, Continental found itself increasingly unable to fund its operations from the U.S. markets. As a result, it began to raise money at much higher rates in foreign wholesale money markets (e.g., Japan). But when rumors about Continental's worsening financial condition spooked the international markets in May 1984, the bank's foreign investors quickly began to withdraw their deposited funds. Continental Illinois was confronted with a full-blown liquidity crisis as depositors withdrew USD 6 billion in only ten days. Regulatory authorities eventually stepped in to prevent a domino effect on other banks, which they feared might put the entire U.S. banking system at risk.

## Northern Rock—Liquidity and Business Models

The 2007 failure of mortgage bank Northern Rock is a more recent illustration of liquidity risk arising from structural weaknesses in a bank's business model. In this case, a combination of an excessive use of short-term financing for long-term assets and a sudden loss of market confidence triggered a funding liquidity crisis that rapidly led to disaster.<sup>7</sup>

Northern Rock was a fast-growing medium-sized mortgage bank based in the United Kingdom. The bank had been growing assets at around 20% per year for several years by specializing in residential mortgages, and it continued to expand aggressively in the marketplace into the first quarter of 2007. The bank's rate of growth was supported by a business model and funding strategy that was unusual among U.K. banks. Specifically, the bank relied on an originate-to-distribute approach,<sup>8</sup> by which it raised money through securitizing mortgages, selling covered bonds, and making use of the wholesale funding markets. As a result, Northern Rock relied much more heavily on investors and wholesale markets and less on retail deposits for funding in comparison to many of its U.K. peers.

The bank hoped to mitigate potential weaknesses in this funding strategy by diversifying its funding markets geographically. For example, it tapped markets in continental Europe and the

<sup>6</sup> Federal funds, or "fed funds" are a form of interbank lending.

<sup>7</sup> In the summer of 2008, California's IndyMac also suffered a bank run. IndyMac's problems were more conventional as they largely involved weak underwriting and difficulties in finding buyers for the mortgages that the bank had originated.

<sup>8</sup> This practice is described in Chapter 4.

Americas as well as in the United Kingdom.<sup>9</sup> As it turned out, however, the bank had overestimated the benefits of geographical diversification.

After years of a strong economy and rising housing prices, widespread doubts about mortgage-related assets began to surface among investors early in 2007. These doubts were initially triggered by rising default rates in the U.S. subprime mortgage market but soon spread globally to asset-backed securities (ABS) as an investment class, then to institutions that invested in or depended on these securities and eventually to the interbank markets.

When the interbank funding market froze in early August 2007, all of Northern Rock's global funding channels seized up simultaneously in a scenario that the bank's executives later claimed was "unforeseeable." Ironically, earlier in the summer of 2007, the bank had announced increased interim dividends after U.K. regulators approved a Basel II waiver that allowed the bank to adopt so-called "advanced approaches" for calculating credit risk that looked likely to reduce its minimum regulatory capital requirements.<sup>10</sup>

When Northern Rock became unable to fund itself through interbank loans, U.K. authorities began to discuss various strategies to relieve the bank's difficulties. News of the Bank of England's planned support operation for Northern Rock leaked, setting the scene for a run on deposits in mid-September. The panic was exacerbated by the tight rules then in effect for compensating depositors,<sup>11</sup> and calm only (slowly) returned after U.K. authorities publicly promised that deposits would be repaid. Northern Rock eventually accepted emergency government support and then public ownership.

## Lessons Learned

As a result of the 2007–2009 crisis, the U.S. Federal Reserve began to mandate liquidity stress testing programs for the largest banks. These programs are aimed at ensuring that banks have liquidity and funding strategies that will survive system-wide stress scenarios.<sup>12</sup> In essence, the challenge of managing funding liquidity risk lies partly in optimizing the bank's

<sup>9</sup> See comments by Adam Applegarth, ex-CEO of Northern Rock, to the House of Commons, Treasury Committee, "The Run on the Rock," January 2008, p. 15.

<sup>10</sup> Though the timing of the waiver later embarrassed the bank and its regulators, it was not a significant factor in the loss of confidence in the bank.

<sup>11</sup> At the time, private depositors were fully guaranteed only up to £2,000, with a further guarantee of 90% of sums up to a ceiling of £33,000.

<sup>12</sup> For the so-called "C-Lar" program, see S. Nasiripour, "Fed Begins Stress Tests on Bank Liquidity," *Financial Times*, December 13, 2012.

borrowing sources and their composition. This optimization is often accomplished by managing the contractual maturities of assets and liabilities, either directly or synthetically, using derivatives such as interest rate swaps. Like most complicated decisions, however, asset/liability management (ALM) decisions are driven by trade-offs.

- There is a trade-off between funding liquidity and interest rate risk: When funding liabilities have shorter duration than loan assets, the bank is exposed to less interest rate risk and more funding liquidity risk. The opposite is true when liabilities have longer duration compared to loan assets.
- There is also a trade-off between cost and risk mitigation. To mitigate funding liquidity risk in a positively sloped yield curve environment, institutions can increase the maturity of their funding liabilities. However, this will clearly cost more than cheaper shorter-duration funding.

Banks may also mitigate funding liquidity risk by reducing the maturity of their assets (e.g., commercial loans), but this is not always possible because asset maturity is often driven by borrower demand, the nature of a bank's business, and its competitive environment.

As it is not possible to perfectly coordinate liquidity, firms also need emergency liquidity cushions to ensure they can meet their commitments. The larger and better quality the cushion, the lower the risk. However, this risk reduction comes at a cost, as highly liquid and marketable assets yield lower returns than less liquid assets. Credit lines also command a cost, even if the funds are not drawn. Again, banks must consider the significant tradeoff between pursuing a risky funding liquidity strategy and the cost of that strategy compared with less risky strategies and liquidity reserves. It follows that all the components of an ALM policy are linked (i.e., interest rate risk management, funding liquidity risk management, profit planning, product pricing, capital management, and fundamental business strategies) and must be part of a holistic and integrated approach to balance-sheet management.

### 9.3 CONSTRUCTING AND IMPLEMENTING A HEDGING STRATEGY

Developing and implementing effective hedging strategies can be both beneficial and challenging. This is true not just for banks and other financial institutions but for non-financial firms as well. The function(s) or individual(s) responsible for developing hedging strategies need access to relevant information (e.g., market data or corporate information), and oftentimes advanced (or at least appropriate) statistical tools. One necessary step in this

process involves selecting appropriate models to use for both pricing and hedging. These are sometimes developed in-house but oftentimes are acquired from external vendors, as are the data used in the modeling, estimation, and hedging process. Regardless of what tools or data are eventually selected, it is critical that the risk management function has a deep understanding of their proper uses and limitations.

The choice of whether to use static or dynamic hedging strategies is a key tactical decision. A *static hedging* strategy involves the purchase of a hedging instrument that very closely matches the position to be hedged and is typically held for as long as the underlying position is kept (or at least for a set period of time).

A static hedging strategy has the advantage of being relatively easy to implement and monitor. A *dynamic hedging* strategy, on the other hand, involves adjusting the hedge through a series of ongoing trades to continuously (or frequently) calibrate the hedge position to the (changing) underlying exposure. As such, a dynamic hedging strategy typically involves greater managerial effort to implement and monitor, and may involve higher transaction costs as the hedge position is rebalanced. Note that a static approach focuses on the result of the strategy at the horizon, whereas dynamic hedging tries to rebalance the strategy over short intervals of time (e.g., on a daily basis).

Firms that implement dynamic hedging strategies must have the appropriate models and expertise to trade in the markets and effectively monitor their positions. This, however, will not necessarily preclude these firms from making mistakes in the implementation and communication of a risk management strategy. The following section illustrates this by examining a dynamic strategy put in place by Metallgesellschaft Refining & Marketing, Inc. (MGRM).

### Metallgesellschaft—How a Dynamic Hedging Strategy Can Go Wrong

MGRM was a U.S. subsidiary of Metallgesellschaft AG, an industrial conglomerate based in Frankfurt, Germany. In 1993, MGRM entered into long-term, fixed-price contracts to deliver oil products (primarily gasoline and heating oil) to end-user customers. Because MGRM could not change its prices after these contracts were signed, it was exposed to the risk of rising energy prices.

Lacking a liquid market for appropriate long-term futures contracts would allow it to hedge its price risk, MGRM implemented a dynamic hedging strategy that used short-dated energy futures contracts. This strategy required that the hedging instruments (i.e., the futures contracts) be "rolled forward" each month as they expired. The derivative position was adjusted monthly to reflect the changing amount of outstanding

contracts to be hedged in order to preserve a one-to-one hedge. "Such a strategy is neither inherently unprofitable nor fatally flawed, provided top management understands the program and the long-term funding commitments necessary to make it work," according to Culp and Miller.<sup>13</sup>

The type of dynamic hedging strategy implemented by MGRM is known as a *rolling hedge*, and it can be profitable when assets for immediate delivery are priced higher (i.e., the spot price) than assets for future delivery (i.e., the futures price). This type of pricing curve situation is known as *backwardation*. When the firm rolls the hedge position in a market characterized by backwardation, the contract that is about to expire is sold at a price that is higher than that of the replacement longer-delivery contract and thus there is a resulting rollover profit. However, this type of strategy can result in losses when the opposite price relationship exists (a situation known as *contango*).

MGRM therefore was exposed to curve risk (i.e., the risk of shifts in the price curve between backwardation and contango). Additionally, the firm was exposed to basis risk resulting from deviations between short-term prices and long-term prices.

Spot oil prices fell significantly in 1993, from nearly USD 20 a barrel mid-year to less than USD 15 a barrel by year-end. This led to USD 1.3 billion in margin calls on MGRM's long futures positions that had to be met in cash. While MGRM had unrealized economic gains on its original short forward contracts, it had a (temporary) substantial negative cash flow. The problem was exacerbated when the oil price curve changed shape, moving from backwardation to contango. MGRM's parent company, which had been told the position was hedged and therefore did not expect a negative cashflow, ordered the hedges liquidated in December 1993. This resulted in large paper losses being turned into large realized losses.<sup>14</sup>

## Hedging Considerations

Another important aspect of a hedging strategy is the time horizon over which it is implemented. As described in the discussion of static and dynamic hedging strategies, horizons can be fixed (e.g., quarter-end or year-end) or rolling. Regardless of the choice of horizon, performance evaluations and investment horizons should be aligned.

<sup>13</sup> C. Culp and M. Miller, "Blame Mismanagement, Not Speculation, for Metall's Woes," *European Wall Street Journal*, 1995, April 25.

<sup>14</sup> The decision by management to liquidate the hedges, while understandable, might not have been the best course of action. According to Culp and Miller, at least three other possible actions should have been considered: obtaining additional financing to keep the program intact, finding another firm willing to buy the program from MGRM, or unwinding the contracts with the original customers.

Accounting issues and potential tax implications need to be considered when devising a hedging strategy. Accounting rules related to derivatives and hedging can be quite complex and are subject to change. A derivative and the underlying position it is intended to hedge must be perfectly matched (e.g., regarding dates and quantities) in order for them to be reported together in operational profit without the need to report an accounting profit or loss. Without such a matching, the International Financial Reporting Standards (IFRS) require that the hedge's mark-to-market profit (or loss) be recorded. If the hedge is at least 80% effective, the resulting profit or loss can be recorded in the firm's operational or gross profit. Otherwise, the financial position will be recorded as a financial expense, while the underlying position will be recorded as an operational expense.

How derivatives are accounted for will directly impact not only how they are reported in a firm's quarterly and annual financial reports but on a firm's profit and loss (P&L) statement as well. The MGRM case highlights the discrepancy between economic and accounting hedging, and between hedging the P&L or hedging the cash flows. Although MGRM was nearly fully hedged in economic terms, it was fully exposed in accounting terms and was therefore not prepared to absorb liquidity risk.

The choice of the derivatives used in a hedging strategy may have very different tax implications and this can have a big impact on the cash flows of a firm. Tax treatment may also vary from country to country and can sometimes result in a multinational corporation finding it advantageous to hedge positions related to business in one country by using derivatives in another country. Getting competent professional guidance on tax matters is therefore critical when developing and implementing a hedging strategy.

For any strategy to be successful, it must be effectively implemented. This is especially important because markets can move and prices can change, making what had initially appeared to be an attractive hedging opportunity unattractive. During implementation, firms must be ready to adapt to changing conditions with the same care and thoroughness that went into the original strategy design. Once implemented, however, the firm must take special care to monitor the positions with respect to their fit with the overall strategy and their ongoing effectiveness as hedges.

## 9.4 MODEL RISK

Sophisticated financial products often rely on valuation models to determine their prices. Models can be theoretical (e.g., CAPM) or they can be statistically based (e.g., the term structure of interest rates). Institutions are exposed to risks arising from the use of models when pricing these financial products. *Model risk*

can stem from using an incorrect model, incorrectly specifying a model, and/or using insufficient data and incorrect estimators.

One way a model can be problematic is if its underlying assumptions are flawed (e.g., assumptions about the underlying asset price or interest rate process). For example, a bond pricing model might incorporate an assumption of a flat yield curve, when in fact the curve is upward-sloping and unstable. This type of risk is both common and dangerous and can be among the most difficult risks to detect. Unfortunately, the annals of finance history are filled with examples of strategies based on faulty assumptions, as well as other types of flawed models, processes, and controls. What follows are a few relatively well-known examples to illustrate this point.

## Wrong Assumptions—The Niederhoffer Put Options

Victor Niederhoffer was a star trader who ran a very successful and well-established hedge fund. One strategy of the fund involved writing large quantities of uncovered (i.e., “naked”) deep out-of-the-money put options on the S&P 500 Index and collecting the option premiums. Of course, because these were deep out-of-the-money, the premiums collected from these options were quite small. An assumption underlying this strategy was that a one-day market decline of more than 5% would be rare. In fact, if market returns were normally distributed, a fall of this magnitude would be virtually impossible.

The strategy was undone, however, when the stock market fell by over 7% in one day in October 1997. The sharp drop in U.S. equity prices followed a large overnight decline in the Hang Seng Index, which in turn was the result of a crisis developing in Asian markets. On the back of this shock, liquidity in the markets dried up. As a result, the fund was unable to meet over USD 50 million in margin calls and its brokers liquidated Niederhoffer’s positions for pennies on the dollar, effectively wiping out the fund’s equity.

The lesson from this case is that one can construct a strategy with options that will produce a small profit over an extended period. Nevertheless, in such strategies there can be a small probability for a major loss. In other words, competitive financial markets rarely offer a “free lunch.”

