First, demand for commercial property strengthens, often in line with general economic upswings. But CRE supply is inelastic[15]: 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).[16]

Jorion defines the VaR measure as the "worst expected loss over a given horizon under normal market conditions at a given level of confidence."[17] 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 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.[18]

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

[15] 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.

[16] 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.

[17] P. Jorion, *Value at Risk: The New Benchmark for Managing Financial Risk*. New York, NY: McGraw-Hill, 2001

[18] 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).

1.6 STRUCTURAL CHANGE: FROM TAIL RISK TO SYSTEMIC CRISIS

Some risk events have a diabolical side that seems designed to outwit the human mind. This may be because such events are very rare and extreme or they arise from unobserved structural changes in a market.

In complex systems, such as the global climate or financial markets, extremely rare events can happen over long time periods, even if the system remains structurally stable. These risks, really an extreme version of unexpected loss, are difficult to identify in the data because (by definition) there are not a lot of them.

Tail risk events (or outliers) might be rare, but a long enough time series of data should reveal evidence of their existence. Where data are scarce, modern risk management can sometimes apply statistical tail risk techniques, utilizing a branch of statistics called Extreme Value Theory (EVT) to help make tails more visible and to extract the most useful information.[19]

[19] 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.

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.

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):[20]

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

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:

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

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.

[20] See M. Crouhy, D. Galai, and R. Mark, *The Essentials of Risk Management*, 2nd 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 xExposure 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 rough 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).

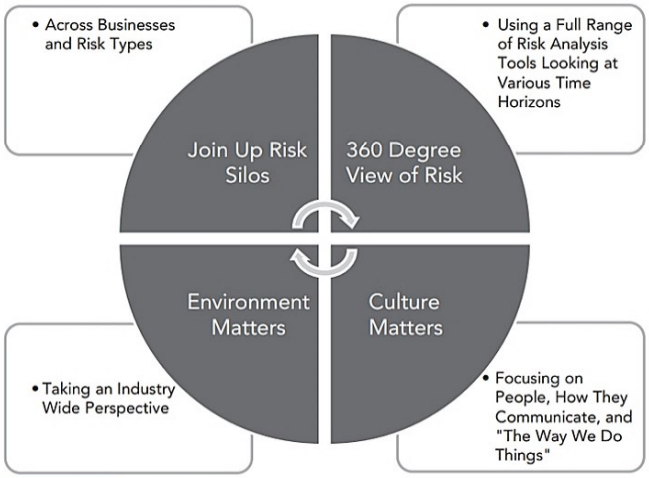

Figure 1.7 ERM needs to think a bit bigger.

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.

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

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 = After-Tax Net Risk-Adjusted Expected Return*/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 mangers 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 C. 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 × LGD × 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 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.

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.**

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.[1] This process continued with the more recent arrival 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,[2] and a decline in interest rates and market volatility following the 2007–2009 global financial crisis. At the same time, there are

[1] 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.

[2] 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)

