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Financial Risk Management

Sources of Financial Risk and Risk Assessment

Peter Moles

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Financial Risk Management

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Prior to taking up his post he worked in the City of London for international and money-centre banks. During the course of his career in the international capital markets he was involved in trading, risk management, origination and research. He has experience of both the Eurobond and Euro money markets. His main research interests are in financial risk management, the management of financial distress and in how management decisions are made and the difficulties associated with managing complex problems. He is author of the *Handbook of International Financial Terms* (with Nicholas Terry, published by Oxford University Press) and *Corporate Finance* (published by John Wiley & Sons). He is a contributing author for *The Split Capital Investment Trust Crisis* (published by Wiley Finance) and has written a number of articles on the problems of currency exposure in industrial and commercial firms.

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Contents

Introduction

This elective course covers one of the core functions of finance, namely risk management.* A large part of the role of finance – the actions of the financial specialist and the operations of the financial department within firms – is devoted to handling, controlling and profiting from risk. This text sets out to show why and how firms manage their financial risks.

For most kinds of activity, risk is unavoidable as long as the outcome is uncertain. Therefore, taking on risk and handling it is a core management discipline. All major corporate decisions involve choices as to how much risk to take and how best to manage these risks. At its simplest, risk management involves procedures for becoming aware of risks and the methods used to analyse risks, assess their impact and respond accordingly.

Financial risk management is the activity of monitoring financial risks and managing their impact. It is a sub-discipline of the wider task of managing risk and also a practical application of modern finance theories, models and methods. The traditional role of finance within the firm has been in terms of reporting and control. The modern approach is to see the financial function as actively formulating policy and directly involved in the subsequent decisions. Financial risk management involves handling those business decisions resulting from financial exposures.

As a subject financial risk management draws on the disciplines of accountancy, economics, management science, decision theory, statistics and psychology as well as the key principles and methodologies to be found in finance. Before starting, the student is expected to have some prior knowledge of the fundamentals of finance, and, in particular, time value of money methods, and a basic understanding of statistical concepts. The level of knowledge required is that which is necessary in order to successfully complete a course in finance.

* The other key functions are valuation and the optimisation of resources across time.

Arrangement of the Course

The modules that go to make up *Financial Risk Management* fall into the following topic areas:

	Topic area	Modules
One	*Introduction*	1 and 2
	The background and basics of risk management	
Two	*The Markets*	3 to 7
	Sources of financial risk from interest rates, currencies, equities and commodities; the nature and structure of financial markets; the asset price generating process	
Three	*Risk Assessment*	8 to 11
	The techniques used to assess, model, manage and control risks	

The course starts with an overview of the financial risk management process and its historical development (Part 1). A rationale for such activity is proposed based on current financial theories about firms and markets. It then proceeds to an examination of the principal financial risks that arise from interest rates, currencies, equities and commodities markets (Part 2).

The text next goes on to examine methods used to identify, measure and reduce these risks (Part 3). In implementing risk management policies, firms seek to quantify the risks they face and the resultant impact on their profits or cash flows. Two separate approaches are covered – the use of quantitative models and qualitative scenario building – and the link between the two is discussed.

In presenting the text in this way, the aim is to provide a comprehensive and logical approach to what is a complex subject.

Approach and Key Concepts

Financial risk management is a holistic subject. The order in which the text is presented follows what may be called the standard risk management model. While this is useful in developing a good understanding of how risk arises and how it is handled, it does have some disadvantages in that material on one subject (for instance, interest rate risk) is presented in modules that do not follow each other. As a result, we would encourage students to look at alternative ways to approach the text.

A basic premise of the text is that it is orientated at the industrial and commercial firm. If anything, the typical firm is taken to be a manufacturer with cross-border transactions of various kinds. That said, some sections provide methods that are more suited to financial firms. On the whole the applicability of a technique to a particular type of firm will be self-evident.

As a course, it is largely technique based and emphasises the financial, scientific or engineering approach to risk management. While this is more appropriate to a course on managing financial risks, the student should be aware that there is an

alternative, behaviourist approach to risk. In most cases, this social science approach provides complementary insights into the sources and treatment of risk by individuals and organisations.

Also financial risk management uses many ideas that are central to finance. For instance, the key idea behind portfolio theory, the mean-variance framework is the main approach to assessing the aggregate risk in an organisation. To use the portfolio approach requires us to know the expected return on an asset, the asset's variance or standard deviation (that is, the dispersion from its expected return) and the correlation to other assets in the portfolio. It is the same methodology used in portfolio selection but applied to a different purpose. In risk management it is as if we were running the ideas of portfolio selection in reverse, starting with a given set of assets and determining their risk, rather than – in traditional portfolio selection – starting with a risk/return objective and finding the appropriate set of assets. Even so, optimising the risks in a firm is still an objective.

A key idea to understanding risk is the dispersion or the variance of return.* At its simplest, the stochastic process that underlies future asset prices can be seen in the binomial model where, for the next period, the asset price can take one of only two states: an increase or decrease. Extending this approach allows one to understand the price-generating process for financial assets as well as how derivatives on these assets are priced.†

Once the text has been read and assimilated, one of the key approaches to assessing risk will become evident, namely the measurement of the position sensitivity to the risk factor (usually the market factor). Sensitivity is a key concept in risk management. Knowing the degree of responsiveness to the source of risk (coupled to its impact) is essential in order to manage the risk. If one might use a medical analogy to help bring home the point, people have different tolerances to outside hazards: sunlight, alcohol, infections, pollutants, irritants and so forth. Knowing how susceptible one is to chemical irritants is useful when determining the amount of exposure one may take and the kinds of precautions that might be in order – for instance, the need to wear rubber gloves.

To manage risk it is necessary to measure it – accurately. An advertising campaign run by the Union Bank of Switzerland (UBS) some time ago promoted its expertise in this area with the slogan: 'Master the detail – manage the risks.' A similar approach is used here. Much of the material presented in the course covers the different approaches used to master the detail of financial risk management. The text introduces ideas at an early stage – for instance, much of the conceptual foundation for risk management is given in Module 1 (Introduction) – that are then taken apart and examined in detail in subsequent modules. In particular, all of Part 3 is devoted to examining different analytical approaches to financial risk management.

* This dispersion is often referred to as 'volatility' by market participants.

† These are the subjects of the *Derivatives* course.

Assessment

As is customary with this programme, you will find self-test questions and cases at the end of each module. Also provided are two pro-forma exams of the type it is necessary to pass in order to gain credit from this course. The exam assessment is based on the following criteria:

Section	Number of questions	Marks obtainable per question	Total marks for the section
Multiple choice questions	30	2	60
Cases	3	40	120
			180

Acknowledgements

I would like to thank Financial Times Ltd and *The Scotsman* for permission to reproduce items from their publications as background material to this course. Also JP Morgan for the right to reproduce material from its RiskMetrics™ system.

Thanks are also in order to the production team at Edinburgh Business School and an anonymous reviewer of an early draft of some of the text who provided valuable comment on the evolving material. As is usual in these matters, all errors remain the author's responsibility.

PART I

Introduction

Module 1 Introduction

Module 2 Risk and the Management of the Firm

Module 1

Introduction

Contents

Learning Objectives

This module introduces the sources of risk, together with the methods used to measure it. It starts by looking at the historical background before going on to define risk. It then examines the basic approaches used to identify, measure and reduce risks. Managing risk is a key activity for firms, and a range of different approaches is outlined. Firms may seek either to examine the totality of the risks they face in the aggregate, an approach known as 'top-down', or to build up their exposures from the individual risks, a procedure referred to as 'ground-up'. In practice, many firms use both methods.

The function of risk management is to control the effects of uncertain and generally adverse external developments (or events) on firms' activities and projects. Financial risk management is a more specific activity that seeks to limit the effects of changes in financial variables such as interest rates, currencies and commodity prices.

After reading this module, you should be able to understand:

- what financial risk management is designed to achieve;
- the difference between uncertainty and risk;
- the multidimensionality of risk;
- how different attitudes to risk lead to different decisions as to what amount of risk is acceptable;
- the basic approaches used to manage risk;
- the basic nature of the financial risks facing the firm;
- the three key steps used in risk management: risk awareness, risk measurement and risk adjustment.

1.1 Introduction

My introduction to the dangers of **financial risk** arose in the early 1970s when I had occasion to travel to Germany and, in order to have money available, was advised by my bank to take traveller's cheques. At the time, there was little choice of currency for these, and I was persuaded to take US dollar-denominated ones on the grounds that they were the most negotiable. When I got to Germany, I found that each time I cashed my cheques I received fewer and fewer Deutschmarks for my dollars. I was a victim of adverse movements in the exchange rate. I had, unknowingly at the time, been exposed to currency risk. In reality I had taken on considerably more risk than I need have, since not only was I exposed to movements in the Deutschmark against the US dollar, but I had also exposed myself to the exchange rate risk between British pounds (known as sterling) and the dollar, a fact I discovered on my return to the UK when I sought to cash in my surplus cheques![*] My experience, as we will discuss below, mirrors that of the modern development of financial risk management, which has its origins in the global financial dislocations that followed the collapse of the post-war global structure called the Bretton Woods Agreement.

This module introduces the basic concepts of risk management and the justification for this process. Managing risk is part of any organisation's strategic and operational activities, and analysing risks is an important aspect of a manager's job. **Risk management** is the process of monitoring risks and taking steps to minimise their impact. **Financial risk management** is the task of monitoring **financial risks** and managing their impact. It is a sub-discipline of the wider function of risk management and an application of modern financial theory and practice. Financial risk management falls within the financial function of an organisation and is a reflection of the changing nature of this function over time. Traditionally, the financial function has been seen in terms of financial reporting and control. The modern approach is to consider the financial function in terms of financial policy and financial decision making. This includes the management of the firm's operational, business and economic risks.

Risk is pervasive. In fact, we experience it in our everyday lives, as it is a constant of the human condition. Everything we do in our lives has a degree of risk attached to it. In living with risk, however, certain potentially high-risk exposures or potential events require us to take corrective action, for instance avoiding violent situations or insuring one's life, home and other possessions. In the terminology of risk management, we would be adjusting the risk; that is, reducing the risk to acceptable proportions by hedging, offsetting or possibly eliminating it, depending on the courses of action that were available. The reason we make such adjustments is that the particular risks are too great for an individual to bear. We may transfer part or all of these risks to those better able to accept them, either by sharing the risk via insurance (as with home and life assurance policies) or, in some cases, by finding others who have the opposite risk and agreeing with them to exchange positions.

[*] A more detailed discussion of this issue is given in the appendix to this module.

An example of risk management is the case of a commodity producer who is concerned about investing in production. To protect against adverse movements in the price of the commodity before it can be sold, the producer may seek out a buyer and agree to a fixed price before committing to produce. On the other side, the buyer has an equal incentive to agree to a fixed price, as he will be concerned that the price might increase in the future. In the parlance of financial markets, the buyer is locking in a fixed forward price for the commodity, in anticipation of its being needed in the future. Taking such a step will eliminate the risk to the producer that the price may decline, and to the consumer that the price may rise before the purchase.* Alternatively, we may change our behaviour to reduce the risk. For instance, one (but not the only) reason that companies establish overseas manufacturing subsidiaries in foreign markets is to eliminate currency risk on exports.

Because certain types of risk are unacceptable, a market for exchanging or offsetting risks has developed. This market in risk includes the insurance markets, capital markets and specialised financial instruments, such as a variety of derivatives. While it is possible to mitigate or transfer a great many types of risk in this way, **the key to the risk management process is choosing those risks to accept, not seeking to avoid all risks**. The latter is impossible.

1.1.1 Historical Background

There is evidence of risk management activity going back to the dawn of time.† There are indications of forward dealing taking place in India as early as 2000 BC; a forward market in grain is said to have existed in Ancient Rome; and certainly by the Middle Ages risk sharing was widely used. Merchants spread their risks through collective ventures by pooling capital to finance trading expeditions, thus allowing them to diversify their investments. Agreements allowing parties with opposite risks to exchange positions were also becoming common practice. For instance, a forward market in currencies was well established in Antwerp by the close of the fifteenth century. The Antwerp exchange was the original model for Thomas Gresham's Bourse, which was set up in 1571 in London, later to be known as the Royal Exchange. By the eighteenth century in England thriving risk exchange activity was taking place, with buyers and sellers willing to contract forward to eliminate price and delivery risk on basic commodities. Since much of the uncertainty arose in relation to imported products, these markets were located at terminal points such as dockyards. It was at this time that life assurance was first introduced as a product and that insurance companies were established. The above evidence is testimony to the ongoing nature of the problem presented by risk in human affairs and the willingness of individuals to create arrangements to mitigate its worst effects.

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* Of course, by buying forward, the buyer forgoes the opportunity to purchase the commodity at a lower price, were it to fall in the meantime. The decision to 'buy forward' – or to hedge – will depend on many factors: the consumer's tolerance of risk, expectations about future price changes, the supply outlook and how much prior price variability (generally known as volatility) there has been or is expected in the future. The same considerations apply to the producer's or seller's decision as to whether to 'sell forward' (that is, hedge the exposure to future price movements).

† A good discussion of the history of risk management is to be found in Bernstein (1996).

In the nineteenth century, the development of modern risk management techniques took a step forward with the formation of organised terminal or futures exchanges to allow participants to exchange risks on a wide range of agricultural commodities. The United States, because of the economic importance of its large agricultural base, led the way with the establishment of commodity exchanges in New York and Chicago. Soon after, similar terminal exchanges were established in other major trading centres, such as London and Paris.