## Long Term Capital Management and Model Risk: When “Normal” Relationships Breakdown

The demise of Long Term Capital Management (LTCM) in August and September of 1998 was notable due to the size of the fund’s exposures and the pedigree of the individuals involved. Founded in 1994 by John Meriwether, LTCM’s

principals included former Federal Reserve Board Vice-Chairman David Mullins, Nobel laureates Robert Merton and Myron Scholes, several world-renowned academics, and experienced traders from the famous Salomon Brothers’ bond arbitrage desk. Before its failure, LTCM had USD 4.8 billion in equity and USD 125 billion in assets, making for a 25-to-1 leverage ratio.

LTCM’s downfall was triggered in August of 1998, when the government of Russia declared a moratorium on its debt and devalued its currency (i.e., the ruble). These actions caused the value of LTCM’s holdings to fall over 40%, a loss of nearly USD 2 billion. Concerned about a potential systemic crisis, the Federal Reserve Bank of New York brokered the rescue of LTCM by a group of banks that agreed to inject USD 3.5 billion into the fund in exchange for a 90% equity stake and control of its management.

How could LTCM have been so adversely affected by a single market event? The reason lay in an arbitrage strategy the fund employed that was based on market-neutral trading (also known as relative-value trading). These strategies typically involve the purchase of one asset and the simultaneous sale of another and are designed to exploit relative mispricings between the two assets. As a result, these strategies generate profits when the price spread between assets moves in the anticipated direction, regardless of directional movements in the overall market.

Many of LTCM’s strategies, based on extensive and intensive empirical research by top-level academics and practitioners at the firm, appeared safe at first glance. The firm made its trades based on the assumption that the spreads between sovereign and corporate bonds in various countries were too wide and would eventually revert to their “normal” levels. For instance, LTCM would purchase UK corporate bonds and sell (or “short”) appropriate UK government bonds to capture a perceived relative-value opportunity. Other trades were motivated by the fact that several European countries were scheduled to join the European Economic and Monetary Union (EMU) and convergence of sovereign bond yields was anticipated. Trades of this type might involve, for instance, buying Spanish or Italian government debt and selling German bunds. As long as the yield spread narrowed, these positions would make money regardless of movements in absolute prices.<sup>15</sup>

The limited returns from these low-risk strategies came under increasing pressure as more traders entered the market to take advantage of the same perceived opportunities. To boost performance (measured by return on equity), LTCM used leverage. With a 25-to-1 leverage ratio, for example, LTCM could turn a 1% return on assets into a 25% return. This was aided by LTCM’s

<sup>15</sup> In some cases, such as when the prevailing spread is negative, the speed of narrowing is also a key factor.

ability to obtain large amounts of financing, collateralized by the bonds it invested in. Part of the fund's ability to access such large loans was due to its strategies being widely perceived as low-risk in nature.

LTCM's failure reflected its inability to anticipate the dramatic increase in correlations and volatilities and the sharp drop in liquidity that can occur during an extreme crisis. LTCM also succumbed to an internal liquidity crunch brought on by large margin calls on its futures holdings. Ironically, LTCM's strategies were valid in the medium term, and as the crisis ended, the banks that took over LTCM realized substantial profits.

## Trading Models

Basing models, or strategies, on relationships that exist during benign market conditions makes them vulnerable to failure during extreme, or crisis, situations. The events of August 1998 in Russia made many market participants fearful of the possibility of other sovereign defaults. These fears triggered an investor exodus from emerging markets and other risky assets into liquid and less-risky assets like US and German government debt. This *flight to quality* caused the spreads between "safe haven" assets, like US treasuries, and riskier assets, like emerging market bonds and corporate high-yield bonds, to diverge sharply. These same fears caused the relative yields between German and Italian debt to widen (because German bunds were thought to be safer than Italian bonds) along with credit spreads across a range of asset classes.

As spreads widened, many relative-value trades began to lose money and lenders began to demand the posting of additional collateral. This forced many hedge funds to either sell assets at fire-sale prices to raise funds to meet the margin calls or to abandon their arbitrage plays. Liquidity evaporated from many markets, especially emerging markets, and volatility increased.

The breakdown in the historic correlation and volatility patterns assumed in LTCM's models led to most of its losses. The factors that were most relevant during the market turmoil included the following.

- U.S. Treasury interest rates and stock prices fell in tandem because investors had deserted the stock market and started purchasing U.S. government bonds in a flight to quality. In normal markets, stock returns and interest rates are negatively correlated (i.e., when interest rates fall, stock prices rise).
- Liquidity vanished in many markets simultaneously and made the unwinding of positions exceedingly difficult. Portfolios that seemed to be well-diversified across markets began to

behave as if they were highly concentrated in a single market, and market-neutral positions became directionally exposed (usually to the wrong side of the market).

## Risk Measurement Models and Stress Testing

LTCM made heavy use of a Value-at-Risk (VaR) model as part of its risk control. VaR is a measure of the worst-case loss for an investment (or set of investments) given normal market conditions over a specific time horizon and at a given confidence level.

LTCM felt that it had structured its portfolio so that the fund's risk should not have exceeded that of the S&P 500. The problems encountered at LTCM shed light on how assumptions made when calculating regulatory VaR calculations do not necessarily apply to hedge funds.

- The time horizon for economic capital should be the time it takes to raise new capital, liquidate positions in an orderly manner, or the period over which a crisis scenario will unfold. Based on the experience of LTCM, ten days is clearly far too short a time horizon to determine a hedge fund's VaR.
- Liquidity risk is not factored into traditional static VaR models. Such models assume that normal market conditions prevail and that markets exhibit perfect liquidity.
- Correlation and volatility risks (i.e., the risk that the realized correlations and volatilities significantly deviate from expectations) can be captured only through stress testing. This was probably the weakest point of LTCM's VaR system.

In describing the role of the Federal Reserve Bank of New York leading up to the private-sector recapitalization of LTCM, the bank's president, William McDonough, testified before Congress that:<sup>16</sup>

*We recognize that stress testing is a developing discipline, but it is clear that adequate testing was not done with respect to the financial conditions that precipitated Long-Term Capital's problems. Effective risk management in a financial institution requires not only modeling, but models that can test the full range of financial transactions across all kinds of adverse market developments.*

During the run-up to its collapse, LTCM experienced daily volatility of more than USD 100 million, more than twice the level it envisioned. Furthermore, despite estimating its ten-day VaR to

<sup>16</sup> McDonough, W. J. (1998, October 1). Statement by William J. McDonough Before the United States House Committee on Banking and Financial Services. Lecture, Washington, D.C. Retrieved from <https://www.newyorkfed.org/newsevents/speeches/1998/mcd981001.html>

be USD 320 million, LTCM suffered losses of over USD 1 billion. Simply put, LTCM's risk model had fatal flaws that ultimately contributed to the firm's demise.

## Model Risk and Governance— The London Whale

During the first half of 2012, J.P. Morgan Chase lost billions of dollars from an exposure to a massive credit derivatives portfolio in its London office. The following case study of the event was compiled using word-for-word extracts from the 300-page report produced by a subsequent investigation by the U.S. Senate.<sup>17</sup>

### Setting the Scene

"JP Morgan Chase & Company is the largest financial holding company in the United States, with USD 2.4 trillion in assets. It is also the largest derivatives dealer in the world and the largest single participant in world credit derivatives markets. Its principal bank subsidiary, JP Morgan Chase Bank, is the largest U.S. bank. JP Morgan Chase has consistently portrayed itself as an expert in risk management with a "fortress balance sheet" that ensures taxpayers have nothing to fear from its banking activities, including its extensive dealing in derivatives. But in early 2012, the bank's Chief Investment Office (CIO), which is charged with managing USD 350 billion in excess deposits, placed a massive bet on a complex set of synthetic credit derivatives that, in 2012, lost at least USD 6.2 billion.

The CIO's losses were the result of the so-called "London Whale" trades executed by traders in its London office—trades so large in size that they roiled world credit markets. Initially dismissed by the bank's Chief Executive Officer as a "tempest in a teapot", the trading losses quickly doubled and then tripled despite a relatively benign credit environment . . ."<sup>18</sup>

### The Risk Exposure Grows

" . . . In 2006, the CIO approved a proposal to trade in synthetic derivatives, a new trading activity. In 2008, the CIO began calling its credit trading activity the Synthetic Credit Portfolio (SCP).

Three years later, in 2011, the SCP's net notional size jumped from USD 4 billion to USD 51 billion, a more than tenfold increase. In late 2011, the SCP bankrolled a USD 1 billion credit derivatives trading bet that produced a gain of approximately USD 400 million. In December 2011, JPMorgan Chase instructed the CIO to reduce its Risk Weighted Assets (RWA) to enable the bank, as a whole, to reduce its regulatory capital requirements. In response, in January 2012, rather than dispose of the high risk assets in the SCP—the most typical way to reduce RWA—the CIO launched a trading strategy that called for purchasing additional long credit derivatives to offset its short derivatives positions and lower the CIO's RWA in that manner. That trading strategy not only ended up increasing the portfolio's size, risk, and RWA, but also, by taking the portfolio into a net long position, eliminated the hedging protections the SCP was originally supposed to provide."<sup>19</sup>

### Operational Risk

"In its first four years of operation, the SCP produced positive revenues, but in 2012, it opened the year with losses. In January, February, and March, the number of days reporting losses far exceeded the number of days reporting profits, and there was not a single day when the SCP was in the black. To minimize its reported losses, the CIO began to deviate from the valuation practices it had used in the past to price credit derivatives. In early January, the CIO had typically established the daily value of a credit derivative by marking it at or near the midpoint price in the daily range of prices (bid-ask spread) offered in the marketplace. Using midpoint prices had enabled the CIO to comply with the requirement that it value its derivatives using prices that were the "most representative of fair value". But later in the first quarter of 2012, instead of marking near the midpoint, the CIO began to assign more favorable prices within the daily price range to its credit derivatives. The more favorable prices enabled the CIO to report smaller losses in the daily profit/loss (P&L) reports that the SCP filed internally within the bank."<sup>20</sup>

" . . . by March 16, 2012, the SCP had reported year-to-date losses of USD 161 million, but if midpoint prices had been used, those losses would have swelled by at least another USD 432 million to a total of USD 593 million."<sup>21</sup>

<sup>17</sup> "JP Morgan Chase Whale Trades: A Case History of Derivatives Risks and Abuses," United States Senate Permanent Subcommittee on Investigations, Carl Levin, Chairman and John McCain, Ranking Minority Member, March 15, 2013 Hearing. For the company's own account of the debacle, see *Report of JPMorgan Chase & Co Management Task Force Regarding 2012 CIO Losses*, January 16, 2013.

<sup>18</sup> Senate report, p. 1.

<sup>19</sup> "JP Morgan Chase Whale Trades: A Case History of Derivatives Risks and Abuses," Senate report, p. 3 and 4.

<sup>20</sup> "JP Morgan Chase Whale Trades: A Case History of Derivatives Risks and Abuses," Senate report, p. 96.

<sup>21</sup> "JP Morgan Chase Whale Trades: A Case History of Derivatives Risks and Abuses," Senate report, p. 96.

“... One result of the CIO’s using more favorable valuations was that two different business lines within JPMorgan Chase, the CIO and the Investment Bank, assigned different values to identical credit derivatives holdings. Beginning in March 2012, as CIO counterparties learned of the price differences, several objected to the CIO’s values, resulting in collateral disputes peaking at USD 690 million. In May, the bank’s Deputy Chief Risk Officer . . . directed the CIO to mark its books in the same manner as the Investment Bank, which used an independent pricing service to identify the midpoints in the relevant price ranges. That change in valuation methodology resolved the collateral valuation disputes in favor of the CIO’s counterparties and, at the same time, put an end to the miskarking.”<sup>22</sup>

## Corporate Governance: Poor Risk Culture

“In contrast to JPMorgan Chase’s reputation for best-in-class risk management, the whale trades exposed a bank culture in which risk limit breaches were routinely disregarded, risk metrics were frequently criticized or downplayed, and risk evaluation models were targeted by bank personnel seeking to produce artificially lower capital requirements.

The CIO used five key metrics and limits to gauge and control the risks associated with its trading activities, including Value-at-Risk (VaR). During the first three months of 2012, as the CIO traders added billions of dollars in complex credit derivatives to the SCP, the SCP trades breached the limits on all five risk metrics. In fact, from January 1 through April 30, 2012, CIO risk limits and advisories were breached more than 330 times.”<sup>23</sup>

“... The SCP’s many breaches were routinely reported to JPMorgan Chase and CIO management, risk personnel, and traders. The breaches did not, however, spark an in-depth review of the SCP or require immediate remedial actions to lower risk. Instead, the breaches were largely ignored or ended by raising the relevant risk limit.”<sup>24</sup>

## Model Risk: Fudging VaR Models

“... CIO traders, risk personnel, and quantitative analysts frequently attacked the accuracy of the risk metrics, downplaying the riskiness of credit derivatives and proposing risk measurement and model changes to lower risk results for the SCP. In the case of the CIO VaR, after analysts concluded the existing model was too conservative and overstated risk, an alternative CIO model was

<sup>22</sup> “JP Morgan Chase Whale Trades: A Case History of Derivatives Risks and Abuses,” Senate report, p. 6.

<sup>23</sup> “JP Morgan Chase Whale Trades: A Case History of Derivatives Risks and Abuses,” Senate report, p. 7.