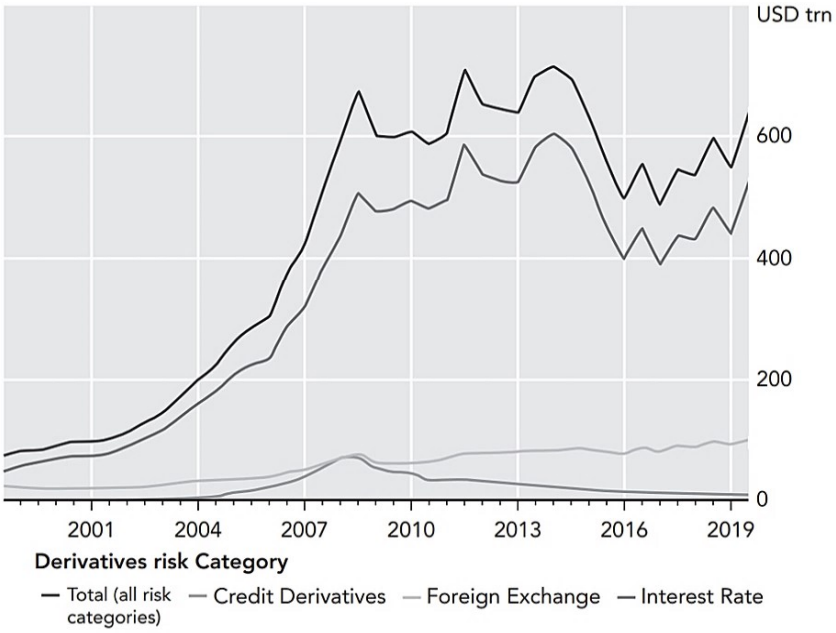

Figure 2.2 **OTC derivative notional volumes by risk type (1999–2019).**

Source: BIS Derivatives Statistics, see https://www.bis.org/statistics/about_derivatives_stats.htm?m=6%7C32. 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.[3]

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

[3] 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).

UK corporate risk appetite—CFO survey data.

Source: Deloitte, The Deloitte CFO Survey (UK), Q1 2018, page 3. Reprinted by permission.

the board know if risk taking looks unnaturally low or if there is a danger of breaching the agreed risk appetite.[4]

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.

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

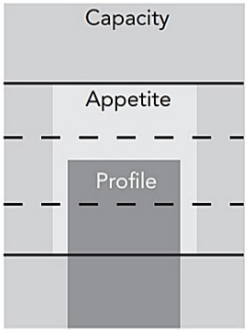

Figure 2.3 **Risk appetite as a metric.**

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.[5] 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 *rightsize* risk management.

For example, transferring a well-understood risk through a one-off market hedge or the purchase of annual insurance can be (relatively) simple. Running a dynamic and sophisticated hedging strategy that involves continual readjustment in the markets is another matter entirely.

- 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.

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.

[5] 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.

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 *buy* 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 *sell* 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.[6] Like other brewers, it is a major user of derivatives to manage these risks (Figure 2.7).

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.[7] 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

[6] Anheuser-Busch InBev, *2018 Annual Report*, Section C: Commodity price risk, page 135.

[7] 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).[8]

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,[9] 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.[10]

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.

[8] 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.

[9] 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

[10] 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.[11] 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).[12]

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

[11] 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 Airlines' 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.

[12] 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; paper: http://www1.american.edu/academic.depts/ksb/finance_realestate/mrobe/Library/howmuch.pdf

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 risk characteristics (currency, fixed versus. variable, etc.) into another using derivatives.
Changing Business and Financing Needs	Deals roll over, and 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 changes in the regulations and taxes.
Market Direction and Behavior	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 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 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).

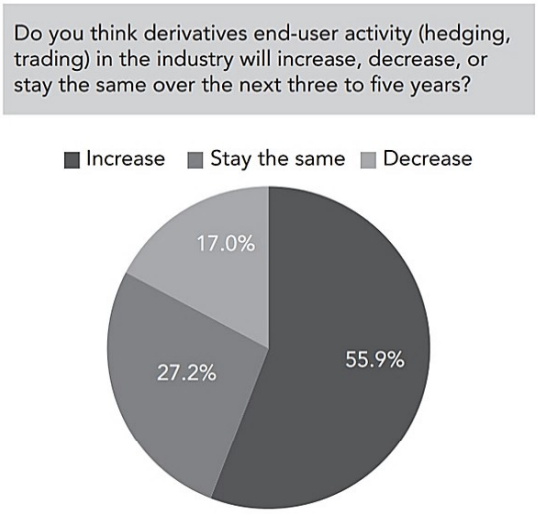

Figure 2.10 **Professionals believe derivatives end-user activity will increase.**

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.

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?[13]

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.

[13] For further discussion see S. Heiligtag, 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 s 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 relations 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.