Financial risk management has always been implicit in the management of the firm. Its recent development as a major management responsibility, however, is the result of two major post-war developments. The first was the collapse of the Bretton Woods Agreement following the decision by the US on 15 August 1971 to stop exchanging dollars for gold at the fixed price of $35 per oz. From that moment on, foreign exchange markets became more volatile, a factor that directly affected interest rates and, indirectly, other assets such as commodities, many of which are priced and traded in dollars.* The collapse of the fixed exchange rate system was shortly followed by the first oil shock, when the price of oil quadrupled in the winter of 1973–4. These two events led directly to a demand for instruments to manage these risks.

The increased price uncertainty or volatility that has been seen since the early 1970s has been one of the main driving forces behind changes in financial risk management tools and techniques and the increased choice available to practitioners. Another development encompassed the fundamental changes that took place in the behaviour of economic variables from the mid-1960s. With the collapse of the Bretton Woods Agreement, individual countries were able to pursue divergent economic policies, the impact of which was now transmitted through the free-floating exchange rate. To combat inflation and to prevent excessive currency depreciation, countries needed to have a more aggressive approach to managing interest rates, which in some cases were raised to unprecedented levels.

1.1.2 Increased Volatility in Foreign Exchange Rates

Figure 1.1 and Figure 1.2 show changes in the exchange rate of the British pound against the US dollar. Apart from the occasional currency devaluation, prior to the breakdown of the Bretton Woods Agreement there was relative stability month on month. After the agreement collapsed, increased volatility is clearly evident. Before the collapse of managed exchange rates, exporters and importers could be relatively confident of the prices they would get or have to pay; afterwards, the rules had changed. With a free-floating exchange rate, both exporters and importers had significant currency risk. Exporters sought to protect themselves by pricing in their domestic currency; importers sought to do the same. By accepting foreign currency prices, one or other party stood to suffer a potential loss if the exchange rate moved significantly between the time when the agreement was reached and that when the payment was made.

* This was the time I experienced my lesson in the vagaries of currency movements, as detailed in the first paragraph of Section 1.1.

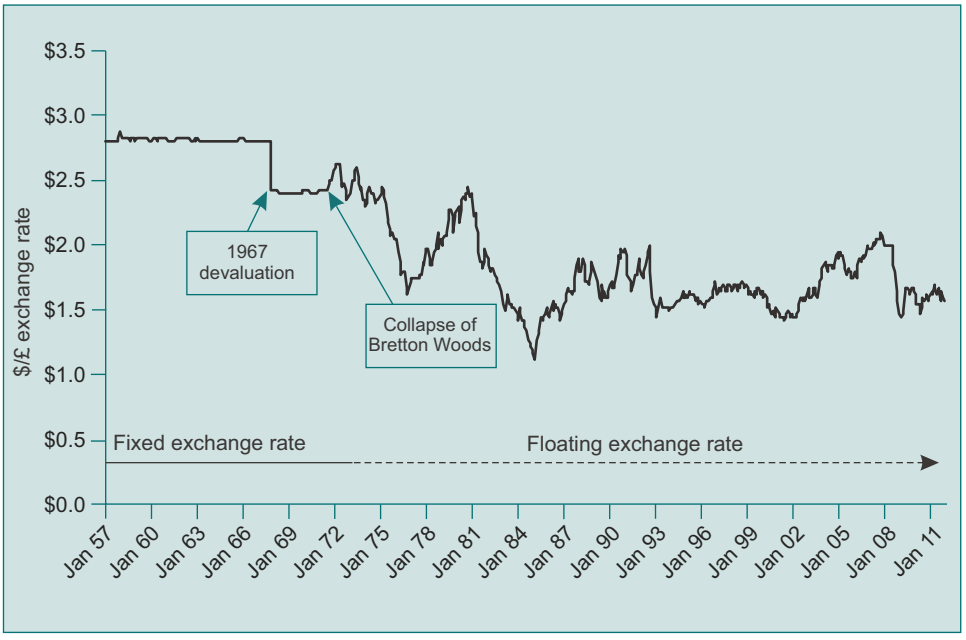

Figure 1.1 **British pound–US dollar monthly changes in exchange rates**

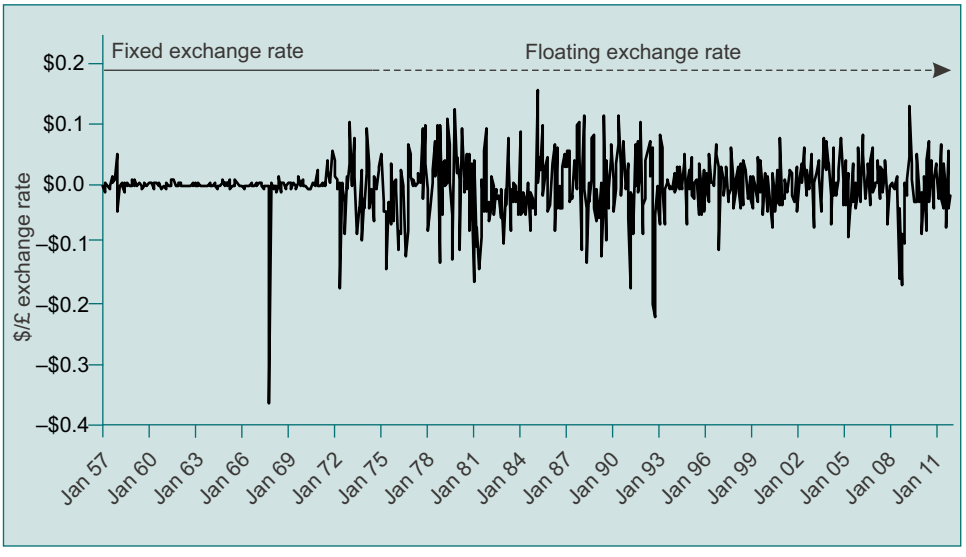

Figure 1.2 **British pound–US dollar monthly volatility**

Note: The data show month by month first differences in exchange rates.

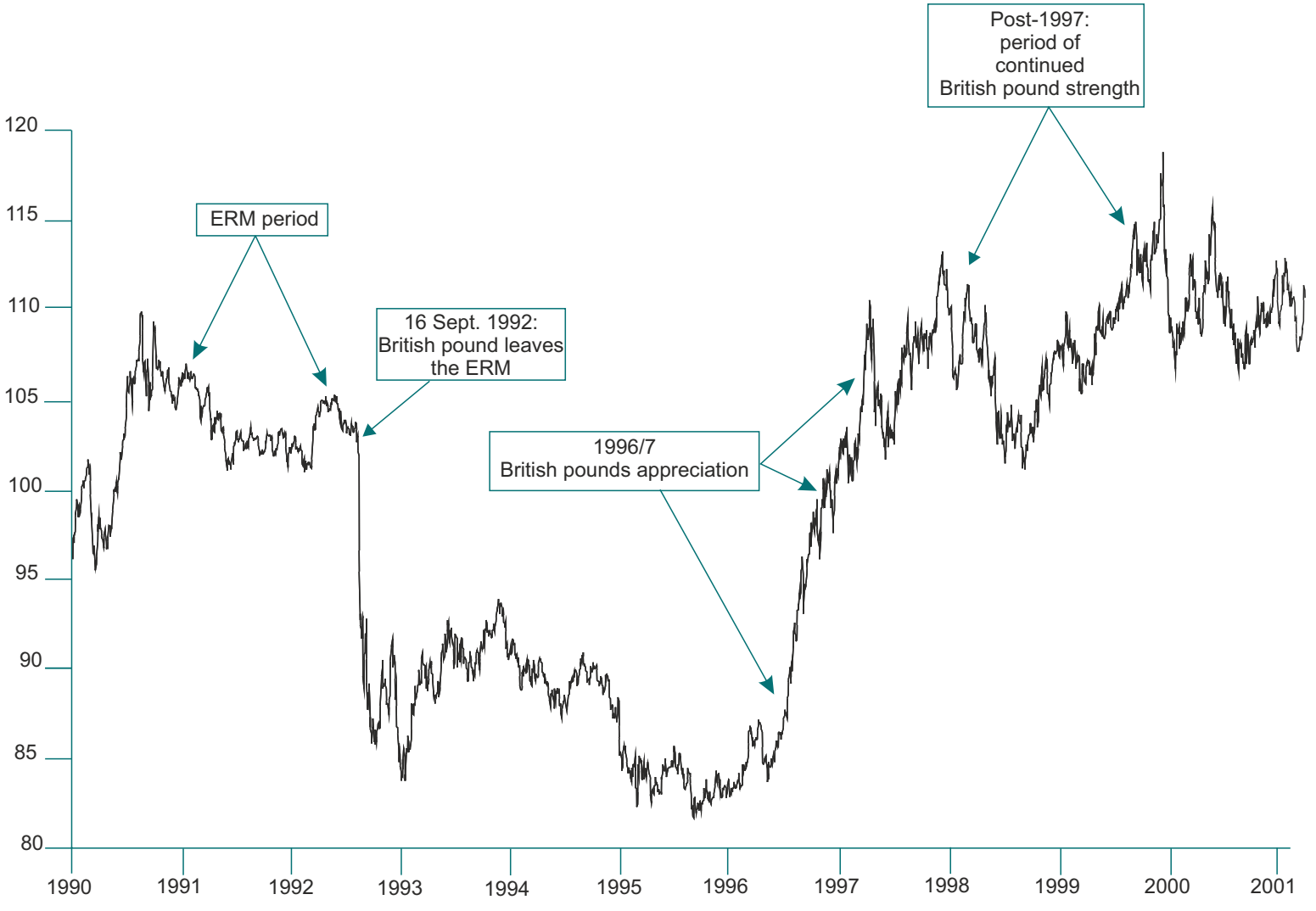

Figure 1.3 **British pound trade-weighted index from 1990 to 2001**

Currency volatility also affects domestic producers and increases their risks. Medium- to long-term changes in exchange rates affecting a country's terms of trade can make foreign producers more competitive relative to domestic ones, thus allowing import penetration. The UK suffered such a change in the 1980s when the exploitation of North Sea oil led to a significant increase in the value of the British pound. Many parts of British industry found it very difficult to compete with imports because of the overvaluation of the currency, and suffered long-term damage as a result.

The situation changed again in the late 1980s and the 1990s as the impact of the oil industry on the British pound diminished (partly as a result of the dramatic decline in oil prices) and the pound fell to a more competitive level. But the 1990s saw the British pound continue to show short-term and longer-term swings in its external value. During the first decade of the twenty-first century, the pound continued to enjoy periods of relative undervaluation and overvaluation as sentiment about the prospects for the British economy and interest rates changed from positive to negative and back again. An indication of the problems for exporters and importers is given by Figure 1.3, which shows the trade-weighted index. This has indicated periods of overvaluation for the currency against economic fundamentals matched by other periods of undervaluation. This has created real dilemmas for firms and emphasised the importance of having a sound risk management strategy.

Even if countries manage the exchange rate, this does not always lead to successful outcomes. In 2011, Brazil faced influxes of foreign money as interest rates, set for domestic purposes, made foreign investment particularly attractive. China, by pegging its currency to the US dollar, has maintained an artificially low exchange rate that has greatly benefited its exports and domestic growth, but at the expense of domestic consumption – and the country seems to suffer from chronic inflation. In addition, currency surpluses have had to be recycled, leading to a build-up of dangerous imbalances.

What is clear is that, looking ahead, currencies are likely to experience periods of appreciation and depreciation, and this emphasises the need for organisations to understand and manage these effects.

A Real Problem for Brazil

In 2011, the appreciation of the Brazilian real against foreign currencies became a huge problem for the country and its domestic firms. The rising exchange rate, which had increased by 8 per cent in the first half of the year and hit a 12-year high against the dollar at the start of July 2011, made local producers increasingly uncompetitive against Asian countries. This problem arose because countries such as China, Vietnam and the Philippines had currencies that were linked to the US dollar. As Figure 1.4 shows, the Brazilian real appreciated against the US dollar, making Asian imports correspondingly cheaper in local currency terms. This had a devastating impact on local firms, leading to President Dilma Rousseff declaring: 'We must protect our economy, our manufacturing efforts and our jobs.'

The problem arose during the spring of 2011 because nominal interest rates in Brazil were significantly higher than elsewhere in the world, and hence foreign capital flooded into the country, pushing up the exchange rate. In 2011, Brazilian

bonds offered some of the highest yields in the world (around 12 per cent at the time). Consequently, Brazilian assets were the fourth-largest foreign holdings by Japanese investors. As a result of Brazil's new-found status, underlying economic strength and stability, foreign investors had been attracted to Brazil and assets denominated in Brazilian reals.* The currency appreciation problem was made worse by government policy that had created a stable exchange rate against the US dollar, coupled to intervention in the currency market to maintain its value and complex foreign exchange controls.

If the currency continued to increase or stayed at the high levels seen in the first half of 2011, local manufacturers would ultimately go out of business. This was due to the fact that foreign producers could undercut locally produced goods of similar quality. Looking at the situation, local firms needed to consider how best to manage this problem. This example is not untypical of the issues that have to be addressed in financial risk management.

Figure 1.4 **Brazil real versus the US dollar**

1.1.3 Increased Volatility in Interest Rates

As with currencies, interest rate volatility also increased as a result of the ending of fixed exchange rates. At first, it was thought that countries would be able to pursue divergent economic policies based on domestic criteria, including monetary conditions and interest rates. However, rising inflation, partly caused by currency

* Brazil was part of what is known as the BRICs – Brazil, Russia, India and China – large emerging market countries with demonstrable high growth. The Brazilian economy grew 7.5 per cent in 2010, at a time when most developed countries struggled in the aftermath of the 2008–9 credit crunch.

depreciation, meant that, after some delay, interest rates too became more volatile. This is shown in Figure 1.5, which plots the short-term interest rates in the UK, and Figure 1.6, which plots short-term interest rate volatility.