<sup>24</sup> “JP Morgan Chase Whale Trades: A Case History of Derivatives Risks and Abuses,” Senate report, p. 7.

hurriedly adopted in late January 2012, while the CIO was in breach of its own and the bankwide VaR limit. The bank did not obtain OCC approval as it should have to use the model for the SCP. The CIO’s new model immediately lowered the SCP’s VaR by 50%, enabling the CIO not only to end its breach, but to engage in substantially more risky derivatives trading. Months later, the bank determined that the model was improperly implemented, requiring error-prone manual data entry and incorporating formula and calculation errors. On May 10, the bank backtracked, revoking the new VaR model due to its inaccuracy in portraying risk, and reinstating the prior model.”<sup>25</sup> (See Figure 9.1)

## 9.5 ROGUE TRADING AND MISLEADING REPORTING

### Barings, 1995

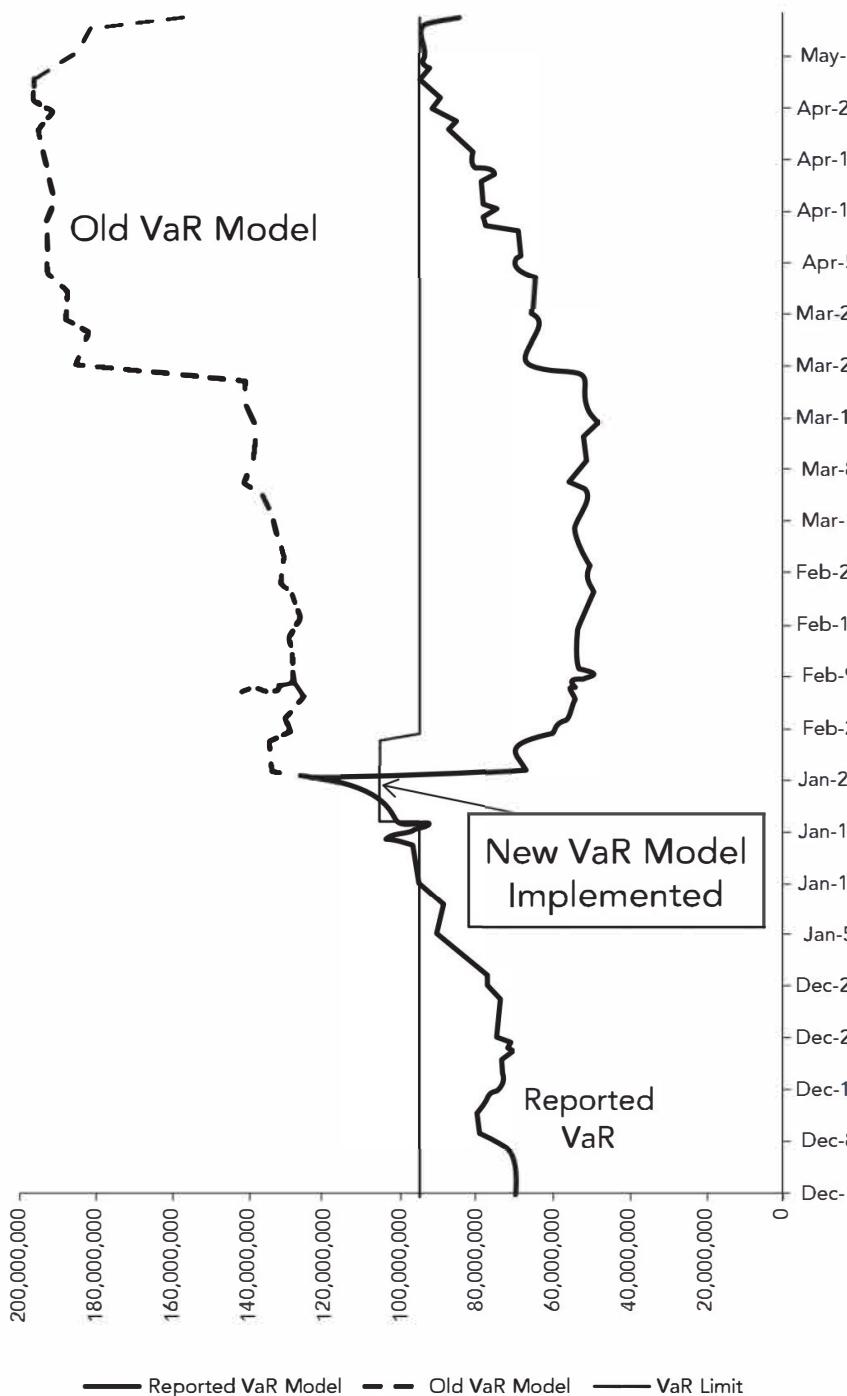
Profits are typically seen as a good thing, particularly at financial firms. The collapse of Barings Bank, caused by the actions of Nick Leeson, should serve as a warning that outsized profits can also be an indicator of unrecognized risk and should be met with as much inquisitiveness as happiness.

In 1992, Nick Leeson moved to Singapore and became the local head of operations for Barings Bank, a centuries-old British financial institution founded in 1762. As part of his role, Leeson executed client trades on the Singapore International Monetary Exchange (SIMEX). Expanding his responsibilities, he received authorization to execute an arbitrage trading strategy designed to exploit price disparities between Nikkei futures contracts listed on the SIMEX and those listed on the Osaka Securities Exchange (OSE). Rather than follow this arbitrage strategy, which involved offsetting trades in the two markets, Leeson instead built speculative positions by buying in one market and holding onto the contracts. His approach quickly generated huge losses.

In addition to his trading authorization, Leeson also controlled the Singapore back office and he used this dual-role to hide his losses. Using a reconciliation account, Leeson converted an actual 1994 loss of GBP 200 million into a reported sizable profit of GBP 102 million. Deepening his subterfuge, Leeson managed to have the reconciliation account excluded from the reports sent to the main office in London.

By late 1994, the outsized amount of Leeson’s profits began to attract the attention of Barings’ risk controllers. Their inquiries to Leeson’s superiors were rebuffed, however, who cited Barings’ “unique ability to exploit this arbitrage.” (It’s possible that the extra bonuses his superiors received on the back of Leeson’s

<sup>25</sup> “JP Morgan Chase Whale Trades: A Case History of Derivatives Risks and Abuses,” Senate report, p. 7-8



**Figure 9.1** VaR for the CIO: "old" versus "new" VaR model.<sup>26</sup>

Source: The United States Senate.

reported profits may have clouded their judgment.) The risk controller's suspicions were raised again in January 1995 after Leeson

<sup>26</sup> United States Senate, Permanent Subcommittee on Investigations, "Exhibits, Hearing on JP Morgan Chase Whale Trades: A Case History of Derivatives Risks and Abuses," March 15, 2013, p. 18.

reported a one-week profit of GBP 10 million in January 1995, and once more their concerns were dismissed. Had his superiors investigated the source and plausibility of the profits, simple calculations would have shown that it would have been impossible for Leeson to have made these profits in the manner he claimed, as that would have required trading four times that week's total volume for the Nikkei futures contracts on both the SIMEX and the OSE.

By the time Barings discovered Leeson's rogue trading, the losses he had accumulated had grown too large and the bank was forced to liquidate. Eventually, ING, a Dutch bank, acquired Barings Bank for the ignominious sum of GBP 1.

A main lesson from the Barings collapse is that reporting and monitoring of positions and risks (i.e., back-office operations) must be separated from trading (i.e., front-office operations). Another basic lesson is that outsized or strangely consistent profits (think Bernie Madoff as well) should be independently investigated and rigorously monitored in order to verify that they are real, generated in accordance with the firm's policies and procedures, and not the result of nefarious or unacceptably risky activities. More broadly, it is incumbent upon risk managers to determine if the reported business profits seem logical with respect to the positions held.

Note that Barings' downfall could have been avoided under regulations implemented just a few years later. In addition to setting capital adequacy requirements for market risk, the Basel Committee set limits on concentration risks. Under the 1996 amendment, banks are required to report risks that exceed 10% of their capital and cannot take positions that exceed 25% of their capital. Had these rules been in effect in 1994, or had the bank developed and enforced prudent guidelines similar to these rules, Barings would have been prohibited from amassing such

large positions and one of the world's most infamous rogue trading scandals might have been avoided.<sup>27</sup>

Large trading volumes and revenues typically result in large bonuses for senior managers. In turn, this compensation framework encourages managers to trust the traders that report to

them. Their reports may not be given proper scrutiny by risk managers or other key individuals who might be able to properly question the veracity of the purported profits. One difficulty is that traders can use their superior knowledge of pricing models, or claims of profound market insights, to confound their internal critics.

The antidote to this problem is for senior managers to engage with a healthy skepticism models and strategies that claim to deliver above-market returns and to insist that all models be transparent and independently vetted. It should be remembered that immediate revenues from a transaction (e.g., ten-year credit default swap) cannot be recognized as economic profit. Rather, a transaction's profitability depends on its performance over its life. Unfortunately, accounting procedures can be used to misreport profits for risky derivative instruments.

## 9.6 FINANCIAL ENGINEERING

Forwards, swaps, and options are the main building blocks of financial engineering. They can be used separately to hedge specific risks or be combined to form complex structures that meet client needs.

Derivatives allow investors and institutions to break apart (i.e., segment) risks. Conversely, derivatives can be used to manage risks on a joint basis. For example, consider a U.S. fund manager holding a bond denominated in euros. The fund manager is exposed to interest rate risk in the euro fixed-income market and to currency risk from changes in the dollar/euro exchange rate. The fund manager can hedge both risks with a currency swap. Alternatively, the fund manager can hedge the foreign exchange exposure separately through a currency forward or option. The fund manager could also avoid the trouble of hedging only the currency exposure by entering into a so-called quanto swap. Under this structure, the fund would receive the coupon of the bond in dollars at a prearranged exchange rate and pay to the counterparty the U.S. Libor floating rate.

The financial engineers responsible for devising complex instruments do so to satisfy the risk-return appetites of their clients. But financial engineering is not by itself risk management, and in the world of derivatives the line between hedging and speculation can be blurry. Firms may be tempted to enter into complex transactions that enhance immediate portfolio returns. However, enhancing returns almost always means taking on more risk in some form or other. This risk may come in the form of an unlikely but potentially very severe future loss. Too often, the embedded risk is not fully understood by firms entering into complex derivative transactions. Or it may be the case that these risks are not fully communicated to senior managers and other stakeholders.

## The Risks of Complex Derivatives

Back in the early 1990s, Bankers Trust (BT) proposed that clients Procter & Gamble (P&G) and Gibson Greetings enter complex leveraged swaps to achieve lower funding costs. In the swap with P&G, for example, BT would pay a fixed rate to P&G for five years, while P&G would pay a floating rate, which was the commercial paper rate minus 75-basis points if rates remained stable. But, through a complex formula, the floating rate would increase considerably if rates rose during the period; for example, an increase of 100-basis points in rates produced a 1,035-basis point spread over the commercial paper!

In 1994, the Fed increased the federal funds rate by 250-basis points, causing colossal losses for both P&G and Gibson Greetings. Both companies sued BT for misrepresenting the risk embedded in these complex swap transactions. BT never quite recovered from the ensuing reputational damage and was eventually acquired by Deutsche Bank.<sup>28</sup>

## The Case of Excess Leverage and Complex Financial Instruments: Orange County

Repos<sup>29</sup> allow investors to finance a significant portion of their investments with borrowed money (i.e., leverage). But using leverage means that the profit or loss on any position is multiplied; even a small change in market prices can have a significant impact on the investor.

Leverage, through the use of repos, was part of the undoing of California's Orange County. In the early 1990s, Orange County treasurer Robert Citron had managed to borrow USD 12.9 billion through the repo market. This enabled him to accumulate around USD 20 billion of securities even though the fund he managed had only USD 7.7 billion in invested assets.

Citron used the borrowed funds to purchase complex inverse floating-rate notes whose coupon payments decline when interest rates rise (as opposed to conventional floaters, whose payments increase in such a circumstance). In the favorable upward-sloping curve environment in the years before 1994, Citron was able to increase the return of the fund by 2% compared to similar pools of assets. However, over the course of 1994, the Federal Reserve raised interest rates by 250-basis points. As interest rates rose, the market value of his positions

<sup>28</sup> There were also a series of actions filed by local authorities in the U.S. and U.K. on the misrepresentation of the risks associated with swaps. In the U.K. these are referred to as "local authorities swaps litigation."

<sup>29</sup> Repos (also called repurchase agreements) are a way to borrow cash by agreeing to sell securities to a counterparty and then repurchase them at (slightly) higher price shortly thereafter.

dropped substantially, generating a loss of USD 1.5 billion by December 1994. At the same time, some of the fund's lenders stopped rolling over their repo agreements. Ultimately, Orange County was forced to file for bankruptcy.

This debacle was caused by a combination of excessive leverage and a risky (and eventually wrong) interest-rate bet embedded in the securities bought by the fund.<sup>30</sup> Citron later admitted he did not understand either the position he took nor the risk exposure of the fund.

Firms need to understand the risks that are inherent in their business models. Senior management then needs to deploy robust policies and risk measures tying risk management, and particularly the use of derivatives, to risk appetite and overall business strategy as it has been communicated to stakeholders. Management and boards should always ask where the risks are hiding and under what circumstances could they produce a loss.

### The Case of Investing in AAA Tranches of Subprime CDOs: Sachsen

Prior to the 2007–2009 financial crisis, some of the biggest buyers of U.S. subprime securities were European banks. Among these institutions were publicly owned banks in Germany called the Landesbanken. While these instruments offered an attractive risk premium, they also required understanding and pricing expertise.

Landesbanks traditionally specialized in lending to regional small- and medium-sized companies. However, during the boom years some began to open overseas branches and develop investment banking businesses. One of the most notorious examples was the Leipzig-based Sachsen Landesbank.

Sachsen opened a unit in Dublin tasked with setting up vehicles to hold large volumes of highly rated U.S. mortgage-backed securities. While these vehicles were technically off the parent bank's balance sheet, they benefited from the guarantee of Sachsen itself.

While this operation was highly profitable,<sup>31</sup> it was simply too large when compared to the size of Sachsen's balance sheet. When the subprime crisis struck in 2007, the rescue operation wiped out

<sup>30</sup> The common mistake made by other asset managers who purchased inverse floaters was that there was no understanding of the embedded leverage. For example, an inverse floater could have a duration of 15 to 25. In several SEC administrative hearings, however, the portfolio managers of limited duration funds whose portfolios blew up as a result of their inverse floater holdings testified that their durations were between 1 and 3.

<sup>31</sup> See P. Honohan, "Bank Failures: The Limitations of Risk Modelling," Working paper, 2008, for a discussion of this and other bank failures. Honohan says that reading Sachsen's 2007 Annual Report suggests that, "The risk management systems of the bank did not consider this [funding liquidity commitment] as a credit or liquidity risk, but merely as an operational risk, on the argument that only some operational failure could lead to the loan facility being drawn down. As such it was assigned a very low risk weight attracting little or no capital." (p. 24)

Sachsen's capital and the bank had to be sold to Landesbank Baden-Württemberg (i.e., another German state bank).

## 9.7 REPUTATION RISK

A firm's reputation is based on the belief that it can and will fulfil its promises to counterparties and creditors, and that the enterprise is a fair dealer and follows ethical practices. In recent years, however, concern about reputation risk has become more prominent with the rapid growth of social networks. Rumors can spread quickly on the internet and destroy reputations in a matter of hours. Companies are also under growing pressure to demonstrate their commitment to environmental, social, and governance-related best practices. As a result, the reputational damage for unethical conduct can be very severe.

### Volkswagen Emission Cheating Scandal

A major scandal to hit the German automaker Volkswagen involved regulatory testing. In September 2015, the United States Environmental Protection Agency (EPA) announced that Volkswagen had programmed certain emissions controls on its diesel engines to be activated only during regulatory testing but not during real-world driving. Thus, while nitrogen oxide levels would meet U.S. standards during regulatory testing, they greatly exceeded these standards when the cars were actually on the road. From 2009 through 2015, Volkswagen put this programming in place in over ten million cars worldwide (500,000 in the United States alone). Volkswagen executives in Germany and the United States formally acknowledged the deception on a September conference call with the EPA and California officials.