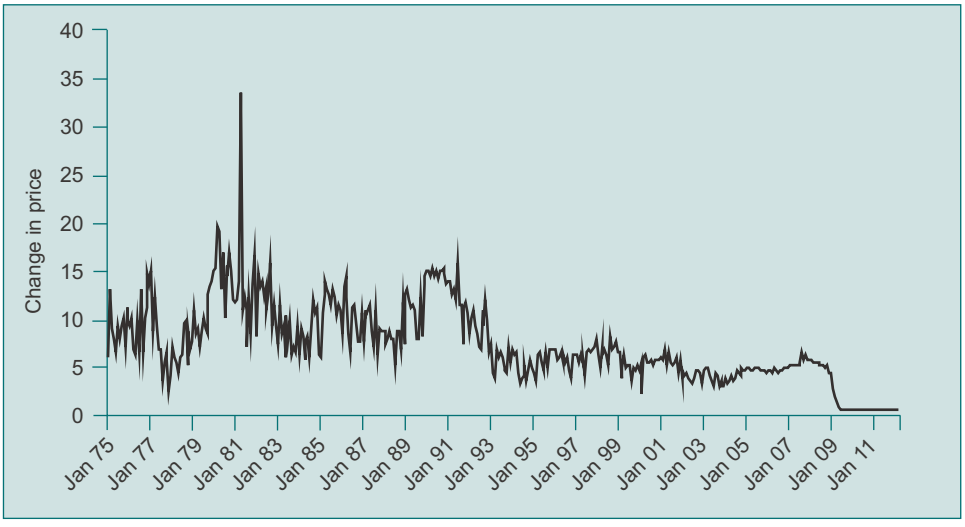

Figure 1.5 **British pound short-term interest rates**

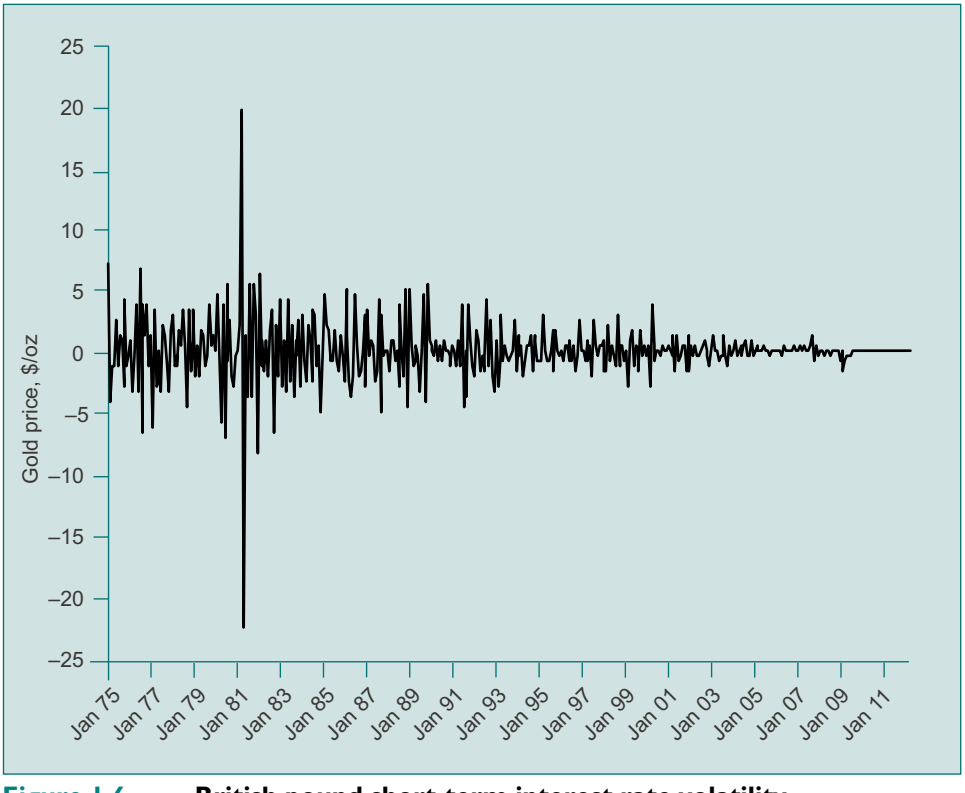

Figure 1.6 **British pound short-term interest rate volatility**

The increased risk had several effects. The fact that borrowing costs, lending rates, bond prices and yields were unpredictable meant that financial institutions were unwilling to enter into long-term fixed-rate commitments. In response, firms increased hurdle rates on investments, required faster payback and sought better ways to manage the risk.

1.1.4 Increased Volatility in Commodity Prices

The same increased volatility can be seen in commodity prices. The price of gold, following the US Treasury's decision to sever the link to the dollar, also changed dramatically, as can be seen in Figure 1.7. The volatility picture in Figure 1.8 is even more dramatic, as the price changes month by month suddenly become very significant.

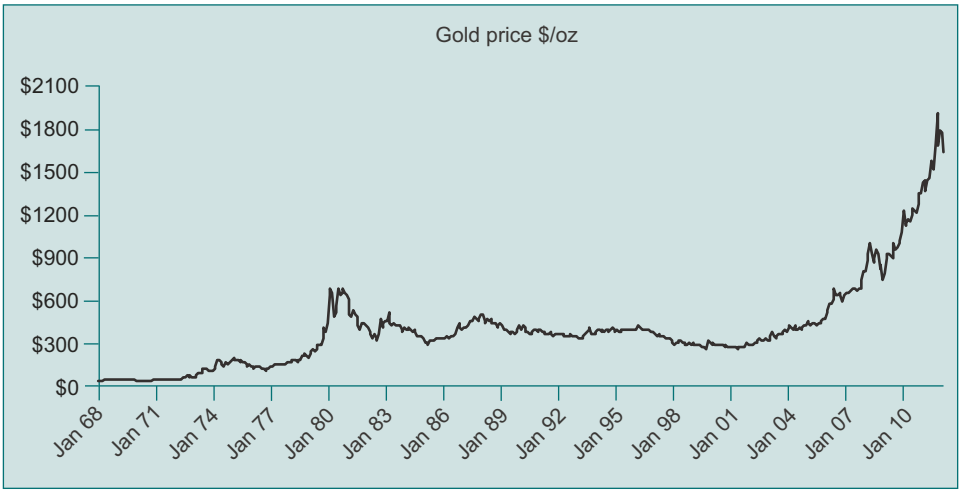

Figure 1.7 **The behaviour of the gold price**

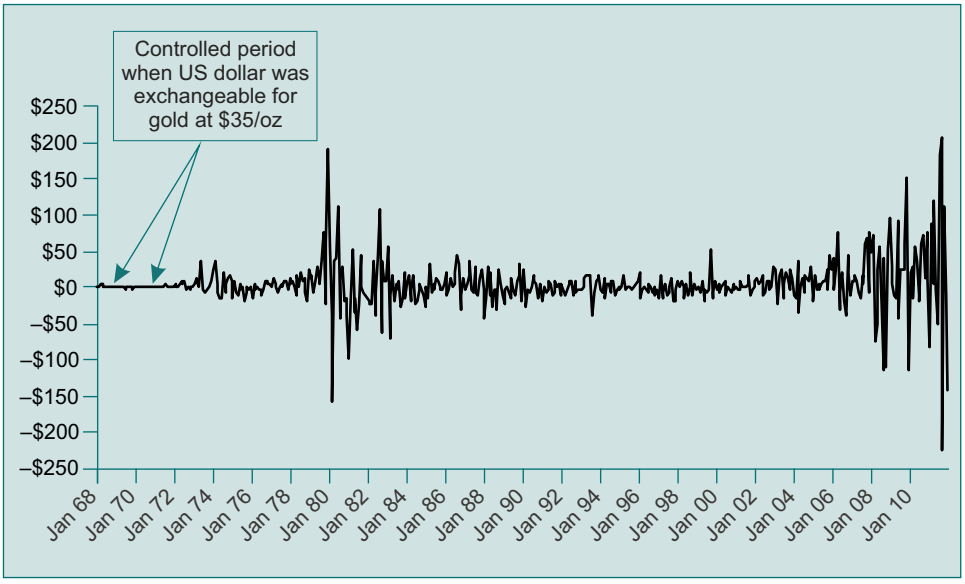

Figure 1.8 **Gold price volatility**

Since the 1970s there have been a number of 'oil shocks', when the crude oil price has risen dramatically and subsequently fallen again, as shown in Figure 1.9 and Figure 1.10. The oil price has also been a very volatile series, with periods of extreme price movements. This has made life difficult for oil producers and consumers and increased the demand for risk management to handle this problem. Fluctuations in the price of oil or, more particularly, jet fuel have been a major issue for airlines. They need to show consistent pricing and, in many instances, set prices well ahead of the point where they provide the service. Hence they have sought various means to manage these price risks; these include extensive operational hedging and financial instruments.

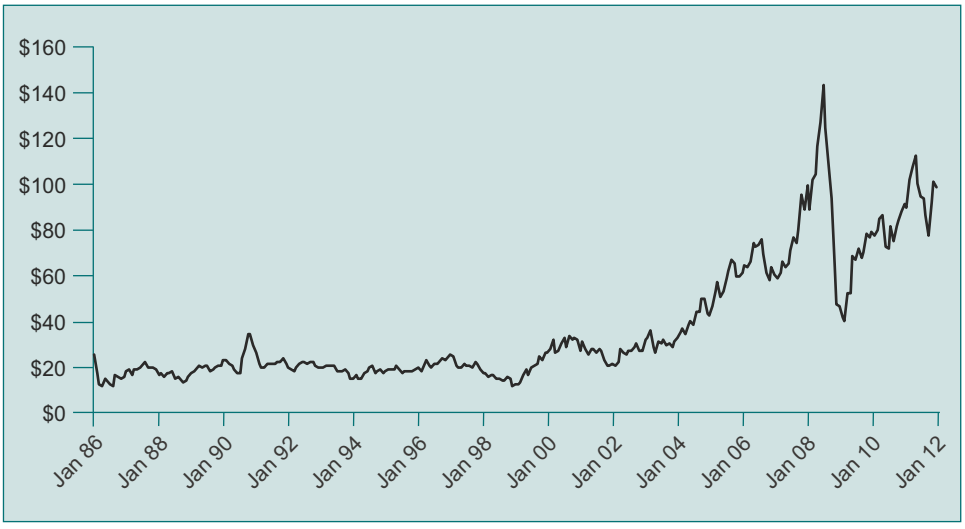

Figure 1.9 **Crude oil price**

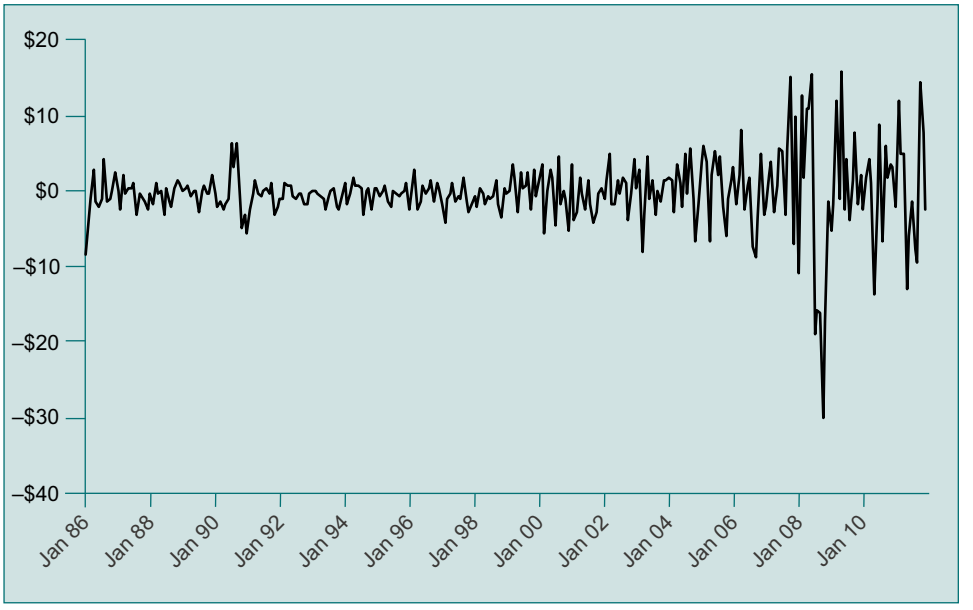

Figure 1.10 **Crude oil volatility**

1.1.5 Increased Availability of Financial Risk Management Products

Another technical development that was to lead to the modern approach to financial risk management was the introduction in the US by the Chicago Board Options Exchange (CBOE) of exchange-traded **options** on common stocks (or ordinary shares, as they are known in the UK). At the same time the Chicago Mercantile Exchange (CME) started trading **financial futures** contracts on both currencies and interest rates. While over-the-counter options and forward contracts had long existed, they had many disadvantages; exchange-traded instruments promised much greater liquidity, since the risk of default by one of the parties to a transaction was negligible. Because of the methods used to manage trading on these exchanges, these markets are open to all parties, with both firms and individuals able to transact. In addition, exchanges, with their large number of competing bids and offers, established robust trading mechanisms. Equally, immediate price dissemination provides transparent and efficient pricing.*

An unrelated but equally important development that was occurring at the same time was the seminal work by Fisher Black and Myron Scholes (1972) on providing a model for option pricing.† Their work and that of others in this area has provided practitioners with accurate analytical models for pricing complex, probabilistic products.‡

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* Forwards and futures, as part of the risk management product set, are examined in detail in the *Derivatives* course.

† *See also* Black and Scholes (1973). The Black–Scholes equation has been described as 'the theoretical workhorse of the financial industry'.

‡ Options are discussed in the *Derivatives* course text.

The combination of increased market volatility and the availability of financial instruments for hedging purposes (latterly called derivatives) has led to the development of modern financial risk management techniques. A related development has been the proliferation of new financial instruments, many incorporating one, or more than one, derivative to alter the pattern of the return offered. The long-established instruments, namely traditional bonds and ordinary shares, have some drawbacks, and structured products, as these new instruments are called, aim to address these. Some of the new structured securities have been 'seven-day wonders'; others have created new possibilities for asset and liability managers. The process of building new financial instruments continues, although there is some evidence that the spurt in financial innovation that took place in the 1970s and particularly the 1980s has abated somewhat.* Nevertheless, securities that have special features can be an important way to manage certain risks. Even governments recognise this. For instance, while the UK has had inflation-protected government bonds for a long time, the US has not. Yet in the late 1990s the US introduced similar securities, and other countries, such as France, have also in recent years begun to issue similar securities. Other securities offer exposure or protection to currencies, commodities and even equities.

As a consequence of the increased volatility and uncertainty, industrial and commercial firms have responded to the increased financial risks by seeking better methods to manage their risks. At the same time, reacting to the increased demand for risk management instruments, financial intermediaries have sought better ways of helping their clients to reduce or eliminate such risks. It is an ongoing dynamic and interactive process where participants' understanding of risk has led to the evolution of new, more specific hedging methods. Over time, increased technical expertise and experience have allowed financial engineers to more fully understand these risks and develop ways of breaking them down into their constituent parts. Complex exposures can then be reassembled with the undesirable or unacceptable elements removed. As mentioned earlier, airlines face a range of risks in their business: fuel prices, interest rates, currency movements, passenger load factors and political events. Some or all of these risks need to be managed. In response, financial intermediaries put together special hedge programmes, such as jet fuel swaps or currency swaps, to provide tailor-made solutions to these and other uncertainties.

1.1.6 New Developments in Technology

In the mid-1960s, International Business Machines (IBM) introduced its 360 series of computers, heralding increased computing power and greater ease of use. Many data-processing tasks that hitherto had to be handled manually were now automated. In 2001, Microsoft, along with computer manufacturers and other software

* A good review of the process is found in Miller (1991). He lists four factors that have increased financial innovation:

i. the move towards floating exchange rates;
ii. information technology and the developing power of the computer;
iii. world economic growth; and
iv. regulation and deregulation as contributory factors to the spurt of innovation in the last 20 years.

firms, celebrated the twenty-fifth anniversary of the introduction of the PC. New developments in information technology (IT) have occurred hand in hand with the need for more extensive risk management activity. Many of the developments in financial methodology are dependent on the availability of cheap and fast processing power. Pricing many kinds of derivatives requires the high-speed ability of computers to crunch the numbers. This applies to virtually all aspects of financial intermediaries' ability to deliver risk management products. Even an established financial derivative like a foreign exchange forward contract cannot be managed without the support of IT systems. More exotic derivatives require computers to perform iterative simulation or optimisation in deriving a price or the instrument's risk characteristics. A side product to the availability of IT systems has been the collection of enormous quantities of financial data with which to test the new instruments and develop quantified risk estimates for the sources of risk.

The Effects of Financial Risk

As we shall see, companies are vulnerable to changes in macroeconomic factors. The following examples show how changes in economic factors are affecting corporate performance.*

- **Polish companies in bad bets against the zloty**
  In 2009, the Polish government stepped in to help companies such as Elwo, which had undertaken extensive transactions in anticipation of a rise in the zloty against the US dollar and the euro only to find the zloty suddenly fall against these currencies in the wake of developing problems in Eastern Europe in the aftermath of the credit crunch. The US dollar gained 70 per cent and the euro 40 per cent as investors fled problematic currencies. Commenting on the problems facing companies such as Elwo, the Financial Supervision Authority estimated that Polish companies had lost 5.5 billion zlotys ($1.6 billion; €1.2 billion; £1.1 billion) from similar transactions. After the bankruptcy filing by Elwo, the chief executive of its parent company stated: 'In retrospect I can only say we chose bad instruments.'
- **Cargill profits decline 66 per cent**
  Cargill, the world's largest agricultural commodity trader, reported a 66 per cent decline in first-quarter profits. It made a profit of $236 million in the first three months of 2011, compared to $693 million in the first three months of 2010. At the same time, revenues rose by 34 per cent to $34.6 billion, which, when combined with the fall in profits, meant that Cargill suffered a significant reduction in its profit margins. The company indicated that the significant volatility in financial and commodity markets and in particular its results reflected the 'stress in financial markets caused by growing economic, fiscal and political concerns on both sides of the Atlantic' (the US and Europe).

* A fuller discussion of the issue of why firms, their managers and investors might be concerned about these effects is deferred to Module 2.

- **Allied Irish Banks suffers from low interest rates**
  The 1998 profitability of Allied Irish Banks (AIB) was adversely squeezed, despite a 15 per cent increase in pre-tax profits to Irish punts (IR£)826 million, up from IR£718 million in 1997, as a result of low interest rates squeezing its net interest margin (the net difference between the rates at which it lends and borrows funds). This fell by 33 basis points (a basis point is one-hundredth of 1 per cent) to 3.33 per cent in 1998. AIB further indicated that, as a result of the introduction of a common interest rate in countries participating in the European Monetary Union, a further reduction in margin was to be expected in 1999.
- **General Mills and ConAgra**
  The US food company General Mills saw increased sales in the first quarter of 2011, rising 9 per cent year on year. However, at the same time, profit margins suffered and net earnings fell to $405.6 million from $472.1 million for the same period the previous year, a decline of 14.1 per cent. The company indicated that it expected its raw material costs, mostly agricultural commodities, to increase by 11 per cent over the forthcoming year. The performance of General Mills has to be contrasted with that of its rival ConAgra, which reported a 42 per cent year-on-year drop in net income as a result of rising input costs. Its net income dropped to $85.3 million, down from $146.4 million.

This example indicates how active risk management can help to overcome the problems of economic factors:

- **Japanese government provides aid to help exporters**
  In August 2011, the rapid rise in the Japanese yen (JPY) against the US dollar and the euro prompted the Japanese government to offer short-term financial support to exporters hurt by the yen's strength. Over the previous year, the JPY had risen from JPY95 to the US dollar to JPY76 to the US dollar – a post-war record – and a currency appreciation of 25 per cent. The loss of international competitiveness in the American and European markets for Japanese exports and the poor outlook for the global economy prompted policy makers to turn to inventive policies to help Japanese export industries. These policy initiatives followed two failed currency interventions by the Bank of Japan designed to drive down the exchange rate.

1.2 What Is Risk?

1.2.1 Definitions of Risk and Risk Management

A single definition of risk will not serve all risk management purposes. Risk management is carried out in such diverse areas as transport, health and safety, finance, and insurance. In mathematics, there is no single definition for the idea of a number; a similar situation arises in risk management when it comes to defining risk and risk management. Each of the disciplines above makes use of the idea of risk in the context of its particular objectives. So, for transport, risk is taken to be an accident or damage; for health, it is taken to be illness, injury or loss of life.

The term risk originates from the Italian *riskare*, which means 'to dare'. The dictionary lists risk as both a noun and a verb. When used as a noun it has the connotation of danger, hazard, the chance of loss, an enterprise that can lead to profit or loss, the amount of a loss (hence the 'sum at risk'), a gamble or a bet. When used as a verb, risk means to expose oneself to the potential for loss, to make a bet or a wager, to gamble, to undertake an uncertain enterprise or venture. Both uses imply that there is the possibility of gains as well as losses.

There is also a psychological meaning to risk: it is that state of uncertainty or doubt in the face of a situation with beneficial and adverse consequences (gains and losses).*

A simple definition of risk that includes the meanings above is:

> The chance (or probability) of a deviation from an anticipated outcome.

The implications of this definition are given below.

- We can attach **probabilities** to risk. Therefore, it can be measured, estimated or calculated in some way. Risk can therefore be quantified and expressed as a parameter, number or value.
- Risk is concerned not just with the extent or probabilities of potential losses but with **deviations from the expected outcome**. It is the extent to which the actual result may deviate from the expected result that makes a situation risky.
- **Risk is a function of objectives**. It is the consequences of the actual result deviating from the expected result that leads to risk. Without an objective or intended outcome, there is only uncertainty. A rider to this is that risk arises only where the deviation from the objective matters; that is, if it affects individuals or firms financially, or entails some other adverse consequence. It can also provide an opportunity.

* For a review of the behavioural aspects of risk, *see* Fischhoff (2012).

Within the discipline of risk management, of which financial risk management forms a sub-element, the following additional concepts for risk are in use:

Possibility of a gain or loss

Where there is a possibility of a gain or loss, this is often referred to as a risk. Note that this usage does not necessarily attempt to quantify the degree of loss.

Probability of a gain or loss

This defines risk as the chance or probability of a gain or loss. In terms of risk theory, the probability of an event occurring takes a value that can range from zero to one. An event is impossible if it has a probability of zero; an event is certain if it has a probability of one. Risk will be greatest if the gain- or loss-making event has a probability of one; that is, it is certain to occur. In practice, the probability of loss (ρ) will lie above zero and be less than one, i.e. $0 < \rho < 1.0$. Often people will talk of the **odds** of gains and losses. This is the ratio of unfavourable to favourable outcomes. So, if the probability of gain is 0.25, the odds are 0.75:0.25, which are more often expressed as 3 to 1. Hence we would say that the odds are 3 to 1 against success.

Cause of loss or peril

Peril is a term used in the insurance industry for the source of a risk. It is the cause of a loss. For instance, fires, floods, explosions, accidents, death and so on are all perils. In finance, the more common term is **risk factor**.

Hazard

Another term common in insurance. It is a condition or action of the insured party that increases the likelihood or likely magnitude of a loss. There are three common types of hazard:

- *Physical hazard*: the condition of the insured property, person or operations that has the effect of increasing the likelihood and/or severity of the loss.
- *Moral hazard*: a condition where the insured intentionally seeks to take advantage of insurance cover either by deliberately causing an accident or by inflating the value of a loss.
- *Morale hazard*: actions taken by the insured party that increase the likelihood and/or severity of a loss. Morale hazard arises because the consequences of the action are borne by the insurer rather than the insured. For instance, car owners with fully comprehensive theft insurance are less likely to lock their cars when they leave them. Such persons are likely to own more expensive vehicles and experience higher theft rates than individuals who are not similarly insured.

(Note that these last two concepts bring in the behavioural aspect of risk.)

Potential gain or loss

The exposure or potential for gain or loss is also referred to as a risk. Practitioners may use the term 'risk' to refer to the values that are exposed to gains and losses. An example is the financial services industry's 'value-at-risk' metrics used to quantify the extent of an expected future loss within a given confidence limit.

Range and variability of outcomes

The actual range of potential outcomes, or a measure of that range (for instance, the variance of a particular set of outcomes), is used to define a particular risk. A more sophisticated approach may specify the exact nature of the probability distribution (such as the normal or Gaussian distribution). Finance professionals will often refer to markets as being 'highly volatile'. The term **volatility** comes from the derivatives markets and is the standard deviation of continuously compounded returns. The intellectual foundation is the mean-variance approach derived from modern portfolio theory and option pricing.

Risk management

Risk management is the identification, assessment and decisions made regarding the treatment by an organisation (or an individual) of particular risks faced by the organisation (or the individual). It can be a formal process involving procedures, quantitative and qualitative assessments leading to review and minuted decision, or it can be informal.

The Three Dimensions of Risk Management

At the level of the economy, risk management makes use of basically two approaches to modifying the level of risk, either risk pooling (sharing) or risk transfer. At the aggregate level the total amount of risk in the economy cannot be reduced, but its economic consequences can be modified through sharing its consequences or transferring the risk to another party better able to accept the consequences of the risk. With risk pooling, or risk sharing, the effects of risks are spread among all market participants. Insurance is an example where losses are shared among the pool of insured parties. Risk transfer involves reassigning the risk to another party for a fee. For instance, many industrial and commercial firms transfer their foreign exchange exposures to banks by buying forward foreign exchange contracts. The bank then manages the resultant risks.

In addition, while the process of financial risk management activities may seem complex – and this often serves to mask the inherent benefits from undertaking the process – this same apparent complexity also hides the fact that the risk management process has three generic approaches, namely hedging, diversification and insurance.

Hedging leads to the elimination of risk through its sale in the market, either through cash or spot market transactions or through a transaction, such as a forward, future or swap, that represents an agreement to sell the risk in the future. For instance, the UK-domiciled exporter being paid in euros when the goods are delivered at some date in the future can hedge this exchange rate risk

by entering into a forward exchange agreement (with a bank) to sell the euros it will receive at a fixed price and receive a known amount of British pounds rather than leave the result to unknown fluctuations in the exchange rate.

Diversification reduces risk by combining less than perfectly correlated risks into portfolios. For instance, while individual borrowers from a bank each represent a significant element of credit risk, for the depositors at the average bank there are virtually no concerns about credit risk.*

Insurance involves paying a fee to limit risk in exchange for a premium. For example, one has only to consider the benefits to be derived from paying a fixed premium to protect against property damage or loss, or for life assurance, in the traditional insurance contract. In doing so, the insurer, usually an insurance company, takes on the risk of unknown future losses.