The damage to Volkswagen, the world's biggest carmaker, was significant. The share price of the company fell by over a third as the scandal unfolded and the firm faced billions of dollars in potential fines and penalties. Numerous lawsuits were filed. Its reputation, particularly in the important US market, took a severe hit. The reputational effect extended beyond the company itself as German government officials expressed concerns that the value of the imprimatur "Made in Germany" would be diminished because of Volkswagen's actions.

## 9.8 CORPORATE GOVERNANCE

Corporate governance was the topic of Chapter 3. This chapter has already illustrated some corporate governance failures with J.P. Morgan Chase and "The London Whale" in Section 9.4 and the Volkswagen emission cheating scandal in Section 9.7. This section examines the bankruptcy of the energy giant Enron in 2001.

## Enron

Enron was formed in 1985 following the heavily leveraged merger of InterNorth and Houston Natural Gas. As the result of deregulation, however, the firm lost the exclusive rights to its pipelines. In order to survive, Enron devised a new and innovative business strategy to become a so-called "gas bank." This strategy involved buying gas from various suppliers and selling it to a network of consumers at guaranteed amounts and prices. In return for assuming the associated risks, Enron charged fees for these transactions. As part of this process, Enron created a market for energy derivatives where one had not previously existed.

Enron was named "America's Most Innovative Company" in 1995 by Fortune and won this prestigious award for six consecutive years. The firm's shares were worth almost USD 90.56 at its peak in August 2000. That year Enron had 20,000 employees and revenues of nearly USD 101 billion.

Enron constantly pushed for deregulation of the energy market, which would give the firm greater flexibility to pursue its business model. The energy market in California was a prominent example of this push that ultimately led to much criticism as Enron played a key role in the 2000–2001 California electricity crisis.

California had previously capped its retail electricity prices after experiencing a shortage of electricity, which it attributed to market manipulations. By taking power plants offline during times of peak demand, Enron could raise power prices by up to 2,000%. Because the California government had capped retail electricity prices, Enron's actions squeezed revenue margins across the industry and eventually led to the bankruptcy of Pacific Gas and Electric Company (i.e., one of the largest power companies in the United States) in 2001.

Enron itself declared bankruptcy in December 2001. The largest corporate bankruptcy in U.S. history when it occurred, the firm's collapse has been widely discussed in academic, practitioner, and popular press forums. It is now clear what went wrong. Enron was a poster child of corporate governance failure and poor risk management.

Many in Enron's senior management acted in their own self-interest and against the interests of shareholders (i.e., this is known as agency risk). For example, Enron chairman and CEO Ken Lay was charged with "falsifying Enron's publicly reported financial results and making false and misleading public

representations about Enron's business performance and financial condition."<sup>32</sup>

However, Enron's board also failed to fulfill its fiduciary duties to the shareholders. For example, the board was aware of and allowed the CFO to become the sole manager of a private equity fund that did business with Enron. As it turned out, however, the private equity fund lacked economic substance.<sup>33</sup>

Most damning, Enron also used "creative" (i.e., fraudulent) accounting practices to hide flaws in its actual financial performance. As one example, note that Enron transferred its stock to a special purpose vehicle (SPV) in exchange for either cash or notes.<sup>34</sup> The SPV classified the Enron stock as an asset on its balance sheet. In turn, Enron guaranteed the SPV's value to reduce its credit risk.<sup>35</sup> Importantly, Enron failed to adequately disclose the lack of an arm's length relationship between the company and the SPV.

Another example of Enron's duplicity is a scheme by which the firm would build a physical asset and then immediately declare projected mark-to-market profit on its books. It would do this even though it had not yet made any money from the physical asset. If the revenue from the asset was less than the projected amount, then Enron would simply transfer the asset to an SPV. The financial loss would therefore go unreported and Enron could write off unprofitable activities without impacting the bottom line. In short, Enron became adept at hiding the financial losses of its operations using a variety of deceptive techniques.<sup>36</sup>

Enron outsourced its audit function to Arthur Andersen, formerly one of the Big Five accounting firms. Andersen either failed to catch or explicitly approved many of fraudulent accounting practices that led to Enron's collapse. Once the scandal came to

<sup>32</sup> SEC, (2004, July 8), Retrieved from <https://www.sec.gov/news/press/2004-94.htm>

<sup>33</sup> See [https://scholarship.law.upenn.edu/cgi/viewcontent.cgi?article=1009&context=fisch\\_2016](https://scholarship.law.upenn.edu/cgi/viewcontent.cgi?article=1009&context=fisch_2016)

<sup>34</sup> See Segal, T. (2019, June 28). Enron Scandal: The Fall of a Wall Street Darling. Retrieved from <https://www.investopedia.com/updates/enron-scandal-summary/>

<sup>35</sup> The SPV was capitalized entirely with Enron stock. The danger is that if the value of Enron's stock declines, the credit risk of the SPV increases.

<sup>36</sup> Primbs, Michael and Wang, Clara, "Notable Governance Failures: Enron, Siemens and Beyond" (2016). Comparative Corporate Governance and Financial Regulation. Paper 3 [https://scholarship.law.upenn.edu/cgi/viewcontent.cgi?article=1009&context=fisch\\_2016](https://scholarship.law.upenn.edu/cgi/viewcontent.cgi?article=1009&context=fisch_2016)

light, Andersen was forced to surrender its accounting licenses to the Securities and Exchange Commission (SEC). This was effectively a death sentence for the firm.

## Aftermath

In the United States, the Sarbanes-Oxley Act (SOX) of 2002 was a key legislative reform that resulted from the Enron debacle, along with associated changes in stock exchange and accounting rules. SOX created the Public Company Accounting Oversight Board (PCAOB),<sup>37</sup> which has assumed an important role in promoting good corporate governance and financial disclosure. As indicated in Chapter 3, boards and audit committees increasingly rely on the chief risk officer (CRO) to integrate corporate governance responsibilities with existing risk management responsibilities to improve overall risk governance.

## 9.9 CYBER RISK

Cyber risk has become a critically important consideration in recent years. Banks' systems can be hacked, their ATMs can be used to steal money and client information, customer identities can be stolen and misused, and so on. Financial institutions are spending billions of dollars every year on their systems to make them safer. These systems must be protected from the outside world as well as from internal misuse. Threats to the banking system from cyberattacks are also a major concern to international regulatory bodies, such as the Bank for International Settlements (BIS) and the International Monetary Fund (IMF), as well to local regulators.

<sup>37</sup> The PCAOB promulgates auditing standards and has the power to investigate.

## The SWIFT Case

SWIFT is the world's leading system for transferring funds electronically among banks processing billions of dollars in transactions every day. In fact, SWIFT is considered so reliable that transactions which normally take days (in order to prevent fraud) are instead completed in seconds.

In April 2016, an article published in *The New York Times* revealed that hackers had used the SWIFT network to steal USD 81 million from the account of Bangladesh Bank (the central bank of Bangladesh) at the New York Fed. The heist involved malware that sent unauthorized SWIFT messages instructing funds to be moved to an account controlled by the hackers. Then, the malware deleted the database record of the transfer and disabled transaction confirmation messages that would have revealed the theft.

## CONCLUSION

Factors such as adverse macroeconomic activity, increased competition, and evolving technologies can cause major losses for financial institutions. This chapter, however, reviewed major losses that stemmed from factors beyond normal business risk.

While each case study describes a unique situation, understanding the mistakes committed by others should help in designing better risk management systems across the enterprise.<sup>38</sup> All this goes beyond, and is even more important than, simply calculating the regulatory or economic capital requirements.

<sup>38</sup> See Crouhy, Galai, and Mark, " 'What's in a Name?' Risk," *Enterprise Wide Risk Management Supplement* (November 1997), pp. 36–40.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## QUESTIONS

- 9.1** What does it mean to *ride the yield curve*?
- 9.2** The S&L crisis of the 80s was mainly due to
- A. S&Ls failing to manage their interest rate risk.
  - B. increased competition among S&Ls.
  - C. increased competition from commercial banks.
  - D. economic recession.
- 9.3** Explain what the major factors leading to Lehman Brothers collapse in September 2008 were.
- 9.4** Liquidity risk, which brought the demise of Lehman Brothers and Continental Illinois, was *not* caused by
- A. expanding the business too fast.
  - B. reliance on short-term financing.
  - C. changes in regulation that required more liquidity reserves.
  - D. worsening macroeconomic conditions.
- 9.5** In the Northern Rock case one of the lessons is that there is a tradeoff between funding liquidity and interest rate risk: When funding liabilities have shorter duration than loan assets, the bank is exposed to \_\_\_\_\_ interest rate risk and \_\_\_\_\_ funding liquidity risk.
- A. lower, higher
  - B. lower, lower
  - C. higher, higher
  - D. higher, lower
- 9.6** Rumors about a possible intervention by the Bank of England contributed to the default of Northern Rock.
- A. True
  - B. False
- 9.7** In which of the following cases did the firm default due to fraud?
- A. Metallgesellschaft Refining and Marketing
  - B. Northern Rock Bank
  - C. Victor Niederhoffer
  - D. None of the above
- 9.8** LTCM was purported to have had an experienced team and operated strategies that were perceived as having minimal risk. So, what were the reasons for the collapse of LTCM in September 1998? Explain.
- 9.9** Which of the financial disasters was *not* affected by increased correlations in the markets?
- A. LTCM
  - B. Metallgesellschaft
  - C. The subprime crisis
  - D. The London Whale
- 9.10** In the "London Whale" case it is mentioned that ". . . the SCP trades breached the limits on all five risk metrics. In fact, from January 1 through April 30, 2012, CIO risk limits and advisories were breached more than of 330 times." How can the inaction of the bank's management be explained?
- 9.11** Explain the term "flight to quality" and explain how it relates to a financial crisis.
- 9.12** What is model risk?
- 9.13** Give some famous examples of rogue trading.
- 9.14** The Enron failure was due to
- A. liquidity risk.
  - B. foreign currency risk.
  - C. commodity risk.
  - D. governance risk.

## ANSWERS

**9.1** Maintain positive spreads between interest rates earned on longer-term assets (e.g., loans) and interest paid on shorter-term liabilities (e.g., deposits).

**9.2 A.** S&Ls failing to manage their interest rate risk.

Interest rate risk led to the US savings and loan (S&L) crisis in the mid-1980s.

**9.3** Concerns about the valuation of the firm's real estate-based assets led to a loss in market confidence. Counterparties began to reduce their exposure significantly and the firm could not roll over its debt. Attempts to organize an industry rescue failed.

**9.4 C.** changes in regulation that required more liquidity reserves.

In each case, the liquidity crisis was brought on by changing conditions in the wider economy and the credit markets.

**9.5 A.** lower, higher

Banks must consider the significant tradeoff between a short-term funding strategy with low rates but frequent rollovers (and thus more liquidity risk) and a long-term funding strategy with higher rates (and thus higher costs) but less frequent rollovers.

**9.6** True

When Northern Rock became unable to fund itself through interbank loans, UK authorities discussed various strategies to relieve the bank's difficulties. News of the Bank of England's planned support operation for Northern Rock leaked, setting the scene for a run on deposits between September 14 and September 17.

**9.7 D.** None of the above

The fraud examples included Barings Bank and Enron.

**9.8** LTCM failed because its models did not anticipate the vicious circle of losses that would arise as volatilities increased, correlations between various instruments and markets approached 1, and liquidity vanished. LTCM also succumbed to a liquidity crunch caused by large margin

calls on its futures holdings. Ironically, LTCM's strategies actually were valid in the medium term, and as the crisis ended, the banks that took over LTCM realized a substantial profit.

**9.9 B.** Metallgesellschaft

Metallgesellschaft was hurt by change in the shape of the price curve.

**9.10** Failure in corporate governance and poor risk culture. Specifically, the whale trades showed that breaches in risk limits were frequently ignored, risk metrics were often criticized or downplayed, and risk models were misused by employees to set capital requirements that were artificially low.<sup>39</sup>

**9.11** When investors are worried about the economic and market environment, they tend to rebalance their portfolio by investing heavily in "secure" assets from "safe heaven" countries (e.g., the United States). As a consequence, the yield on US securities goes down during a financial crisis, whereas interest rates in other countries go up.

**9.12** Trading of financial securities, especially derivative products, relies heavily on mathematical models. Trading losses can be the consequence of model errors due to incorrect assumptions about the underlying asset price process, errors in the calibration of key input parameters such as volatility and correlations, and errors in the derivation of the hedge ratios.

Note that when markets become illiquid (e.g., during a financial crisis), even the best model might not be able to help in hedging the risk of a trading position because traders might not be able to execute the hedge in the market.

**9.13** Barings

**9.14 D.** governance risk.

Enron was a poster child of corporate governance failure and poor risk management.

<sup>39</sup> Frierson, R. D. (2013, June 7). Re: Docket No. 1457 and RIN 7100-AD-95 on Large Bank Assessments [Letter to United States Senate Committee on Homeland Security and Governmental Affairs].





# 10

# Anatomy of the Great Financial Crisis of 2007–2009

## ■ Learning Objectives

After completing this reading, you should be able to:

- Describe the historical background and provide an overview of the 2007–2009 financial crisis.
- Describe the build-up to the financial crisis and the factors that played an important role.
- Explain the role of subprime mortgages and collateralized debt obligations (CDOs) in the crisis.
- Compare the roles of different types of institutions in the financial crisis, including banks, financial intermediaries, mortgage brokers and lenders, and rating agencies.
- Describe trends in the short-term wholesale funding markets that contributed to the financial crisis, including their impact on systemic risk.
- Describe responses made by central banks in response to the crisis.

## 10.1 INTRODUCTION AND OVERVIEW

The cascade of events that came to be known as the Great Financial Crisis of 2007–2009 (GFC) began with a downturn in the U.S. subprime mortgage market in the summer of 2007 (Box 10.1).<sup>1</sup> The years preceding the crisis saw an exceptional boom in credit growth in the United States, a massive housing price bubble, and an excess of leverage in the financial system that had been building since the previous credit crisis of 2001–2002.<sup>2</sup> The boom years had also been accompanied by a wave of financial innovations related to securitization, which expanded the capacity of the financial system to generate credit assets but outpaced its capacity to manage the associated risks.

Unlike previous U.S. credit crises, the GFC affected investors all over the world. Massive losses spread from subprime mortgages in the United States to other segments of the credit market.

Banks began to experience large losses and liquidity problems amid growing uncertainty about the valuation of credit assets. As a result, banks stopped lending to one another. Governments around the world intervened by offering liquidity support facilities and recapitalizing insolvent banks in an effort to encourage bank lending. Many banks failed entirely or were taken over.