Figure 1.11 illustrates how the relationship between risk modification (through risk pooling and risk transfer) and the generic risk management approaches might work. Any risk management transaction can be mapped onto this template.

	Risk pooling	Risk transfer
Hedging	Risks are not pooled as such, but transactions undertaken which have the economic effect of selling (or transferring) the risk	Risks are exchanged (transferred) from one party to another
Diversification	Risks are placed into portfolios and the aggregated risk is less than the sum of the individual risks	No risks are transferred: risk reduction is obtained through portfolio effects
Insurance	Assumed risks, as in the case of insurance, may be pooled at the aggregate level and hence risk taker may get benefits of diversification	Risks are sold (transferred) from the buyer to the seller. Seller assumes all future uncertainty about value

Figure 1.11 Relationship between risk processes and generic risk management approaches

All definitions of risk share two common factors: the **indeterminacy of the outcome** and the **chance of loss**. That the result is not a foregone conclusion is implicit in any concept of risk: the outcome must be in question. For a risk to exist, there must

* This is to simplify. Of course, depositors may be concerned about the financial stability of a bank given other factors such as the competence of its management, lending policy and the level of defaults. Past experience shows that banks can – and do – fail. It is for this and other public policy reasons that banks are regulated and in some countries deposit insurance is provided. But banks thrived prior to regulation.

be at least two possible outcomes. If we were to know for sure that a loss was the result, there would be no risk; we would avoid the situation or accept the consequences. For instance, when we buy a new car, we know that the value of the car will depreciate with age and use: here the outcome is (more or less) certain, and there is no risk. The other element of risk is that at least one outcome is unexpected and undesirable. This is a loss in the sense that something of value is lost or that the gain in value is less than what it was possible to achieve. For instance, an asset whose return – or appreciation in value – is less than an alternative would result in an opportunity loss. That is why the depreciation you experience when you own a car is not a risk. While it is undesirable, it is not unexpected. It follows from knowing that the asset, a car in this case, will lose value over time as it wears out.

Bryan Wynne (1992) proposes a four-level stratification:

1. **risk**, where probabilities are known;
2. **uncertainty**, where the main parameters are known but quantification is suspect;
3. **indeterminacy**, where the causation or risk interactions are unknown.
4. **ignorance**, where we don't know what we don't know. This refers to the risks that have, so far, escaped detection or have not manifested themselves.

We can define risk as the set of outcomes for a given decision to the occurrence of which outcomes we may assign a probability. Uncertainty implies that it is not possible to quantify the extent of the hazard. It follows, therefore, that with risk the outcome is unknown but we can somehow define the boundaries of the possible set of outcomes. Risk can be quantified, whereas uncertainty cannot. While we can make great play of the difference between risk and uncertainty, the two are often used interchangeably. In so far as certain unexpected outcomes cannot be easily quantified, they are uncertain rather than 'risky' under this definition. This is clear when we consider the relationship between **risk** and **exposure**, two terms that are often used interchangeably.

Risk is the probability of a loss; exposure is the possibility of loss. While the two terms are often used interchangeably, risk arises from an exposure. Hence, as shown by the example companies given in Section 1.1.6, a firm's line of business creates exposures that are risky and therefore need to be managed.

We can further refine our thinking by considering events that are common but lead to small losses and events that are infrequent but lead to high losses. This latter category is often the most troublesome, since occurrences are infrequent and difficult to anticipate. We can hence categorise risk and frequency as shown in Figure 1.12.

Size of economic effect	Probability: High	Probability: Low
Small	Frequent, low economic effect events e.g. processing errors; short delays in deliveries Impact: minor Firms can anticipate these and allow for them in operations, etc.	Infrequent, low economic effect events e.g. machine breakdowns and outages Impact: negligible Firms can easily recover from such events
Large	Frequent, high economic effect events e.g. changes in exchange rates, interest rates, commodity prices Impact: major Firms anticipate such events and undertake risk management to control potential economic losses	Infrequent, high economic effect events e.g. earthquakes, civil unrest, economic depression Impact: catastrophic Firms are often caught unawares by such events and suffer significant economic losses

Figure 1.12 **Relationship between economic effect and the frequency of occurrences**

To be able to assess risks involves breaking the overall risk down into its component parts. The basic risk paradigm, as shown in Figure 1.13, based on MacCrimmon and Wehrung (1986), is a **decision problem** where there is a choice between only two outcomes: a certain outcome (X: often but not exclusively the status quo) and an uncertain outcome that is the result of two possible events, each of which has a certain chance or probability of occurring, where one outcome produces a gain (G) and the other a loss (L). The financial equivalents to this risk model are the Sharpe–Lintner Capital Asset Pricing Model (CAPM), as developed by Sharpe (1964), Lintner (1965) and others, and Arbitrage Pricing Theory (APT), as proposed by Ross (1976).

As the risk paradigm shows, we face the problem of deciding whether it is advisable to take on a particular risk. This requires us to calculate the benefits of bearing the risk. As a decision problem, this requires us to balance the possibility of a gain against the possibility of a loss. When deciding on the appropriate course of action, the risk paradigm also requires us to establish our attitude to the possibility of a loss if the risky course of action is decided upon. Resolving the problem is a complicated task that often depends on the situation, its context and the knowledge and attitudes of the person or group making the decision. This is because the risk capacity of individuals and groups varies enormously. Hence, developing an understanding of an organisation's risk tolerance or risk appetite is part of the process, since what is acceptable to one individual or organisation may be unacceptable to another. Factors such as the size, effect and potential consequences will need to be factored in to the decision.

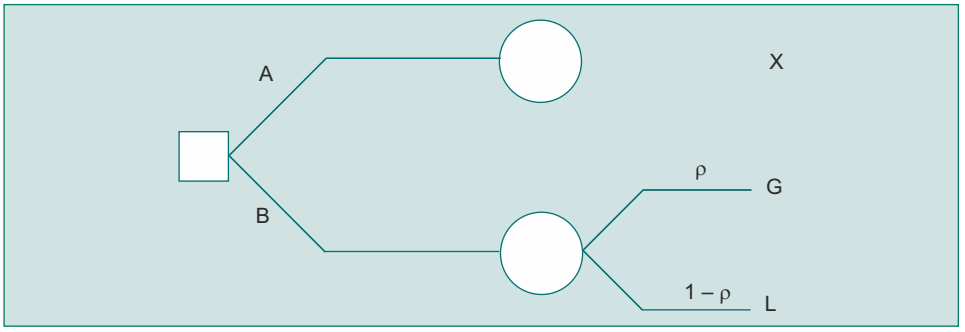

Figure 1.13 Basic risk paradigm

Source: MacCrimmon and Wehrung (1986).

In order to resolve the decision problem, the evaluation often takes the form of some **cost–benefit** or **risk–reward analysis** where the various outcomes, their costs (in terms of losses, etc.) and benefits (in terms of gains) are weighed up in an appropriate way, taking into account the risk appetite or risk tolerance of the decision maker.

To do this, we would require an estimate of the probability (ρ), which forms one part of the resolution to the problem. A high probability of success is more likely to make the risky decision seem the appropriate one. The risk of a loss, if it is small, might make the risky alternative seem the best choice. However, these probabilities are not sufficient alone and have to be integrated into the overall analysis to allow a decision to be made. The **expected value** or **certainty equivalent** approach, as proposed by **decision theory**, can be used to derive a probabilistically weighted average value for the risky course of action. In the case of the risk paradigm above, the course of action B would have an expected value (EV) of:

$$\text{EV(B)} = \rho \cdot G + (1 - \rho) \cdot L$$

A more general outcome with n mutually exclusive possibilities would be:

$$\text{E(V)} = \sum_{i=1}^{n} \rho_i v_i$$

where ρ_i is the probability or likelihood of the ith outcome and v_i is its value. Note that the various probabilities sum to 1 (that is, all possible outcomes are catered for):

$$\sum_{i=1}^{n} \rho_i = 1.0$$

The expected value (E(V)) is the average value of the payoffs from the possible outcomes weighted by their probability. Once we have this average value, we can calculate the **dispersion** or **variability** of the range of outcomes as a measure of the risk we take. Again using the basic risk paradigm example, the **variance** in possible outcomes from taking the risk would be:

$$\text{VAR(B)} = \rho \cdot (G - E(V))^2 + (1 - \rho)(L - E(V))^2$$

A situation where there is greater deviation from the expected outcome has a higher risk than one where the deviation is smaller. We will look at how this deviation (or variance) can be defined and measured in Module 7. In practice, and because it is easier to interpret, we tend to use the square root of the variance of a distribution, which is the standard deviation. In finance, the standard deviation of

the return for a financial asset is called **volatility**. This is a very important measure of risk, and we will be calculating it and using it later on in this course.

Calculating Risk

To see how we might estimate risk, think of the situation when we throw two dice with the normal 1 through 6 on each of the faces. There are 36 possible combinations with values ranging from 2 (snake eyes, or double 1) through to 12 (double 6). The likelihood of any number on a given dice is 1/6. But a little thought will show that the likelihood of both dice giving a 1, for instance, is 1/6 × 1/6 or 1/36. So extreme values of 2 and 12 are unlikely. A number such as 7 (which is also the expected outcome) has a much higher likelihood, since a number of different combinations of values can add up to 7: 1 + 6; 2 + 5; 4 + 3 (this can occur in six different combinations when we throw two standard dice). The likelihood of obtaining a value for the two dice of 7 is in fact 6/36 or 1/6. For risk management purposes, to determine just how much risk there is involved, we want to know the possible deviation from the expected outcome. To know this, we need to know the distribution of the outcomes. A histogram of the possible values of the two dice and their frequency is given in Figure 1.14.

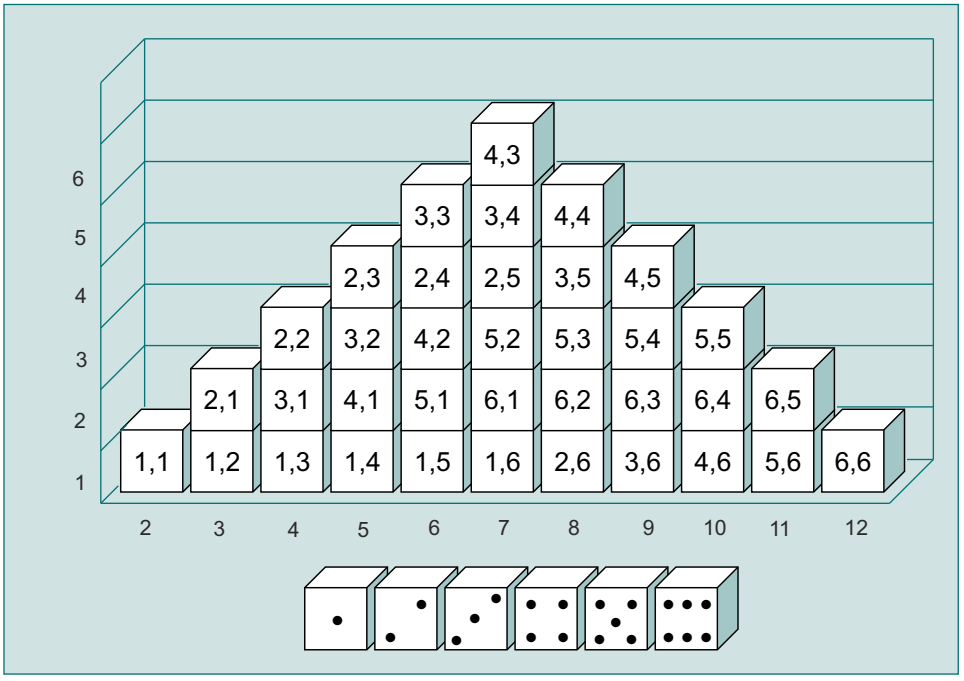

Figure 1.14 **Histogram of outcomes for two six-sided dice with faces with values of 1 through 6**

A spreadsheet version of this figure is available on the EBS course website.

In quantifying the risk, we can first calculate the expected value of the two dice. This is 7. Given this, we can now calculate the variance and standard deviation using the quantification formula:

$$\text{Variance} = \sum_{i=1}^{11} \rho_i (X_i - E(X))^2$$

This gives a value for the variance of 5.83, and for the standard deviation, which is the square root of the variance ($\sqrt{5.83}$), of 2.42.

Now let us look at another example of dice similar to the one above, except in this case the dice are what are known as average dice. These dice have values that are closer to the average of a normal dice (which is 3.5) and have faces numbered 2, 3, 3, 4, 4 and 5.

The histogram of outcomes is given in Figure 1.15. A comparison of Figure 1.14, for the normal two dice outcomes, and that of Figure 1.15, for two average dice outcomes, shows that the spread of possible outcomes and their likelihood is very different. Whereas with the normal two dice the average value, 7, is expected in 6/36 cases, with the average dice it occurs in 10/36 cases. Also, the likelihood of getting outcomes close to the average (namely 6 or 8) is much higher in the case of the average dice.

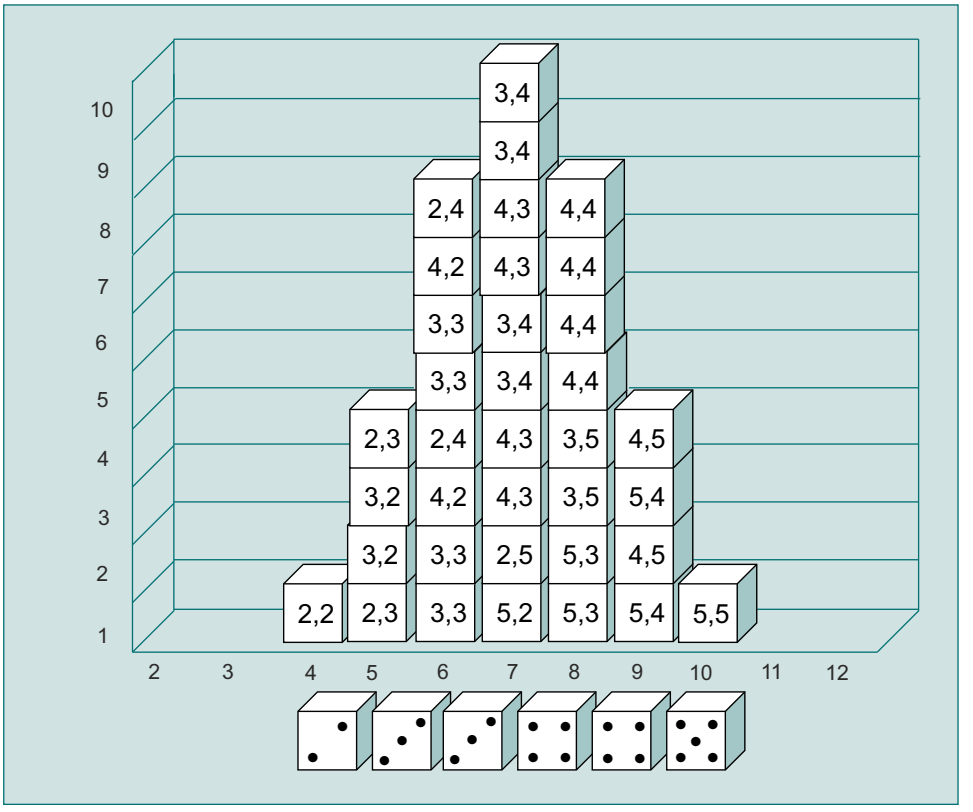

Figure 1.15 **Histogram of outcomes from two average dice with faces with values of 2, 3, 3, 4, 4 and 5**

A spreadsheet version of this figure is available on the EBS course website.

As with the normal dice, we can calculate the spread using the variance equation. This gives 1.83 for the average dice variance and 1.35 for its standard deviation. Hence, the dice are missing the extreme values of 1 and 6. In the language of risk management, we would say that an average dice is less risky than a conventional one, since the dispersion of values is smaller. The maximum range for a standard six-sided dice is 1 to 6, or a variance of 5 between the extreme outcomes. For the average dice, the range is 2 to 5, or a range of 3. Both dice have the same expected value. Hence, following our definition of risk, the standard dice is the riskier.

What the two statistics do is to provide us with a metric for measuring the relative riskiness of the two situations. A glance at the two histograms will immediately show there is a greater chance of significantly divergent outcomes for the normal dice. For instance, the probability of getting an outcome more than two values away from the mean (in either direction) – i.e. values that are less than 5 (4, 3, 2) and more than 9 (10, 11, 12) – for the two cases is:

Normal dice: 0.33
Average dice: 0.06

We can use the variance or standard deviation statistic, therefore, as an objective measure of risk for comparison purposes.

In practice we are more concerned with negative outcomes than positive outcomes (that is, we concentrate on the **downside** element of risk in any given situation). However, risk taking is as much about opportunity as it is about loss, although such risk taking is often equated with gambling or speculation. It is thus correct to consider the **risk/reward** of a situation. This is the trade-off between the risk being taken and the expectation of reward. This makes risk a more neutral concept and is in line with the way many financial market practitioners consider risk. As in practice, to purely focus on risk elimination is to miss the fact that risks provide opportunities as well as problems.

Risk is multidimensional. Any given situation may involve a number of different risks, some of which may be related. Typically, in financial markets, we concentrate on **price risk** – that is, the risk that prices may change – but other related risks exist, for instance **liquidity risk**.* Liquidity risk arises from the problem that there may not be a willing buyer (or seller) on the other side of a given transaction at a price close to the previous recorded transaction within a reasonable time frame.† Although price risk and liquidity risk are distinct, they may interact: there will be more price risk in an illiquid market since the time required to execute a transaction may be greater and the market price may shift significantly in the meantime. When dealing in financial markets, practitioners talk about **marketabil-**

* Price risk is also known as **market risk**.

† Note that, as with most financial terminology, the term is somewhat imprecise. Liquidity risk has other meanings, like the ability of a company to meet maturing obligations from available (liquid) assets, or for a company to raise funds when required.

ity, which is the ease with which an asset, such as a financial security or instrument, can be sold. **Liquidity** is an allied term that implies that, when selling an asset, it can be sold quickly without loss of value.

We will use the term **risk factor** to describe any single particular risk.* A given risk will thus be made up of one or more risk factors, the sum of which is the **total risk**. Given that risks are complex, some of these risk factors might actually be mutually offsetting. For instance, inflation and interest rates are highly correlated – that is, they tend to move together. Thus a combination of increases in both factors may not be the sum of the two risks in a given situation. An organisation, for instance, may be able to benefit from inflation by increasing prices, which will, to some extent, counteract the effects of higher interest rates. Whether the combined risk benefits a particular organisation will depend on how the two factors interact. Module 9 looks at how we can integrate the different risk factors or exposures mathematically using modern portfolio theory.

One way of understanding the effects of a risk is to establish the **risk profile** of a given exposure. The risk profile is the size and direction of the payoffs that can be expected in the future, given the risk, as shown in Figure 1.16. It will also show us, as with a payoff diagram, the relationship between the risk and the gains and losses from the risk factor (which are our exposures to risk). The slope of this relationship shows the sensitivity of the position to the underlying risk – an idea we will return to frequently (*see* the slope in Figure 1.16). Equally, when undertaking quantitative analysis we can also determine how well the exposure correlates to the underlying risk factor.

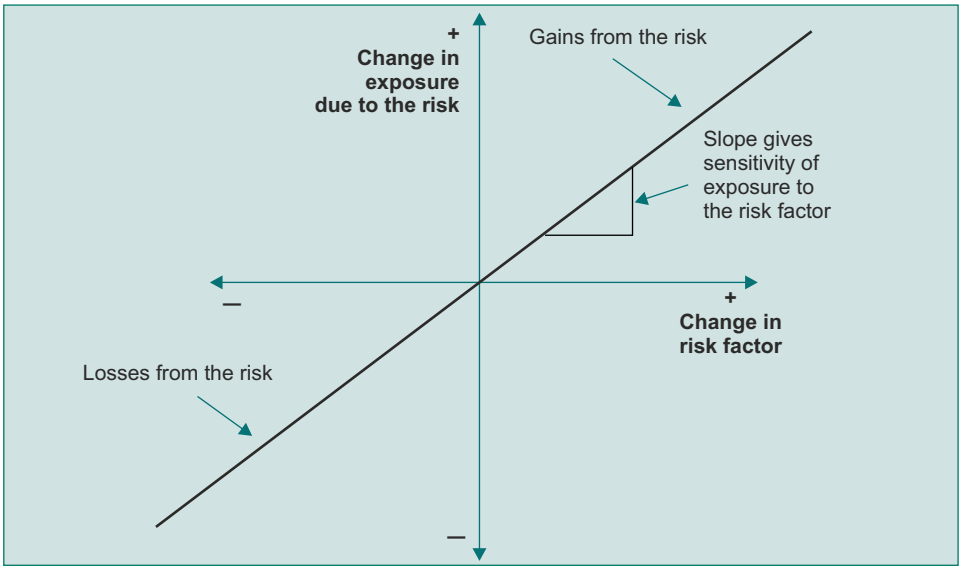

Figure 1.16 **Risk profile and sensitivity of an exposure to a risk factor**

We need to broaden our understanding somewhat when considering risk and exposure. We may face risks, but in practice organisations manage their **exposures**. To understand the difference, we need to introduce the concept of **materiality**.

* This is a standard term that is in common usage in risk management.

There may be very great risks in certain circumstances, but if they are immaterial to the specific organisation – that is, insignificant economically – our attitude to such risks will be different from what it would be if they were likely to have a serious impact on the organisation. For instance, an organisation with a £100 million turnover and a foreign exchange transaction exposure of £100 000 is not likely actively to manage this risk, since in the overall context of its business such a sum is not important. It hardly warrants much management time devoted to the problem. Managers will therefore weight risks by their materiality to derive a firm's **exposure** to a particular risk. The analysis in Table 1.1 illustrates the process of evaluating risks to obtain exposures.

Table 1.1 Risk and exposure

Potential degree of change in variable (risk) (i)	Amount of the variable exposed (total amount at risk) (ii)	Value at risk (i) × (ii)
−5%	1 000 000	50 000
−5%	25 000	1 250

Note: Value at risk is a measure of the value loss or gain that arises from the potential change in the risk based on the exposed amount.

The organisation will want to manage the large exposure, which has a 50 000 value at risk, but will devote only minimal time to the small exposure. To do otherwise is to misuse management time and effort. Material is, in this context, of course, a relative term. When deciding which exposures are significant and hence need action, organisations should manage the absolute values at risk in relation to their size and the organisation's overall objectives.

Thus material exposures, which we do want to manage, are the risk factors times the total amount at risk in relation to the whole. A further examination of Table 1.1 shows that, if the potential degree of change in the variable had been only 0.5 per cent, then the amount at risk would have been 5000. It is the combination of change in the risk factor and the amount of the exposure that creates materiality. Of course, we can argue about what is material in a given context. For an individual, the orders of magnitude are much smaller: 500 might be a large loss to an individual and consequently quite material. So it is beyond this course to set fixed criteria on materiality and what risks organisations and, indeed, individuals should actively manage.

One of the decisions to be made by a particular organisation is what constitutes materiality in the context of the business, given that any time devoted to managing such an exposure will involve a cost. Remember that the risk paradigm is a cost–benefit analysis. Different organisations will arrive at different decisions in this regard depending on their **attitude to risk**. A key policy decision facing any organisation is how great an exposure it is prepared to assume. Economists generally define individuals' and organisations' attitudes to risk as **risk averse**, **risk neutral** or **risk seeking** (**risk taking**). Generally, an individual's or organisation's risk tolerance or risk appetite is an important determinant of how risks are managed.

The kind of risks taken by, say, an oil exploration company may be very different from those that a retailer is willing to take. The former will be taking very large bets on finding oil, the latter very small bets on new products and the quantities of existing products to order. The risk appetites, and consequently the risks they are taking, are very different.

In determining the amount of risk being assumed, we may also be helped by the lack of correlation between the different types of risk. As with a portfolio, the benefits of diversification come to our rescue, with bad and beneficial consequences cancelling each other out in most instances. The organisation's 'portfolio of risks' is likely to be, in the main, self-hedging. However, an organisation's risk manager would nevertheless want to check that this is the case. In the main, it is the excess of the risks in the portfolio that needs to be managed. That is, it is the risks over and above a certain threshold, determined by the organisation's risk appetite, that will be managed.

We must also distinguish between risk, which is manageable, and uncertainty, which is not. Just to confuse matters, financial literature sometimes uses uncertainty to mean the same thing as risk! Risk is the impact of events the occurrence of which is predictable but the exact form of which is unpredictable. For example, with risk we can predict a range of potential outcomes within which the actual outcome will occur. Uncertainty is the impact of completely unpredictable events. In an uncertain situation, we cannot make forecasts about the range of outcomes. Although uncertainty is not amenable to quantifiable forecasts, it can be handled within a generalised risk management framework. Risk managers will seek to build **flexibility**, **resilience** and **redundancy** into an organisation to cope with these events. Such forward planning involves qualitative forecasts, scenario building and other similar methods to ascertain the nature and scope of the impact of future, uncertain developments. An example of such planning is the requirement for banks to have duplicated data-processing facilities that can be brought online in the event of a disruption of the main installation. As a general precaution, organisations routinely prepare contingency plans for unpredictable events such as product tampering or contamination, or systems failure. Equally, at the macro level, situations like the outbreak of war or civil strife are foreseeable but impossible to predict.*

The principal point is that, as we move from frequently occurring events to the less common ones, there is a gradual reduction in our ability to calculate accurately the chances of different events taking place. Since we largely base the future probability of such events on their past occurrences (making any reasonable adjustments for the future), we need a database of such occurrences on which to build our analysis. We can rely on statistical assessment methods for events that occur very frequently, but we will need to use alternative methods for events that occur less frequently or potential discontinuities between the past and the future. These are the high-impact but low-probability events shown in Figure 1.12.

* These fall within the category of risks or uncertainties that we know exist but are impossible to quantify.

It may be argued that there is plenty of evidence that war, for instance, is a fairly common event. We are aware that such a risk exists, but, due to the complexity and variability of the factors that are likely to lead to the breakout of a war, we cannot predict such an event with any degree of confidence. It is inherently uncertain. On the other hand, we can predict with a great deal of confidence that about 3000 people will be killed in road accidents in the UK in the next 12 months. This is risk. That said, it is a remarkable fact that many low-frequency events are amenable to quantification through sophisticated statistical inference techniques, even if the estimate itself should be subject to considerable uncertainty. An example of such calculations is the safety estimates for nuclear power stations. However, in analyses of these rare events, the process by which the result is achieved is often more informative than the numerical estimate. In addition, there is strong research evidence that people, in considering and analysing risks, tend to disregard undesirable low-probability outcomes and, likewise, overestimate desirable ones (as with gambling, where people inflate the odds of winning long-odds outcomes).