February 2008 saw the nationalization of troubled U.K. mortgage lender Northern Rock, a victim of the first bank run that nation had experienced in 140 years. The following month, U.S. investment bank Bear Stearns was absorbed by J.P. Morgan Chase in a deal brokered by the U.S. Treasury Department and the Federal Reserve.

The crisis also brought the asset-backed commercial paper (ABCP) and repo markets to a halt, causing numerous hedge funds to freeze redemptions or fail. Many special investment vehicles (SIVs)<sup>3</sup> and conduits were also wound down. Credit losses worldwide eventually exceeded USD 1 trillion.

The peak of the subprime crisis came in September 2008, which saw a cascade of events.

- Lehman Brothers declared bankruptcy, leading to an immediate acute reduction in the interbank borrowing market. Banks with excess cash were unwilling to lend money to banks looking for liquidity in the overnight repo markets.

<sup>1</sup> Some analysts point to the role that US government policy had in precipitating the GFC, see for example Peter J. Wallison's *Dissent from the Majority Report of the Financial Crisis Inquiry Commission*.

<sup>2</sup> Between 2002 and 2007, debt as a percent of national income rose from 375% to 475% while at the same time average housing prices increased at 11% per year, a record rate.

<sup>3</sup> SIVs and conduits were part of what is popularly referred to as the shadow banking system, which is defined as a network of financial systems made up of non-depository banks. Post-crisis legislation in the U.S. has addressed some of the issues associated with shadow banking.

### BOX 10.1 SUBPRIME MORTGAGE MARKET PRE-CRISIS

Subprime mortgages<sup>a</sup> are residential home loans made to borrowers with poor credit. In the United States, consumer credit quality is measured with a FICO score.<sup>b</sup> Factors that can drive down a FICO score include a limited credit history, a large amount of outstanding debt, or a history of delinquent payments. The exact definition of a subprime borrower can vary, and some lenders even consider borrowers with relatively high credit scores as subprime if their mortgages have low down payments. Broadly speaking, subprime mortgages have more default risk than prime mortgages and therefore pay higher interest rates.

There is another key category of borrowers termed Alt-A. These are borrowers that have reasonably strong credit ratings but lack essential documentation needed to verify their assets and income.

Subprime mortgages became very popular in the United States in the years preceding the financial crisis. According to former Fed chairman Ben Bernanke, “[f]rom 1994 to 2006, subprime lending increased from an estimated USD 35 billion, or 4.5 percent of all one-to-four family mortgage originations, to USD 600 billion, or 20 percent of originations.”<sup>c</sup>

By early 2007, total outstanding subprime mortgage debt was estimated at USD 1.3 trillion.<sup>d</sup>

<sup>a</sup> M. Crouhy, D. Galai, and R. Mark provide an extended discussion on subprime mortgages in *The Essentials of Risk Management*, 2<sup>nd</sup> Ed., McGraw Hill, 2014, Ch. 12.

<sup>b</sup> FICO is an acronym for Fair Isaac Corporation, the developer of the methodology.

<sup>c</sup> FRB: Speech-Bernanke, *Fostering Sustainable Homeownership*, FederalReserve.gov, March 14, 2008. Chairman Bernanke was referencing data from the website <https://www.insidemortgagefinance.com/Inside Mortgage Finance>

<sup>d</sup> Statement of Scott M. Polakoff, Deputy Director Office of Thrift Supervision, before the Committee on Banking, Housing and Urban Affairs, U.S. Senate, March 22, 2007. <https://www.banking.senate.gov/imo/media/doc/polakoff.pdf>

- The last two major investment banks in the United States, Morgan Stanley and Goldman Sachs, were converted to bank holding companies and became regulated by the Federal Reserve. This move gave them access to the Fed's liquidity facilities.
- Fannie Mae and Freddie Mac were nationalized.
- AIG was brought back from the brink of collapse via a USD 150 billion capital infusion by the U.S. Treasury and the Federal Reserve.
- In Europe, many countries had to step in to provide massive support to their banks. Dutch financial conglomerate Fortis was

broken up and sold. Iceland's largest commercial bank, and subsequently the entire Icelandic banking system, collapsed.

- Many government budgets in Europe were stretched thin due to the massive cost of the bank rescues, a situation that contributed to a subsequent European sovereign debt crisis in 2010.<sup>4</sup>
- There was a fundamental spillover from the financial crisis to the wider global economy. This resulted in a massive loss of wealth and high unemployment around the world.

## 10.2 HOW IT ALL STARTED<sup>5</sup>

Growth in housing demand and concomitant mortgage financing was fueled (in part) by the low interest rate environment that existed in the early 2000s.<sup>6</sup> This demand helped drive substantial increases in housing prices.<sup>7</sup> Low interest rates also spurred investors, including institutional investors, to look for investments that offered yield enhancement. They found this yield in subprime mortgages, which typically carry premiums of up to 300-basis points over the rates charged to prime borrowers.

Subprime loans also became increasingly in demand for securitization. Through this process, securitizers:

- Created pools of below investment-grade assets;
- Bifurcated the cash flows by model-driven certainty; and
- Packaged the "safest" cash flows into investment-grade securities.<sup>8</sup>

This encouraged banks to develop or grow an originate-to-distribute (OTD) business model (see Chapter 4).

Subprime mortgages became an increasingly large share of the overall mortgage market, rising from 7% of total mortgage originations in 2001 to 20% in 2006 (Table 10.1).

<sup>4</sup> Countries such as Greece, Portugal, and Ireland were forced to take rescue packages from the International Monetary Fund and the European Central Bank.

<sup>5</sup> This section borrows from Crouhy, Jarrow, and Turnbull, "The Sub-prime Credit Crisis of 2007," *Journal of Derivatives*, Fall 2008, 81–110.

<sup>6</sup> In 2007, in the United States, 50 million, or two-thirds of homeowners, had mortgages, with 75.2% being fixed rate mortgages and the remaining 24.8% with adjustable-rate mortgages (ARMs). These figures come from the Mortgage Bankers Association, August 15, 2007.

<sup>7</sup> The Fed funds rate was 1% in June 2003. It started to slowly increase in June 2004 and was 5.25% by June 2006. It was reduced to 4.75% on September 18, 2007.

<sup>8</sup> As a very simple illustration, consider a pool of bonds that in one year's time is scheduled to deliver USD 100, with a "worst-case loss" of USD 35. Then USD 65 could be said to be a very reliable minimally expected cash flow and the claim on this amount would be packaged and sold as a high-grade asset; the claims on the other USD 35 would also be packaged and sold as high-yielding paper.

**Table 10.1 Percentage of Total Mortgage Loans, which are Subprime, by Year of Origination**

2001	7%
2002	8%
2003	9%
2004	11%
2005	14%
2006	20%

Sources: B&C Lending Federal Reserve Bank of St. Louis; EIR.

Many subprime mortgages were structured with low teaser rates for the first few years (which were then followed by much higher rates once the teaser period ended). Many of these mortgages were *interest-only* over the teaser period as well, meaning that no principal payments were required.

Some borrowers used subprime lending to purchase a house in which they intended to live, whereas others were merely speculating on rising home prices. For either type of borrower, a loan could typically be refinanced into another similar mortgage once the teaser rate period ended (as long as housing prices rose). If refinancing was not possible, a speculator could simply default on the mortgage.

Under the OTD model, losses on subprime mortgages were borne not by the banks that initially made the loans, but by the investors that eventually owned them. This reduced the incentive for the originating banks to conduct the appropriate due diligence (e.g., proper credit assessments on the borrowers and rigorous collateral valuation on the homes being purchased) before extending credit.

Many subprime mortgages were securitized into collateralized debt obligations (CDOs) during this time. These credit risk transfer instruments played a major role in the subsequent sub-prime mortgage meltdown.

Delinquencies on adjustable-rate subprime mortgages rose markedly in 2007 and by August of that year, the rate of serious delinquencies was approaching 16% (roughly triple its level in mid-2005).<sup>9</sup> By May 2008, this figure had risen to 25%,<sup>10</sup>

<sup>9</sup> B. S. Bernanke (2007, October 17), "The Recent Financial Turmoil and its Economic and Policy Consequences (Speech)," New York. Retrieved July 13, 2008.

<sup>10</sup> B. S. Bernanke (2008, May 19), "Mortgage Delinquencies and Foreclosures (Speech)." Columbia Business School's 32nd Annual Dinner, New York City. Retrieved May 19, 2008.

leading to a massive number of ratings downgrades<sup>11</sup> for sub-prime mortgage securitized products.

There are several reasons for why delinquencies rose significantly after mid-2005.

- In a subprime mortgage transaction, the inherent credit quality of the borrower is typically weak, and the mortgage is often under-collateralized. Spotty income and payment histories, as well as high debt-to-income ratios, are typical of subprime borrowers.
- Traditionally, first-time home mortgages required a 20% down payment. In 2005, 43% of first-time home buyers paid zero down payment,<sup>12</sup> significantly reducing the collateral cushion in case housing prices declined.
- As mentioned previously, many subprime mortgages included teaser rates. For example, a 2/28 adjustable-rate 30-year mortgage would typically have a teaser rate for the first two years, after which it would reset to a (potentially) much higher rate (i.e., a short-term rate or index plus a several hundred-point spread) for the remaining 28 years. This was not much of a problem as long as a borrower could refinance the mortgage before the reset date. But if the borrower could not refinance and if interest rates increased, the monthly mortgage costs could rise very quickly. As it turned out, interest rates did start to increase, with the rate on the three-month Treasury bill rising from less than 1.0% in April 2004 to over 4.0% in November 2005.<sup>13</sup> Other mortgage features, such as interest-only teaser periods, made this issue even worse.
- The ability to refinance mortgages ahead of the reset date was a common assumption amongst subprime borrowers. However, this ability declined significantly when housing prices began to fall sharply in 2006. Furthermore, subprime mortgage balances quickly began to exceed the market value of the homes that collateralized the loans, increasing the incentive for borrowers to default.
- The heavy demand for subprime mortgage products encouraged questionable practices by some lenders. Some borrowers were steered into subprime mortgages although they qualified for mortgages with more attractive terms. Meanwhile, other borrowers ended up with mortgages they were not qualified to hold and could not afford. Meanwhile, increasingly risky products entered the subprime market,

including NINJA loans (i.e., no income, no job, and no assets) and *liar loans* (which required such a scant amount of documentation that borrowers could safely lie on their applications). In an attempt to take advantage of the lax lending standards and increasingly weak controls, some borrowers and mortgage brokers submitted false documentation that enabled some borrowers to receive funding under fraudulent terms. This situation was exacerbated by the compensation structure for most mortgage brokers, which incentivized increasing the volume of loans originated and not necessarily the long-term performance of those loans. In fact, there were few (if any) consequences to a broker if an originated loan eventually defaulted. Originating brokers therefore had very little incentive to conduct proper due diligence.

## 10.3 THE ROLE OF FINANCIAL INTERMEDIARIES

Banks moved assets to be securitized off their balance sheets to structured investment vehicles (SIVs), also called conduits. SIVs are a limited-purpose, bankruptcy remote companies used by banks to purchase assets. They are typically funded with short-term commercial paper as well as some medium-term notes and capital.

Securitization involves taking a portfolio of existing assets and repackaging their associated cash flows into claims on tranches. Bonds are issued against these tranches and the proceeds are used to purchase the collateral assets.

To appeal to investor demand, the different tranches are typically structured to have a desired credit rating (with most tranches being rated as investment grade). A waterfall structure is introduced to differentiate the credit risk associated with the claims on the different tranches. The tranches are established in order of safety, beginning with Senior AAA debt (often referred to as super senior), Junior AAA, AA, A, BBB, BB, and so on. To ensure that the super senior tranche receives a AAA rating, a surety wrap was sometimes used.<sup>14</sup>

In theory, the OTD model, coupled with extensive use of securitization, would distribute risk more broadly throughout the financial system. This in turn would make banks less sensitive to credit crises, reduce systemic risk, and give banks additional funding sources to support their lending.

The crisis, however, exposed flaws in this theory. Over the period from 2003 to 2007, banks appear to have used securitization to keep their credit exposures to AAA rated tranches to generate extra yield without increasing their regulatory capital minimums under Basel II.

<sup>11</sup> It should be noted that the market was heavily dependent upon the rating agencies to provide an explicit risk analysis of these securities, which in turn translated to a high implicit impact on market valuation.

<sup>12</sup> N. Knox, "43% of First-time Home Buyers Put No Money Down," USA Today, 2006, Jan. 17.

<sup>13</sup> Board of governors of the Federal Reserve system, H.15 Selected Interest rates.

<sup>14</sup> A surety wrap is supplied by a monoline insurer who is obligated to make interest and principal payments in the event of default.

For example, a residential mortgage attracts a risk-weighted asset (RWA) of 50%. Meanwhile, a AAA rated tranche of securitization is only subject to an RWA of 20% (because an asset with such a rating is presumed to be at low risk of default). The AAA rating also served to greatly reduce incentives for investors to investigate and perform proper due diligence on the pool. Accordingly, investors thought they could increase their returns without adding risk by purchasing CDOs, rather than lower yielding corporate bonds or similar assets. As explained in the following section, they were wrong.

## 10.4 ISSUES WITH THE RATING AGENCIES

As part of a CDO structuring process, the equity holders (known as the CDO trust partners) would pay credit rating agencies to rate the various liabilities of the CDO.<sup>15</sup> Because CDO trusts were aware of the requirements and assumptions that credit rating agencies used to assign these ratings, they were able to structure the payment waterfalls and associated liabilities in such a way as to obtain a high percentage of AAA rated bonds.

The assumptions used in this rating process were based on historical data. However, this data did not reflect the changes in the asset characteristics that were taking place at the time, including the growing number of NINJA (slang for “no income, no job, and no assets”) loans, liar loans (i.e., loans with little to no documentation), and subprime mortgages with 100% loan-to-value ratios.

Rating agencies also relied on data received from the issuers and arrangers, who were bundling the mortgages and performing due diligence. Despite widespread knowledge of declining lending standards and increasing fraud, it is alleged that the rating agencies themselves did not perform any additional due diligence or monitoring of the data.

It is also important to note that subprime mortgage loans were too new in the marketplace to offer long-term data that could inform risk analyses. Therefore, many of the initial ratings assigned to these securitizations (typically the senior tranches that were given AAA ratings) were likely faulty from the outset.

Despite these analytical flaws, there were strong incentives for agencies to provide the required ratings. These agencies are paid to monitor the CDO over its life. But if the CDO trust did not get formed because too few bonds were AAA rated, the agency would miss out on this profitable and continual cash stream.