Analytic techniques that are useful for high-frequency events may not be suitable for examining rare occurrences. This is a point that will be taken up later. Risk management does not, therefore, restrict itself to a single analytical approach; rather it makes use of a wide variety of techniques from finance, statistics and the management sciences. Therefore, it would be wrong to see financial risk management as embodying one particular methodology, although, as we will see, there is a logical approach to risk management that is widely used by risk managers whether in finance, industry, commerce or government.

1.2.2 The Risk Landscape

As previously stated, the risk landscape is multidimensional. Different management and administrative disciplines have to confront the problems of risk: health and safety, transportation, public policy, the environment, technology, science and many other areas are involved. There are a number of different ways of laying out the different risks facing an organisation. One such way of looking at risks is shown in Figure 1.17.* Two important conclusions can be drawn from this approach.

The first is that financial risk management is only one aspect of risk. Although this course concentrates on financial risk management, the approaches used to manage financial risk may be applied to other aspects of an organisation's activities. The second is that, although the material covers the top right-hand quadrant, the other quadrants impact on financial risks. Ultimately, every part connects with everything else. The objective of risk management is to control risks in such a way as to allow the effective operation of the organisation within its capabilities and resource constraints.

* Other modules will show other ways to categorise risks.

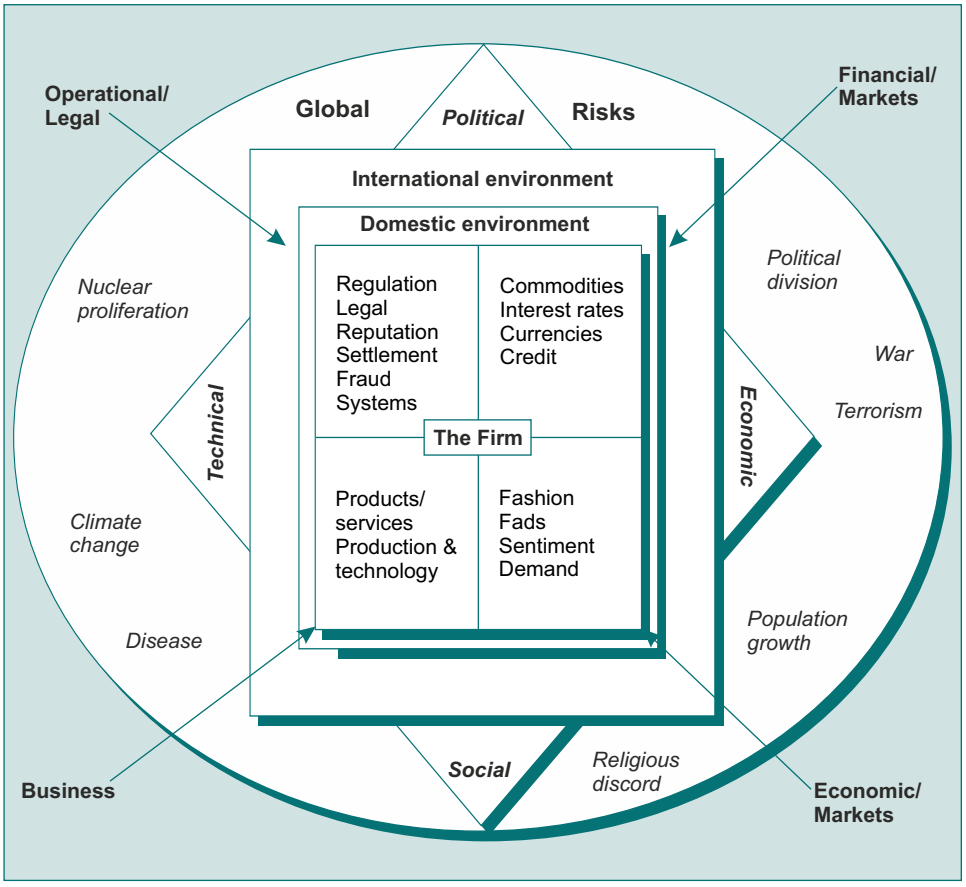

Figure 1.17 **A topography of corporate risk**

1.2.3 Risk Management

Organisations have no choice in managing risks. If an organisation has a sensitivity to a particular kind of risk due to the activities it pursues, then changes in this risk factor will change the current and future cash flows of the organisation. As previously discussed, organisations have to choose what objectives to pursue in handling these exposures. The basic risk management premise is to have more of the good and less of the bad. The key management task is to balance the desirable objective of risk reduction with the costs of so doing (the cost–benefit analysis discussed earlier). We will examine why organisations manage risks and what these risks are in detail in the next module. Typically, the organisation will want to be confident that changes in the external environment do not affect its objectives. As the next section indicates, the organisation is likely to have a multiple set of objectives that it will seek to pursue in handling its various exposures.

Objectives of Risk Management

In seeking to manage risk, individuals and organisations need to define an objective or a set of objectives in deciding how and when to manage and what to do about risk. A common goal for firms is to increase shareholder value. For individuals it may be their wealth, or what economists call 'utility'. That is, the object is to increase the value of the firm through increasing the present value of its future expected cash flows. In normal circumstances, in pursuing the goal of increased shareholder value, firms are likely to evaluate risk management decisions on the basis of two criteria: the **cost of reducing risk** and the **cost of setting risk levels at an acceptable level** – that is, in line with the particular firm's risk appetite or risk tolerance. In essence, firms will be evaluating risk on the basis of cost–benefit criteria. The cost of risk management relates to the price to be paid for risk control, be it via insurance, management time or lost opportunities from hedging. Firms will want to economise on these incidental expenses of being in business. In doing so, firms will want to arrive at an acceptable level of exposure in order to allow managers to focus on the core activity of value creation and not be preoccupied by the nature, extent and consequences of the risks in the business to the exclusion of its value-enhancing objective.

The situation is different once a major loss has occurred. At this point, the objectives of risk management change. The overriding objective becomes survival. In such a situation, the results of excessive risk taking are likely to significantly jeopardise the firm's survival. Firms will be looking to create a stable set of earnings and, where the loss has been a physical one, such as a fire or damage to plant and equipment, the ability to continue operations. Lastly, the firm will be concerned about its future growth prospects and development. The objectives of risk management are thus different depending on the firm's development and recent history.

Hence, since the nature of the firm's objectives is changed by a major loss, to the possible detriment of its fundamental objective, avoiding the loss becomes, in itself, a desirable objective.

Of course, concerns such as satisfying externally imposed obligations, for example health and safety regulations, employment law and so on, as well as meeting issues of good corporate citizenship, will be applicable both before and after any serious loss.

Summary of Pre- and Post-Loss Corporate Objectives

Pre-loss Enhancing shareholder value	Post-loss Survival
Objective is achieved by: • Cost–benefit analysis with emphasis on costs of reducing risks • An acceptable level of worry and anxiety so as not to distract from core objective	Objective is achieved by: • Maintaining earnings stability • Restarting and maintaining operations • Continued future growth
Social responsibility Satisfying externally imposed obligations	

- **Enhancing shareholder value**: a criterion for decisions about future courses of action that recognises the value-maximisation objective for the firm's managers. The goal of the firm's managers is to increase the value of the firm to benefit its owners;
- **Survival**: the ability of the firm to continue in operation in spite of sustaining a loss;
- **Cost–benefit analysis**: evaluative technique that seeks to balance the benefits of risk management against the costs;
- **Acceptable level of worry and anxiety**: corporate attitudes to risk taking such that the risks being accepted do not detract from the pursuit of the overall business objective. This objective includes the firm's strategy for delivering value and ensuring the well-being of its employees, customers, society and so on;
- **Earnings stability**: keeping earnings within acceptable bounds;
- **Maintaining operations**: restoring normal operations with the minimum of delay after a loss;
- **Continued growth**: ability to take advantage of growth opportunities;
- **Social responsibility**: the firm will be a good citizen;
- **Satisfying externally imposed obligations**: to comply with existing laws and regulations.

We may want to distinguish between two aspects of individual and corporate behaviour. The first is the idea of **speculation**; the second is **hedging**. With speculation, risk is deliberately taken on with the direct intention of producing a gain. The change in value or impact of the risk will be beneficial. On the other hand, hedging (which can include risk transfer or buying insurance) is a defensive action aimed at protecting against the effects of uncertainty. Hedging involves giving up the 'upside' in return for protection against the 'downside'. Insurance provides cover against potential adverse developments; that is, providing compensation for the 'downside' while retaining the benefits of the 'upside'. While, as we will see in

the next module, companies will want to choose the mix of risks they assume, firms that decide not to hedge are, in effect, speculating. In the face of risks, deferring a course of action is as much a 'decision' as buying insurance or putting on a hedge.

1.3 What Is Financial Risk?

There are several ways in which we may define financial risk. In understanding the impact of financial risk on the organisation, the nature of the cash flows or transactional exposures needs to be understood. The risk is in both the amount involved and its timing. The most obvious way to understand such risks is in terms of the impact of changes in the risk factors on the organisation's **accounting numbers**. Changes in the reported earnings will be indicative of the different outcomes experienced by the organisation. However, as mentioned earlier, financial risk will extend to **contingent exposures**; that is, expected future transactions. But there is a further, more general type of financial risk, known as **economic exposure**, that comes from the interaction between changes in macroeconomic variables and an organisation's overall competitive position. Note that all of these ultimately relate to the value of the firm, and – in financial terms – this can be considered as the present value of the future cash flows that the firm will generate.

1.3.1 The Nature of Cash Flows

We can define the nature of financial risk to cash flows in two ways: first, whether the amount of the cash flows is known and, second, whether the timing is known. We therefore have four different types of cash flow, as shown in Figure 1.18.

Financial risks involve contractual or potential contracted payments where the cash flows either are known for certain or are conditional. A conditional cash flow requires some event to make it take place. For instance, an insurance company may expect to make claims on policies, but it will not know the exact amount until a claim is made. The timing of these cash flows is also either certain or conditional. Conditional timing is where the exact date that the cash flow will occur is not known for certain ahead of time, although it might be expected. Payments firms receive for goods sold on trade credit fall into this category. These lead to the four types of risk given in Figure 1.18.

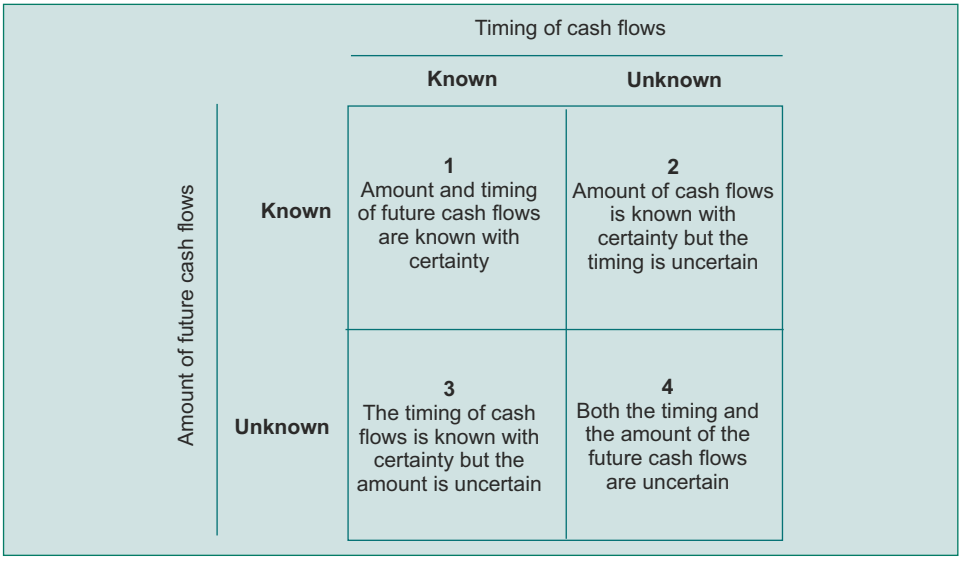

Figure 1.18 **The nature of financial assets and liabilities (cash flows)**

Type 1 cash flows are contracted payments that it is known will have to be met in the future. Examples of such known cash flows include the fixed-rate term deposits made with a bank and the coupon and principal payments on a fixed-rate bond. Both the cash flows and their timing are known with certainty. The deposit will mature at a given date, and both the amount deposited and the set interest thereon will be paid to the depositor. With a bond, the issuer will pay periodic coupon payments as defined by the bond terms on set dates. The holder knows in advance when these will take place.

Type 2 cash flows are contracted payments where the amount due is known but where the actual timing is undetermined. These include, for instance, the payments from customers when trade credit is given by the seller. The payment amount is known, but the exact date on which payments will be received is not known for certain. Uncertainty about the payment date also applies to various types of conditional financial contracts, such as life insurance, where the payout is known, since it is contracted, but the timing is unknown, since it depends on an uncertain event: the death of the insured.

Note that indeterminate does not mean that estimation is not feasible. Estimation is possible, often with a fair degree of accuracy. When a large number of transactions are involved, the statistical properties of the event come into play and, in particular, the law of large numbers applies. As we will see in later sections, the risk manager will make use of data from past cases as a predictor for outcomes in the future.

Type 3 cash flows have fixed timing but unknown amounts. These can arise, for instance, when money is borrowed at a floating rate over a given period. In this case, the contracted interest payments are not known for certain, since these will be set in line with future, unknown market conditions for each of the interest periods. For example, on a five-year bank loan that has the interest set every six months the

timing of the interest payments is known, but the amount will not be known until the actual interest rate is set in accordance with the terms of the borrowing. Note that, once this happens, the cash flow then becomes a Type 1 cash flow.