<sup>15</sup> At one time, credit rating agencies charged investors to use ratings. That model changed and now securities issuers pay a fee to have their securities rated, which is referred to as the *issuer-pay model*. Obviously, this causes potential conflicts in that credit rating agencies may compete for business by having lower credit enhancement requirements (and therefore lower funding costs) than the competition so that more CDO tranches will have a AAA rating.

## 10.5 A PRIMER ON THE SHORT-TERM WHOLESALE DEBT MARKET

There are two main instruments that constitute the short-term wholesale debt market: repurchase agreements and commercial paper (CP). Both markets shut down early in the crisis as market participants started to doubt the quality of the collateral.

Repurchase agreements (also known as repos) are used by many financial institutions, including banks, brokerage firms, and money market funds. A standard repo involves

- The sale of an asset; and
- An agreement to buy the asset back at a slightly higher price at a specified future date.

The seller of the security receives cash at the outset of the repo and can thus be viewed as a borrower in a collateralized loan transaction (with the security serving as the collateral). The buyer of the security, who gives cash at the outset of the repo and then receives a higher sum at the end of the term of the repo, can be considered a lender (with the higher sum representing principal plus interest).

Various types of securities can be used as collateral in repo transactions, ranging from government bonds and high-quality corporate bonds to tranches of securitizations. The quality of the collateral greatly influences the size of the *haircut* (i.e., the percent reduction from the initial market value the lender is willing to give the borrower), with higher (lower) quality collateral having smaller (larger) haircuts. For example, a haircut of 10% means that a borrower can borrow USD 90 for each USD 100 pledged collateral. A haircut is intended to protect the lender from recovering less than the full value of the loan amount in the event they need to sell the collateral after a default.

Repos are excluded from the bankruptcy process. This means that if one counterparty fails, the other may terminate the transaction unilaterally and either keep the cash or sell the collateral.

In unsecured CP financing, short-term debt is issued but is not backed by any specific assets. Because there is no specific collateral that a lender can seize in the event of default, unsecured CP issuers generally have very high credit quality. If a CP issuer's credit quality deteriorates, such as through a rating downgrade, there is usually an *orderly* exit through margin calls.

Asset-backed commercial paper (ABCP) is a special case of CP where the issuer finances the purchase of the assets by issuing CP, with the assets serving as collateral.

The demand for collateral increased in the years preceding the crisis, driven by the growth of the OTC derivatives markets and an increasing reliance on short-term collateralization by financial

institutions. This demand was (in part) satisfied by the issuance of AAA rated securitization tranches. According to statistics from the Federal Reserve Bank of New York, the total primary dealers' inventory of repos increased from USD 1.6 trillion in 2000 to over USD 4.5 trillion in 2008.<sup>16</sup>

## 10.6 THE LIQUIDITY CRUNCH HITS

Note that SIVs were typically funded short-term and relied on being able to regularly roll over short-term debt to finance their longer dated assets.

As mortgage-backed securities began to lose value, however, the credit quality of many SIVs declined. This led to the rapid downgrading of the credit ratings of the ABCP issued by these SIVs and an increasing skepticism about pledged collateral value, which prevented a growing number of SIVs from rolling over their ABCP. Simultaneously, liquidity in the subprime-related asset markets disappeared.

Note that until the middle of 2007, counterparty credit risk was not priced by the market. There was hardly any difference (i.e., only 2- to 5-basis points) between the unsecured overnight index swap (OIS) rate and the swap rates for all reset periods (i.e., three months, six months, one year).<sup>17</sup>

Starting in June of that year, market participants began to worry not only about the value of asset-backed securities but also about how much exposure banks and other financial institutions had to the subprime market.<sup>18</sup> As a result, the OIS-swap spread exploded (as shown in Figure 10.1). It remained high during the crisis, jumped again when Lehman Brothers failed, and did not come back to pre-crisis levels.<sup>19</sup>

<sup>16</sup> Adrian et al., 2009, "Federal Reserve Bank of New York Current Issues in Economics and Finance," Volume 15, Number 4, August 2009.

<sup>17</sup> Banks repriced their swap books with only one interest rate term structure curve (e.g., the three-month swap rate curve). This all changed in mid-2007, when market participants started to price counterparty credit risk and credit spreads on all credit assets went up substantially. Banks switched to a new methodology called bi-curve, which uses one interest rate curve to derive coupons and another for discounting cash flows.

<sup>18</sup> Since the 1970s monoline insurance providers had an important role in municipal finance. In the years preceding the financial crisis, much of the growth of the monolines came in structured credit products such as asset-backed bonds and CDOs. Initially monolines carried enough capital to earn a AAA rating which removed the need for them to post collateral.

<sup>19</sup> Since 2007 the pricing of OTC derivatives incorporates the risk of default of the counterparty (CVA—counterparty valuation adjustment) and Basel III imposes a capital charge against counterparty credit risk.



**Figure 10.1** Libor-OIS spread.

Source: Carpenter and Demiralp, 2011, "Volatility, Money Market Rates, and the Transmission of Monetary Policy," Finance and Economics Discussion Series: 2011–22, Federal Reserve Board.

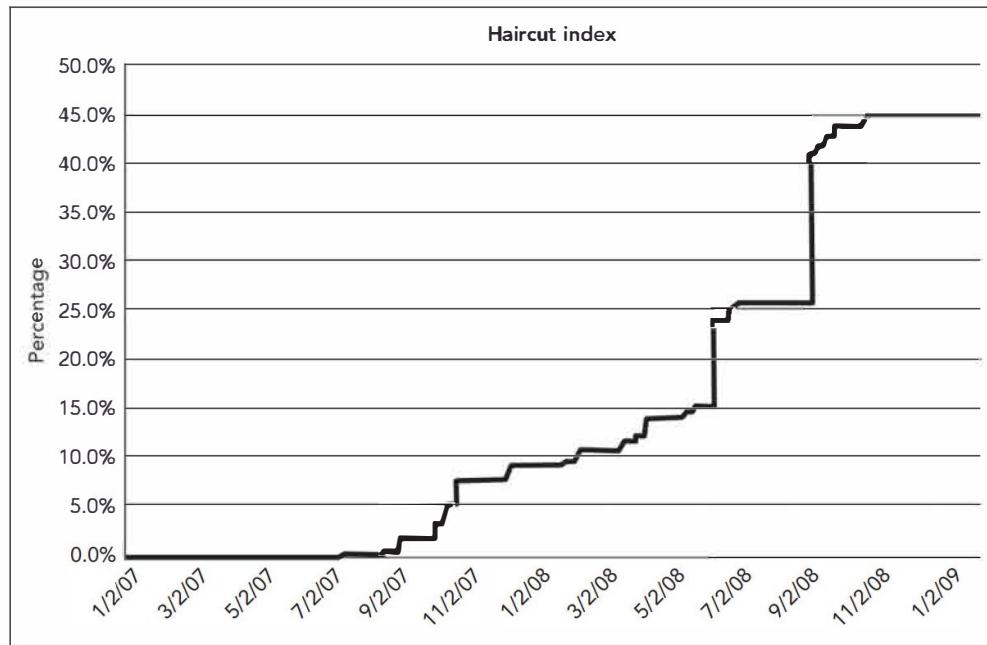
At the same time, credit spreads on all credit assets increased substantially, lowering the market price of the credit assets. This led to a systematic increase in haircuts, from zero pre-crisis to more than 45% when Lehman failed in September 2008 (see Figure 10.2).

Gorton<sup>20</sup> provides an illustration of the dynamics that began with a liquidity crisis and ended up in a solvency crisis, especially for highly levered institutions that relied heavily on short-term wholesale funding (repos).

For example, consider a bank with USD 100 in assets. In turn, these assets are backing USD 40 in long-term debt, USD 50 in repo financing, and USD 10 in equity. Suppose repo haircuts increase from zero to 20%, dropping repo financing from USD 50 to USD 40. The bank is now short of funding by USD 10. In a normal market, the bank could simply sell USD 10 in assets. Its new balance sheet would look like the following: USD 90 in assets backing USD 40 in long-term debt, USD 40 in repo financing, and USD 10 in equity.

However, if there is a simultaneous sell off in the markets, the market value of the assets can fall precipitously. If the value of the bank's assets falls below USD 90, then the equity is wiped out and the bank becomes insolvent.

<sup>20</sup> G. Gorton, *Slapped in the Face by the Invisible Hand: Banking in the Panic of 2007*, Yale University and the National Bureau of Economic Research, 2009. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.189.1320&rep=rep1&type=pdf>



**Figure 10.2** The Repo-Haircut Index.

Source: Used with permission of Elsevier, from "Securitized Banking and the Run on Repo," November 9, 2010. Yale ICF Working Paper No. 09-14. Available at SSRN: <https://ssrn.com/abstract=1440752>; permission conveyed through Copyright Clearance Center, Inc.

By the summer of 2007, the short-term wholesale funding markets started to freeze, including both the ABCP market and the repo market. Investors stopped rolling maturing ABCP, forcing banks to repatriate SIV assets onto their balance sheets. With the significant increase in repo haircuts, institutions that relied on repo financing were unable to roll their short-term funding. At that point, there were only three outcomes: bailout, merger, or bankruptcy.

This is exactly the scenario that led to the failure of Bear Stearns, mortgage banks Northern Rock in the United Kingdom, IndyMac in California, and Lehman Brothers. Note that all these institutions satisfied Basel minimum regulatory capital requirements before they failed.

Relying heavily on short-term wholesale funding can be dangerous, as it can disappear overnight.

## 10.7 VALUATION UNCERTAINTY AND TRANSPARENCY ISSUES

Previous sections showed how a wave of uncertainty over the valuation of asset-backed structured products exacerbated the crisis by effectively freezing the short-term debt markets. But what made these products so problematic?

First of all, they are difficult to value even when there isn't an ongoing crisis. Their liability structure and cash flow waterfalls

tend to be complex and contain different types of collateral and interest rate triggers. Also, even if they share a basic securitization framework, each structured product is unique. Therefore, the model(s) used to simulate the cash flows for each bond must be customized to fit the unique aspects of the structure.

The assets in the collateral pool must also be valued. In the case of ABS trusts, this can require the valuation of thousands of subprime mortgages, with a wide variety of borrower characteristics and loan terms. CDOs may contain securities issued by ABS trusts, while CDO-squared structures contain securities issued by other CDOs. Some asset pools contain synthetic ABS credit default swaps. All of these complex instruments must be valued.

Modeling the cash flows to the trusts can be further complicated by the fact that they are often dependent on the future values and credit ratings of the collateral. All future values and credit ratings must therefore be estimated in order to estimate the value today. The fact that there is often little data available, even to sophisticated investors, on the different asset pools presents another challenge when it comes to valuation.

These products also had transparency issues. Many investors, even seemingly sophisticated investors, simply did not have the in-house expertise to understand/analyze the complex products they were buying. Furthermore, they did not understand the potential risks that might arise from the assumptions underlying

the valuation and credit rating models. Investors simply did not foresee how these assumptions might fail under stressed conditions. As a result, they chose to be completely reliant on the rating agencies for risk measurement. Moreover, many buyers of these products were yield buyers who made their investment decisions based on projected cash flows. However, this is a poor measure of potential return because it assumes the cash flow estimates are accurate and that all cash flows can be reinvested at an interest rate equal to the computed cash flow yield.

At the same time, the valuation of illiquid assets was opaque. With no readily available benchmark prices, this lack of transparency made investors highly skeptical of reported prices when assessing the credit risk of a counterparty.

The lack of transparency extended to types of products within the SIVs, because banks may hold assets until they can be securitized and sold. Their exact holdings are, therefore, often unknown to investors.<sup>21</sup>

The total volume of outstanding commitments that a financial institution had given, including existing backstop lines of credit the bank was committed to or loan commitments for private equity buyouts, was also hard to determine. Many banks also had profitable money market franchises and these relationships carried implicit commitments to these funds in the event they experienced significant difficulties (e.g., a run on the fund).

A wave of uncertainty, combined with a lack of transparency, triggered the subprime crisis in the summer of 2007.

- In June 2007, Bear Sterns tried to rescue two hedge funds that were threatened by losses from subprime mortgages. The prime broker for one of the funds, Merrill Lynch, seized USD 850 million in underlying collateral but had great difficulty selling any of it. Merrill's troubles showed how illiquid the market for some of these assets had become.
- In August 2007, BNP Paribas froze (i.e., barred investors from making withdrawals from) three funds with USD 2.2 billion in assets because of an inability to value the subprime assets in the funds.

The market became increasingly concerned that many of the structured products that had been issued in recent years might

be mispriced. Worry spread beyond just the products themselves, however, as the significant exposure of large financial institutions to the subprime market was also called into question.

Shortly after these events, the markets for wholesale short-term funding effectively shut down.

## 10.8 CENTRAL BANKS TO THE RESCUE

In response to the growing crisis, the Federal Reserve and other central banks from around the world came up with innovative liquidity injection facilities. Between the fall of 2007 and the end of 2008, the Fed created backstop facilities for a majority of the asset classes that experienced stress during the crisis. Its actions included

- Creating long-term lending facilities against high quality collateral,
- Opening the discount window<sup>22</sup> to investment banks and securities firms,
- Providing funds to be lent against high-quality illiquid asset-backed securities,
- Providing funds to finance the purchase of unsecured CP and ABCP,
- Providing liquidity to money market funds, and
- Purchasing assets from Fannie Mae and Freddie Mac.<sup>23</sup>

These actions were liquidity-targeted measures. Consequently, the size of central banks' balance sheets increased considerably.

The major government interventions in the United States during the crisis were the following.<sup>24</sup>

- The Term Auction Facility (TAF), a program implemented in December 2007 and designed to provide funds to depository institutions by auctioning funds against a wide range of collateral
- The Primary Dealer Credit Facility (PDCF), which allowed the Fed to lend funds, via repos, to primary dealers
- The Economic Stimulus Act of February 2008

<sup>21</sup> The amount of reported Level 3 asset, however, could offer a rough guide. In 2006, the U.S. Financial Accounting Standards Board (FASB) required firms to value their assets through a classification system. Level 1 assets are those that can be valued according to observable market prices. Level 2 assets are those that can be marked to market. Level 3 asset values are determined based on models and unobservable inputs. Their valuation can be rather subjective. Examples of Level 3 assets are MBS, private equity shares, complicated derivatives, foreign stocks, and distressed debt.

<sup>22</sup> The discount window is a Federal Reserve lending facility that helps financial institutions manage short-term liquidity needs.

<sup>23</sup> Fannie Mae and Freddie Mac were two U.S. government sponsored enterprises that played a significant role in the mortgage markets at that time.

<sup>24</sup> Viral Acharya, Thomas Philippon, Matthew Richardson, and Nouriel Roubini, *The Financial Crisis of 2007–2009: Causes and Remedies*, 2009, NYU Salomon Center for the Study of Financial Institutions publication.

- A Government takeover of Fannie Mae and Freddie Mac in September 2008
- The Troubled Asset Relief Program (TARP) in October 2008<sup>25</sup>

## 10.9 SYSTEMIC RISK IN ACTION

*Systemic risk* is the risk that events at one firm, or in one market, can extend to other firms or markets. In turn, this can put entire markets or economies at risk. Systemic risk played a large role in exacerbating the impact of the crisis.

Note that in the ABCP and repo markets, collateral quality is important in reducing the risk of a default by the borrower.

Lenders in these markets need to have confidence in the nature and value of the assets used as collateral. As the ABCP and repo markets deteriorated, however, this confidence disappeared.

Lenders became increasingly concerned about whether the collateral contained subprime mortgages and whether any of the reported valuations could be relied upon. Due to the lack of transparency in these markets, even borrowers without subprime exposure simply could not roll over their debt.

It is often difficult to estimate the price of illiquid assets even under normal market conditions. For many in the summer of

2007 (e.g., BNP Paribas), it became impossible. Managers of money market funds, typically large purchasers of ABCP and active participants in the repo markets, began to flee and to seek refuge in Treasury bills.

The collapse of the ABCP and repo markets had numerous repercussions. Many hedge funds, unable to roll over their debt, were forced to sell assets. As hedge funds tend to hold a wide variety of assets, this impacted many markets. One of the first to be hit was the CDO market, which came under significant selling pressure. Many funds though, feeling that prices were artificially low or simply unable to practically liquidate such holdings, resorted to liquidating other assets. To close out existing positions, some funds sold higher credit-rated assets and bought lower credit-rated assets that were shorted. This pushed the prices of the higher quality assets down and the prices of the lower quality assets up. Some quantitative hedge funds that traded on pricing patterns were adversely impacted by this type of price reversal. Institutional investors and hedge funds unwound carry trades at a loss in an effort to reduce leverage.

At the same time, banks began to hoard cash (in part) due to the uncertainty around the magnitude of possible drawdowns on the backstop credit lines they had extended to SIVs. Adding to banks' concerns were outstanding commitments to underwrite leveraged buyouts. During the first part of August 2007, the three-month Libor (London interbank offered rate) rose over 30-basis points. The reluctance to lend became widespread as credit standards tightened, negatively impacting hedge funds and other financial institutions, squeezing the availability of mortgages (both residential and commercial), and restricting business lending. Thus, a financial crisis became an economic crisis.

<sup>25</sup> On October 28, 2008, Bank of America, BNY Mellon, Citigroup, Goldman Sachs, J.P. Morgan Chase, Morgan Stanley, State Street, and Wells Fargo received a total of USD 115 billion under the TARP program.

See United States., Government Accountability Office. (2009). *The Troubled Asset Relief Program March 2009 status of efforts to address transparency and accountability issues: Report to congressional Committees*. Washington, D.C.: U.S. Govt. Accountability Office. <https://www.gao.gov/assets/290/288105.pdf>

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## QUESTIONS

- 10.1** Unlike other financial crises, the GFC did not spillover from the financial markets to the wider economy.  
A. True  
B. False
- 10.2** A key driver of the demand for housing in the U.S. was the environment of low interest rates.  
A. True  
B. False
- 10.3** Many subprime mortgages were structured with lower teaser rates and higher down payments compared to traditional mortgages.  
A. True  
B. False
- 10.4** Under the originate-to-distribute model, losses on subprime mortgages were absorbed by the banks that initially made the loans (and not by investors) because the loans were guaranteed by the banks.  
A. True  
B. False
- 10.5** What triggered the subprime crisis in the summer of 2007 was a wave of uncertainty combined with a lack of transparency.  
A. True  
B. False
- 10.6** Structured investment vehicles (SIVs) were typically funded short-term and relied on being able to regularly roll over short-term debt to finance their longer dated assets.  
A. True  
B. False
- 10.7** As part of the CDO structuring process, the CDO trust partners pay one or more credit rating agencies to rate the various liabilities of the CDO.  
A. True  
B. False
- 10.8** Only government securities can be used as collateral in repo transactions.  
A. True  
B. False
- 10.9** As credit spreads on all credit assets increased substantially during the financial crisis, the market price of credit assets declined, leading to a systematic decrease in haircuts on repos from pre-crisis levels.  
A. True  
B. False
- 10.10** Residual risk is the risk that events at one firm, or in one market, can extend to other firms or markets.  
A. True  
B. False
- 10.11** At the peak of the GFC in September 2008, which of the following events did not occur  
A. Lehman Brothers declared bankruptcy.  
B. Morgan Stanley and Goldman Sachs were converted to bank holding companies.  
C. Fannie Mae and Freddie Mac were officially designated government sponsored enterprises.  
D. AIG was brought back from the brink of collapse.
- 10.12** Subprime loans became increasingly in demand for securitization because, through this process, securitizers  
A. Created pools of below investment-grade assets  
B. Bifurcated the cash flows by model-driven certainty  
C. Packaged the "safest" cash flows into investment-grade securities  
D. All of the above
- 10.13** Which of the following statements is incorrect?  
A. Prior to the GFC, many subprime mortgages were securitized into collateralized debt obligations (CDOs).  
B. Delinquencies on adjustable-rate subprime mortgages rose markedly in 2007.  
C. Prior to the GFC, banks moved assets to be securitized off their balance sheets to structured investment vehicles.  
D. During the GFC, asset-backed commercial paper provided banks with sufficient liquidity, which reduced the adverse impact of the financial crisis.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

- 10.14** Which of the following statements is incorrect about the securitization of mortgages?
- A. Securitization eliminates the credit risk associated with mortgage pools.
  - B. Securitization involves taking a portfolio of existing assets and repackaging their associated cash flows into claims on tranches.
  - C. To appeal to investor demand, the different tranches are typically structured to have a desired credit rating.
  - D. Tranches are established in order of safety, beginning with Senior AAA debt, Junior AAA, AA, A, BBB, BB, and so on.
- 10.15** Which of the following statements is incorrect?
- A. In unsecured commercial paper financing, short-term debt is issued but is not backed by any specific assets.
  - B. Repos are included in the bankruptcy process.
  - C. In a repo, a haircut is intended to protect the lender from recovering less than the full value of the loan amount in the event it needs to sell the collateral after a default.
  - D. Asset-backed commercial paper is a special case of CP where the issuer finances the purchase of the assets by issuing CP, with the assets serving as collateral.
- 10.16** Which of the following was not a form of intervention by the U.S. government during the global financial crisis?
- A. The Term Auction Facility (TAF)
  - B. The Primary Dealer Credit Facility (PDCF)
  - C. The repeal of the Truth in Lending Act
  - D. The Troubled Asset Relief Program (TARP)
- 10.17** During the summer of 2007, banks such as Northern Rock in the U.K. started to run into funding problems because of the shutdown of
- A. the asset backed commercial paper (ABCP) market.
  - B. the repo markets.
  - C. A and B.
- 10.18** As early as the summer of 2007, the short-term wholesale funding markets started to freeze. As a consequence, there was a significant increase in
- A. the Libor-OIS spread.
  - B. repo haircuts.
  - C. A and B.
- 10.19** The Lehman Brothers collapse
- A. could have been easily predicted from the ratings of Lehman's debt instruments.
  - B. could have been predicted from the financial reports of the company.
  - C. all of the above.
  - D. none of the above.
- 10.20** How did governments throughout the world intervene during the GFC?
- 10.21** What is the originate-to-distribute (OTD) business model?
- 10.22** Describe in a few words the systemic impact of the default of a major OTC derivatives dealer such as Lehman Brothers.

The following questions are intended to help candidates understand the material. They are not actual FRM exam questions.

## ANSWERS

### 10.1 False

The GFC not only spilled over to the U.S. economy, but throughout the world.

### 10.2 True

Low interest rates available on mortgages did encourage housing demand.

### 10.3 False

Although subprime mortgages were structured with teaser rates, the down payment was very low.

### 10.4 False

Under the OTD model, losses on subprime mortgages were not absorbed by the banks that initially made the loans, but by the investors that eventually owned them.

### 10.5 True

### 10.6 True

### 10.7 True

The CDO trust partners do pay to obtain a rating for the tranches of a CDO.

### 10.8 False

Various types of securities can be used as collateral in repo transactions, ranging from government bonds and high-quality corporate bonds to tranches of securitizations.

### 10.9 False

It leads to a systematic increase in repo haircuts.

### 10.10 False

This is the definition of systemic risk.

### 10.11 C.

Fannie Mae and Freddie Mac were already GSEs. They were nationalized.

### 10.12 D.

All choices lead to an increase in demand for subprime loans.

### 10.13 D.

D is incorrect since the asset-backed commercial market failed as a source of funding during the GFC.

### 10.14 A.

Securitization redistributes the credit risk associated with a pool of mortgages; it does not eliminate the credit risk.

### 10.15 B.

Repos are in fact excluded in the bankruptcy process.

### 10.16 C.

All of the others were forms of intervention.

### 10.17 C. A and B

By the summer of 2007, the short-term wholesale funding markets started to freeze, including both the ABCP market and the repo market.

### 10.18 C. A and B

The OIS-swap spread exploded (as shown in Figure 10.1) in the summer of 2007. It remained high during the crisis, jumped again when Lehman Brothers failed, and never came back to pre-crisis levels. At the same time, there was systematic increase in haircuts, from zero pre-crisis to more than 45% when Lehman failed in September 2008 (see Figure 10.2).

### 10.19 D. None of the above

Note that Lehman satisfied the Basel minimum regulatory capital requirements before it failed.

### 10.20 Governments around the world intervened by offering liquidity support facilities and recapitalizing insolvent banks in an effort to encourage bank lending.

### 10.21 In the originate-to-distribute business model, banks:

- Extend loans;
- Securitize the loans; and
- Sell the securities to investors.

### 10.22 Lehman's default triggered a cascade of defaults among its counterparties, who could not get back their collateral. Dealers that had no direct link to Lehman, but were counterparties of failed direct counterparties of Lehman, also defaulted.



# 11

## GARP Code of Conduct

### ■ Learning Objectives

After completing this reading, you should be able to:

- Describe the responsibility of each GARP Member with respect to professional integrity, ethical conduct, conflicts of interest, confidentiality of information, and adherence to generally accepted practices in risk management.
- Describe the potential consequences of violating the GARP Code of Conduct.

## I. INTRODUCTORY STATEMENT

The GARP Code of Conduct ("Code") sets forth principles of professional conduct for Global Association of Risk Professionals ("GARP"), Financial Risk Management (FRM®) and Energy Risk Professional (ERP®) certifications and other GARP certification and diploma holders and candidates, GARP's Board of Trustees, its Regional Directors, GARP Committee Members and GARP's staff (hereinafter collectively referred to as "GARP Members") in support of the advancement of the financial risk management profession. These principles promote the highest levels of ethical conduct and disclosure and provide direction and support for both the individual practitioner and the risk management profession.

The pursuit of high ethical standards goes beyond following the letter of applicable rules and regulations and behaving in accordance with the intentions of those laws and regulations, it is about pursuing a universal ethical culture.

All individuals, firms and associations have an ethical character. Some of the biggest risks faced by firms today do not involve legal or compliance violations but rest on decisions involving ethical considerations and the application of appropriate standards of conduct to business decision making.

There is no single prescriptive ethical standard that can be globally applied. We can only expect that GARP Members will continuously consider ethical issues and adjust their conduct accordingly as they engage in their daily activities.

This document makes references to professional standards and generally accepted risk management practices.

Risk practitioners should understand these as concepts that reflect an evolving shared body of professional standards and practices. In considering the issues this raises, ethical behavior must weigh the circumstances and the culture of the applicable global community in which the practitioner resides.

## II. CODE OF CONDUCT

The Code is comprised of the following Principles, Professional Standards and Rules of Conduct which GARP Members agree to uphold and implement.

### 1. Principles

**1.1 Professional Integrity and Ethical Conduct.** GARP Members shall act with honesty, integrity, and competence to

fulfill the risk professional's responsibilities and to uphold the reputation of the risk management profession. GARP Members must avoid disguised contrivances in assessments, measurements and processes that are intended to provide business advantage at the expense of honesty and truthfulness.

**1.2 Conflicts of Interest.** GARP Members have a responsibility to promote the interests of all relevant constituencies and will not knowingly perform risk management services directly or indirectly involving an actual or potential conflict of interest unless full disclosure has been provided to all affected parties of any actual or apparent conflict of interest. Where conflicts are unavoidable GARP Members commit to their full disclosure and management.

**1.3 Confidentiality.** GARP Members will take all reasonable precautionary measures to prevent intentional and unintentional disclosure of confidential information.

## 2. Professional Standards

### 2.1 Fundamental Responsibilities.

- GARP Members must endeavor, and encourage others, to operate at the highest level of professional skill.
- GARP Members should always continue to perfect their expertise.
- GARP Members have a personal ethical responsibility and cannot out-source or delegate that responsibility to others.

### 2.2 Best Practices.

- GARP Members will promote and adhere to applicable "best practice standards," and will ensure that risk management activities performed under his/her direct supervision or management satisfies these applicable standards.
- GARP Members recognize that risk management does not exist in a vacuum. GARP Members commit to considering the wider impact of their assessments and actions on their colleagues and the wider community and environment in which they work.

**2.3 Communication and Disclosure.** GARP Members issuing any communications on behalf of their firm will ensure that the communications are clear, appropriate to the circumstances and their intended audience, and satisfy applicable standards of conduct.

### III. RULES OF CONDUCT

#### 1. Professional Integrity and Ethical Conduct

##### GARP Members:

- 1.1 Shall act professionally, ethically and with integrity in all dealings with employers, existing or potential clients, the public, and other practitioners in the financial services industry.
- 1.2 Shall exercise reasonable judgment in the provision of risk services while maintaining independence of thought and direction. GARP Members must not offer, solicit, or accept any gift, benefit, compensation, or consideration that could be reasonably expected to compromise their own or another's independence and objectivity.
- 1.3 Must take reasonable precautions to ensure that the Member's services are not used for improper, fraudulent or illegal purposes.
- 1.4 Shall not knowingly misrepresent details relating to analysis, recommendations, actions, or other professional activities.
- 1.5 Shall not engage in any professional conduct involving dishonesty or deception or engage in any act that reflects negatively on their integrity, character, trustworthiness, or professional ability or on the risk management profession.
- 1.6 Shall not engage in any conduct or commit any act that compromises the integrity of GARP, the (Financial Risk Manager) FRM designation or the integrity or validity of the examinations leading to the award of the right to use the FRM designation or any other credentials that may be offered by GARP.
- 1.7 Shall endeavor to be mindful of cultural differences regarding ethical behavior and customs, and to avoid any actions that are, or may have the appearance of being unethical according to local customs. If there appears to be a conflict or overlap of standards, the GARP member should always seek to apply the higher standard.

#### 2. Conflict of Interest

##### GARP Members:

- 2.1 Shall act fairly in all situations and must fully disclose any actual or potential conflict to all affected parties.
- 2.2 Shall make full and fair disclosure of all matters that could reasonably be expected to impair their independence and

objectivity or interfere with their respective duties to their employer, clients, and prospective clients.

#### 3. Confidentiality

##### GARP Members:

- 3.1 Shall not make use of confidential information for inappropriate purposes and unless having received prior consent shall maintain the confidentiality of their work, their employer or client.
- 3.2 Must not use confidential information to benefit personally.

#### 4. Fundamental Responsibilities

##### GARP Members:

- 4.1 Shall comply with all applicable laws, rules, and regulations (including this Code) governing the GARP Members' professional activities and shall not knowingly participate or assist in any violation of such laws, rules, or regulations.
- 4.2 Shall have ethical responsibilities and cannot out-source or delegate those responsibilities to others.
- 4.3 Shall understand the needs and complexity of their employer or client, and should provide appropriate and suitable risk management services and advice.
- 4.4 Shall be diligent about not overstating the accuracy or certainty of results or conclusions.
- 4.5 Shall clearly disclose the relevant limits of their specific knowledge and expertise concerning risk assessment, industry practices and applicable laws and regulations.

#### 5. General Accepted Practices

##### GARP Members:

- 5.1 Shall execute all services with diligence and perform all work in a manner that is independent from interested parties. GARP Members should collect, analyze and distribute risk information with the highest level of professional objectivity.
- 5.2 Shall be familiar with current generally accepted risk management practices and shall clearly indicate any departure from their use.
- 5.3 Shall ensure that communications include factual data and do not contain false information.
- 5.4 Shall make a distinction between fact and opinion in the presentation of analysis and recommendations.

## **IV. APPLICABILITY AND ENFORCEMENT**

Every GARP Member should know and abide by this Code. Local laws and regulations may also impose obligations on GARP Members. Where local requirements conflict with the Code, such requirements will have precedence.

Violation(s) of this Code may result in, among other things, the temporary suspension or permanent removal of the GARP Member from GARP's Membership roles, and may also include temporarily or permanently removing from the violator the right to use or refer to having earned the FRM designation or any other GARP granted designation, following a formal determination that such a violation has occurred.



# INDEX



## A

accuracy, 98, 99  
adaptability, 98  
airline risk management, 30–31  
anchoring, 118  
Anheuser-Busch, 29  
arbitrage pricing theory (APT), 86  
asset-backed commercial paper (ABCP), 63, 145  
asset/liability management (ALM), 127  
avoid risk, 8, 26–27

## B

balancing risk and reward, 14–15  
bank holding companies (BHCs), 44  
banking industry, 14, 24  
bank operational risk, 6  
bank's audit function, 54–55  
Basel Committee on Banking Supervision (BCBS), 42  
board audit committee, 50  
board risk management committee, 50  
brainstorming, 7  
business comparison, 14  
business lies strategic risk, 6–7  
business managers, 54  
buy-and-hold strategy, 66–69

## C

capital asset pricing model (CAPM), 76–78, 86, 87  
  performance measures, 80–81  
captive insurance, 108–109  
central banks, 148–149  
Chen, N., 87  
Chicago Board of Trade (CBOT), 29

chief executive officers (CEOs), 41  
chief risk officer (CRO), 51  
clarity, 99  
classic risk management process, 7  
Coca-Cola, 88  
collateralized debt obligation (CDO), 62, 145  
collateralized loan obligations (CLOs), 62  
commercial mortgage backed securities (CMBS), 66  
commercial real estate markets (CRE), 10  
Commodity Futures Trading Commission (CFTC), 46  
completeness, 98  
Comprehensive Capital Analysis and Review (CCAR), 45, 114, 115  
comprehensiveness, 99  
confidentiality, 154, 155  
conflict of interest, 12–13, 154, 155  
Conner, G., 86  
Conservative Minus Aggressive (CMA), 87  
Continental Illinois bank, 125–126  
corporate governance, 40, 42, 45–47, 135–137  
  aftermath, 137  
  Enron, 136–137  
Corzine, Jon, 46  
credit default swaps (CDSs), 62  
credit derivatives, 64  
credit risk, 5, 66  
  limits, 51–52  
credit risk transfer mechanisms  
  buy-and-hold strategy, 66–69  
  collateralized debt obligations, 62  
  collateralized loan obligations, 62  
  credit default swaps, 62  
  originate-to-distribute, 66–69  
  securitization, 65–66  
  uses, 63–65  
cyber risk, 137

## D

day-to-day applications, 14  
digital risk management, 16  
distribution, 99  
diversification, 74  
Dodd-Frank Act, 44–45  
Dodd-Frank Act Stress Test (DFAST), 45, 114

## E

economic capital, 14  
effective risk analysis, 94  
effective risk data aggregation  
    benefits, 95  
    characteristics, 98–99  
    data architecture and IT infrastructure, 96–97  
    key governance principles, 95–96  
Enron, 136–137  
enterprise risk management (ERM), 15–16  
    benefits, 104  
    dangerous concentrations, 108  
    dimensions, 106–107  
    history, 105–106  
    risk culture, 109–113  
    risk retention decisions, 108–109  
    sharpest blade  
        post-crisis trends, in scenario building, 114–116  
        scenario analysis, 113, 114  
        sensitivity test, 113  
        stress test, 116  
    strategic decisions, 116–117  
    thinking beyond silos, 108  
    vertical vision, 107–108  
    from vision to action, 106–107  
equity investors, 24  
ERM. See enterprise risk management (ERM)  
European Banking Authority (EBA), 45, 116  
Exchange Traded Fund (ETF), 88  
expected loss (EL), 10, 12  
Extreme Value Theory (EVT), 12

## F

fundamental factor models, 87–89  
Federal Reserve Board (FRB), 45  
feedback effects, 118  
financial disasters  
    constructing and implementing, 127  
    hedging strategy, 128  
    Metallgesellschaft Refining & Marketing,  
        127–128  
corporate governance, 135–137  
    aftermath, 137  
    Enron, 136–137  
cyber risk, 137

financial engineering, 134  
complex derivatives, 134  
complex financial instruments, 134–135  
excess leverage, 134–135  
Sachsen, 135  
funding liquidity risk  
    Continental Illinois, 125–126  
    Lehman brothers, 125  
    lessons learned, 126–127  
    Northern Rock, 126  
interest rate risk, 124  
model risk, 128–132  
    corporate governance, 132  
    fudging VaR models, 132  
    governance, 131  
    long term capital management, 129–130  
    operational risk, 131–132  
    risk exposure grows, 131  
    risk measurement models, 130–131  
    setting the scene, 131  
    stress test, 130–131  
    trading models, 130  
    wrong assumptions, 129  
reputation risk, 135  
rogue trading, 132–134  
SWIFT, 137  
financial engineering, 134  
complex derivatives, 134  
complex financial instruments, 134–135  
excess leverage, 134–135  
Sachsen, 135  
financial services holding companies (FSHCs), 44  
Financial Stability Board (FSB), 47  
firm-level vs. industry-level risk appetite, 25  
firms, 67  
    corporate hedging, 32–33  
    modern imperative to manage risk, 22–24  
        hedging philosophy, 23–24  
        instruments, 23  
        principal derivatives markets, 22–23  
    rightsizing risk management, 27–28  
    risk appetite, 24–26  
    risk management road map, 22  
    risk mapping, 26  
    risk transfer toolbox  
        airlines, 30–31  
        beer and metal, 29–30  
        exchange-based derivatives, 28  
        foreign exchange risk, 31–32  
        interest rate risk, 31–32  
        trading mechanics, 28  
        strategy selection, 26–27  
    foreign exchange risk, 31–32  
    framing, 118  
    frequency, 99

fundamental responsibilities, 155  
Fundamental Review of the Trading Book (FRTB), 42  
funding liquidity risk, 5  
Continental Illinois, 125–126  
Lehman brothers, 125  
lessons learned, 126–127  
Northern Rock, 126

## G

GARP Code of Conduct  
applicability, 156  
confidentiality, 155  
conflict of interest, 155  
enforcement, 156  
fundamental responsibilities, 155  
general accepted practices, 155  
principles, 154  
professional integrity and ethical conduct, 155  
professional standards, 154  
general market risk, 4  
Ginnie Mae. See Government National Mortgage Association (GNMA)  
Glass-Steagall Act, 44  
global financial crisis, 40  
governance  
bank's audit function, 54–55  
implementing board-level risk  
board audit committee, 50  
board risk management committee, 50  
risk advisory director role, 50  
incentives and risk-taking, 53–54  
infrastructure  
best-practice risk management, 46–47  
board and corporate, 45–46  
interdependence of organizational units, 54  
post-crisis regulatory response  
Basel Committee on Banking Supervision, 42  
Basel I, 42  
Basel II, 42  
Basel III, 42  
industry restructuring, 44–45  
net stable funding ratio, 42  
Supervisory Review and Evaluation Process, 45  
risk appetite, 50–51  
chief risk officer (CRO), 51  
limits policies, 51–52  
monitoring risk, 52–53  
statement, 47–49  
Government National Mortgage Association (GNMA), 66  
Graham-Leach-Bliley Act, 44  
Great Financial Crisis of 2007–2009 (GFC)  
central banks, 148–149  
financial intermediaries, 144–145  
issues with the rating agencies, 145  
liquidity crunch hits, 146–147

originate-to-distribute, 143  
short-term wholesale debt market, 145–146  
subprime crisis, 142  
subprime mortgage market pre-crisis, 142  
systemic risk, 149  
valuation uncertainty and transparency issues, 147–148  
Greenspan, Alan, 62  
groupthink, 118

## H

hard numbers, 15  
hedging exposure, factor analysis, 89  
hedging philosophy, 23–24  
herding, 118  
high minus low (HML), 87  
holistic thinking, 117–118  
home bias, 118  
home/host cooperation, 100  
human agency, 12–13

## I

information ratio (IR), 81  
Institute of Internal Auditors (IIA), 55  
integrity, 99  
interest rate risk, 31–32  
internal capital adequacy assessment process (ICAAP), 45  
internal liquidity adequacy assessment process (ILAAP), 45  
International Monetary Fund (IMF), 64  
International Professional Practices Framework (IPPF), 55  
investment analysis, 15

## J

Jensen's performance index (JPI), 80–81  
J.P. Morgan, 88

## K

key risk indicators (KRIs), 15  
Knightian uncertainties, 9

## L

liquidity risk, 5  
long term capital management (LTCM), 129–130  
loss aversion, 118

## M

macroeconomic factor models, 87  
market liquidity risk, 5  
market portfolio, 77  
market risk, 4, 13  
limits, 52  
Markowitz, Harry, 74  
McDonald's financing and market risk, 31

mental accounting, 118  
Metallgesellschaft Refining & Marketing (MGRM), 32, 33, 127–128  
mitigate risk, 8, 27  
model risk, 128–132  
    corporate governance, 132  
    fudging VaR models, 132  
    governance, 131  
    long term capital management, 129–130  
    operational risk, 131–132  
    risk exposure grows, 131  
    risk measurement models, 130–131  
    setting the scene, 131  
    stress test, 130–131  
    trading models, 131  
    wrong assumptions, 129  
modern portfolio theory (MPT), 4–76  
moonwalking bears, 9  
mortgage backed securities (MBS), 63

## N

New York Stock Exchange (NYSE), 87  
Northern Rock, 126  
nuclear war, 9

## O

operational risk, 6  
orange county, 134–135  
originate-to-distribute (OTD), 66–69, 143  
Osaka Securities Exchange (OSE), 132  
ostrich effect, 118

## P

pricing strategies, 15  
professional integrity and ethical conduct, 154, 155

## Q

quantitative asset management techniques, 75

## R

referencing, 118  
remedial actions, 100  
repos, 145  
reputation risk, 7, 135  
retain risk, 8, 26  
rightsizing risk management, 27–28  
risk-adjusted return on capital (RAROC), 14–15  
risk aggregation, 13  
risk appetite, 24–26, 46, 50–51  
    chief risk officer (CRO), 51  
    limits policies, 51–52  
    monitoring risk, 52–53  
risk appetite statement (RAS), 47–49

Risk Data Network (RDN), 99  
risk management building blocks, 2  
    balancing risk and reward, 14–15  
    conflicts of interest, 12–13  
    enterprise risk management, 15–16  
    human agency, 12–13  
    interactions between factors, 11–12  
    knowns and unknowns, 8–10  
    process, 7–8  
    quantitative risk metrics  
        expected loss, 10  
        expect the unexpected, 10  
        risky relationships, 10–11  
        from unexpected to extreme, 10  
        value-at-risk, 11  
    risk aggregation, 13  
    risk factor breakdown, 11–12  
    structural change, 11  
    timeline, 2, 3  
typology  
    banking industry, 2–4  
    business lies strategic risk, 6–7  
    credit risk, 5  
    liquidity risk, 5  
    market risk, 4  
    operational risk, 6  
    reputation risk, 7  
    risk management cost/benefit analysis, 15  
    risky relationships, 10–11  
Robust Minus Weak (RMW), 87  
rogue trading, 132–134  
Roll, R., 87  
rolling hedge, 128  
Ross, S., 87  
Rumsfeld, Donald, 8

S

Sarbanes-Oxley (SOX), 41  
savings and loan (S&L) crisis, 124  
scenario stress test, 118  
securitization process, 65–66  
self-insurance, 108–109  
sharp performance index (SPI), 80  
Singapore International Monetary Exchange (SIMEX), 132  
small minus big (SMB), 87  
Sortino ratio (SR), 81  
special purpose vehicle (SPV), 65  
specific market risk, 4  
Standard and Poor's Depository Receipts (SPDR), 88  
State Street Global Advisors, 88  
statistical factor models, 89  
strong risk data aggregation capability, 97–98  
supervisory measures, 100

Supervisory Review and Evaluation Process (SREP), 44, 45  
surprise factor, 86  
SWIFT, 137  
syndication, 64  
systemic risk, 149

## T

timeliness, 98  
tracking error (TE), 81  
trading liquidity risk. *See* market liquidity risk  
transfer risk, 8, 27  
Treynor performance index (TPI), 80  
triaging risks, 7

## U

underwater icebergs, 9  
U.S. Dodd-Frank Act, 44  
usefulness, 99

## V

Value-at-Risk (VaR), 11, 13  
Volcker Rule, 44  
Volkswagen Emission Cheating Scandal, 135

## W

wrong way risk, 63