Type 4 cash flows have neither fixed timing nor known amounts. These are typically various contingent contracts or obligations where the cash flow crystallises only when a specific event occurs. These include many types of insurance contract that require payments if a loss is incurred by the insured party and where the extent of the loss becomes known only when the event happens. Type 4 cash flows also include situations such as tenders for contracts, where the future cash flows are conditional on success in the bidding process.

The different nature of these cash flows is captured in most organisations through internal management information, often of an accounting or transactional nature.

1.3.2 Accounting Definition

Various risks will affect an organisation's reported accounting numbers. The most common type of exposure is **transaction exposure**, which is based on **contracted transactions**. This is most evident in terms of foreign exchange rate risk where the value of **payables** and **receivables** in a foreign currency will vary directly with changes in the foreign exchange rate. There is, therefore, a **risk of an actual cash loss** if the position is not managed or completely hedged.

The second kind of accounting exposure arises from the **translation** of foreign currency items into the reporting currency (and hence it is also known as accounting exposure). Although no cash transactions arise, since the organisation is merely consolidating different sets of accounting numbers, changes in the rate used to convert currencies between one reporting date and another will create bookkeeping losses or gains. The translation problem arises because of two different effects. Accounting numbers are a combination of historic and current activities, and one view holds that it is the inherent contradictions within accounting conventions for creating sets of financial statements that create the problem.

1.3.3 Contingent Exposures

Contingent exposures are those created by expected but not, as yet, contracted transactions. Typically an organisation will have some expectation of sales to be made or costs to be incurred in the future on its recurring business. Although these revenues and expenses are not yet binding, there is a high probability that some or all of the anticipated cash flows will materialise. If such cash flows are denominated in a foreign currency or sensitive to changes in commodity prices or interest rates, then the value or magnitude of such expected cash flows may change in line with changes in these risk factors. A typical example would be an organisation bidding for a project or contract in a foreign currency where the value will fluctuate in line with changes in currency rates, adding a large undesirable element of unpredictability to the profitability of the contract.

1.3.4 Economic or Competitive Exposure

Economic or competitive exposure arises from changes in foreign exchange rates, interest rates and commodity prices, which have an impact on the organisation's profitability. It can be seen as the extent to which an unexpected change in a risk factor changes the value of the organisation's future expected cash flows and ultimately its profitability. The change in expected cash flows depends on the effect of changes in the variables affecting future sales volumes, prices and costs and hence competitiveness. It has second-, third- and higher-order effects since an organisation will be looking not only at how changes in the risk factors affect its suppliers and competitors but also at the effects on suppliers to the organisation's competitors and their competitors and so on.

Codelco Savaged by Poor Copper Price

An example of how economic factors affect firms' cash flows and profitability is the case of Codelco, the world's largest copper producer. In 1999, the half-year profits at the company were nearly halved to US$122 million as a result of low copper prices. Over the first half of the year, the copper price had averaged just $66.47/lb, one of the lowest in the twentieth century. At the time, the state-owned mining concern accounted for 15 per cent of world output, producing some 725 000 tons of fine copper annually, and had first-half sales of $1.27 billion, a fall of 7 per cent compared with the previous six months, even though sales volumes had risen by 5.5 per cent over the same six-month period in the previous year.

The situation would have been even worse had not managers at Codelco embarked on a radical cost-cutting plan that involved job cuts and pay freezes at the concern's five mines. As a result, direct production costs had been pared down from 44.3 cents/lb to 41.3 cents/lb.

Note the exposure that the company had to the copper price and its operational response to the low copper price, which involved cutting production costs and overheads – these are typical operational risk management decisions.

1.4 Steps to Risk Identification

Risk management, financial or otherwise, follows a logical process. At its simplest it involves three steps: an **awareness** of the risks being taken by the firm, organisation or individual; **measurement** of the risks to determine their **impact and materiality**; and **risk adjustment** through the adoption of policies or a course of action to manage or reduce the risks.

1.4.1 Risk Awareness

It is not obvious how we may become aware of or identify risks. Some risks will be well known since they have long been identified; other risks will emerge as a result of changing conditions. Management may have a prior awareness, or there may be a specific experience of certain risks. Other methods of becoming aware of risks include standard analytic methods such as fault tracing; the use of experts (for

instance Delphi forecasting); scenario building (via an investigation of Murphy's law – that is, what can go wrong will go wrong); brainstorming; and other similar approaches used to identify the factors in a particular industry, economic environment or within the firm. Careful examination of accidents that happen to others is also useful in creating awareness.*

Being aware of risks is an ongoing discovery exercise that needs to be repeated at frequent intervals to capture changed conditions. As human beings, we also have the problem that we may not either perceive the risk or be able to assess its significance due to our interpreting data through our own 'world view'. In addition, different financial markets have varying degrees of efficiency, market transparency and development. Dominic Casserley (1993) suggests three levels of risk awareness.

1. **Risks that are unknown and unmeasurable** (that is, they have not manifested themselves or have not been perceived). An example would be global interlinkages that affected banks and other financial institutions in the wake of the collapse of the US housing market. The contagion effect from the global holding of various kinds of collateral debt obligations (CDOs) was unexpected, especially since CDOs were supposed to diversify risk rather than enhance it. While a few commentators had questioned the suitability of CDOs as financial instruments, no one had understood the systemic risk that the wide dissemination of these instruments had created. Banks in virtually every single major country were adversely affected by the collapse in the CDO market and in a number of countries required government support. Fear that some banks were holding large quantities of CDOs and other such 'toxic assets' caused a virtual collapse of the world financial system in 2008, and only intervention by governments, regulators and central banks prevented the system from totally failing.
2. **Risks that are known but still unmeasurable** (where, although the risk is known, there are insufficient data on which to base an evaluation of the likely consequences or to quantify the exposure). The Greek crisis started in late 2009, when Greece announced that, far from having a manageable budget deficit as previously forecast of 3.7 per cent of GDP, this was an unsustainable 12.7 per cent. A few months later, in May 2010, the country was given a bailout by the European Union and the International Monetary Fund. While the risk of a country defaulting is known, it is hard to measure, since there are relatively few countries and few incidences of default. In addition, there are individual factors that make each country's case unique. Ireland and then Portugal were also given European Union assistance later on. There are common factors that affect all three countries, but, equally, the causes of their need for bailouts to prevent default are also country specific.
3. **Risks that are both known and measurable.** (In such cases, there are many observations on which to build a statistical model in order to predict future behaviour.) This is the situation with which risk management typically has to deal, when organisations seek to measure their exposure to the principal financial risk factors. As discussed earlier, we have historical data on currency exchange rates, commodity prices and interest rates that show how these have fluctuated considerably over time.

* The airline industry is a good example here: accident reports are widely circulated within the industry.

1.4.2 Risk Measurement

Risk measurement transforms that which is difficult to measure into quantifiable risks. The principal task initially is to **model risk** in order to measure its impact. Once the extent of the exposure has been determined, decisions about the appropriate course of action can be made. Typically, the procedure is to evaluate these risks using a cost–benefit approach (or, alternatively, the risk–reward trade-off) according to predetermined criteria. In principle the decision will depend on the costs and benefits involved in the different courses of action. There will be a trade-off between the benefits of risk reduction and the costs to be incurred. Normally the risks are contingent, while the costs involve actual cash outlays (for instance, insurance premiums against damage to property from fire, floods, etc. that may never occur). Also, many risk-reducing measures may involve opportunity costs – eliminating the potential for loss may also eliminate the potential for gain. In practice, organisations will also have different views about the level and types of risk that are acceptable. Consequently, there is no hard and fast rule governing any particular course of action. Indeed, one aspect of risk measurement involves determining the organisation's own risk-taking approach.

1.4.3 Risk Adjustment

Risk adjustment involves changing the nature of the risk from an undesirable level to an acceptable one. Three different approaches exist that include elements of risk pooling and risk transfer. The first involves **insurance**, where the risk is transferred to another party better able to accept the risk. Many kinds of standard risk can be insured at a price (known as a premium). The problem is that, as the risk to be insured becomes more specific to a particular organisation, insurers have the same problem as the insured! They will have the same difficulty quantifying the risk, and the price of such insurance will rise to reflect this uncertainty.

The second approach uses **hedging**. This is the principle of offsetting one risk with an opposite position in the same or similar risk. If the hedge works, the two risks should be self-cancelling. A decision can be made about how much of the total risk is to be hedged.

Organisations can undertake two different kinds of hedging. There is operational hedging (which shares some of the characteristics of the third approach discussed below), which involves the firm in changing sources of supply, the location of manufacturing and so on in order to reduce the impact of economic factors. The firm will also seek to match inflows and outflows in foreign currencies so as to become self-hedging.

The alternative is via financial hedging, which uses both on-balance-sheet and off-balance-sheet instruments.* Organisations using foreign-currency-denominated borrowings, for instance, seek to eliminate foreign exchange rate risk by using

* Under current International Financial Reporting Standards (IFRS), the accounting distinction between what is reported on the balance sheet and transactions that were once not so reported and hence are 'off balance sheet' has largely vanished. Nevertheless, it is useful to maintain the distinction since items once considered off balance sheet do not require significant new operational assets or liabilities.

foreign currency income to service the foreign currency loan. This has the effect of creating new liabilities and hence increasing the size of the balance sheet. On the other hand, the great expansion in what were formerly off-balance-sheet instruments (largely through the use of derivatives) used to manage financial risk has greatly increased the organisation's scope for such financial engineering. The advantage of these specialised instruments is that they are relatively low cost but can be rapidly adjusted to take account of changing economic circumstances. On-balance-sheet hedging is less flexible in this regard and becomes very inflexible when real assets, such as property and plant, are involved.

The third approach involves accepting the risk but reducing some of the more undesirable aspects by **changing behaviour**. This typically involves strategic decisions by organisations that seek to minimise undesirable risks. For instance, in certain areas of the world, there is considerable country and political risk. To cope with such a position, firms might form consortia, to spread the risks, or joint ventures with local firms better able to understand local conditions. Another alternative involves breaking down and separating the component risks in any given situation and assuming only the acceptable risks. Such 'cherry picking' of risks is typically seen in certain kinds of capital or venture-type projects and is the normal practice in project finance, where the different parties connected with the undertaking accept different parts of the overall risks involved.

Although the above suggests a sequential approach, risk analysis and management is in fact a dynamic situation, as the perception of risks evolves over time. As with so many management tasks, risk assessment has to be kept under constant review as circumstances change. In addition, as organisations become more familiar with different risks, they are better able to assess these and to handle the consequences.

The Step-By-Step Risk Management Process

The risk management literature often adopts a stages model from the project management and decision theory literature. A typical set of steps is given below:

1. Identify the source of the risk exposure.
2. Quantify and/or assess the exposure.
3. Assess the impact of the exposure on the firm's business and financial strategy. Determine the degree of risk adjustment required against predetermined criteria. This often takes the form of a cost–benefit analysis.
4. Assess the firm's capabilities, competencies and/or capacity to undertake its own hedging and insurance programme.
5. Select the appropriate risk management product and mix. This will typically include both operational hedging and the use of external risk management products such as insurance contracts, derivatives and risk pooling.
6. Keep the risk management process under review.

In their discussion of how financial risk exposure can be applied in practice, Bauman *et al.* (1994) also provide a logical series of steps, together with the required analysis, policy formulation and operational procedures that are required in order to properly manage and control the ongoing risks in the firm.

This generic model, with its five steps, is shown in Figure 1.19. In their approach, the formulation and execution of the risk management strategy is deemed to be simultaneously taking place at different levels within the firm, within different functions and business units, and also over time.

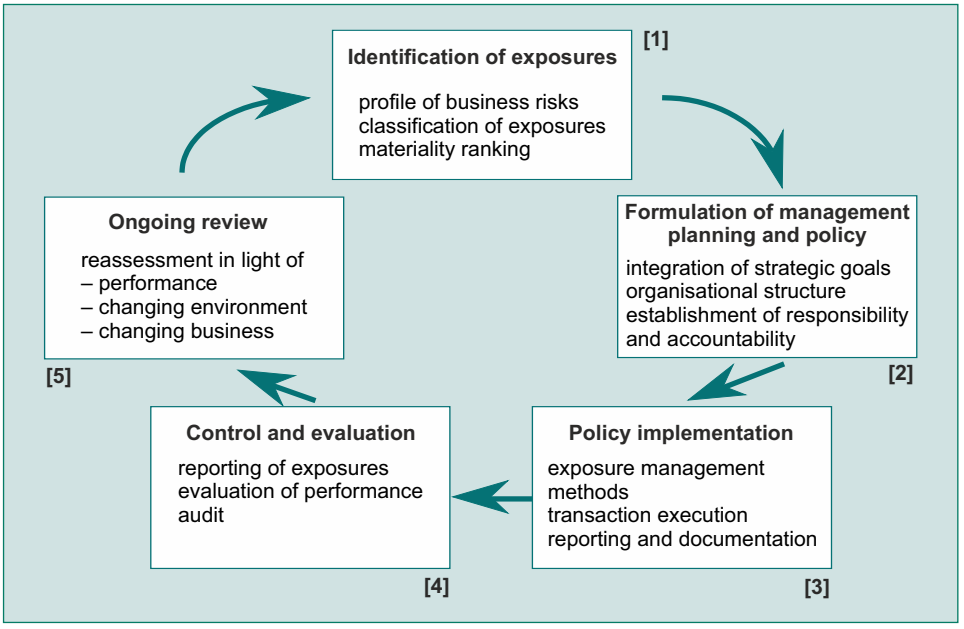

Figure 1.19 The stages in strategic risk management

The dynamic element leads to a continual process of review and modification. In Figure 1.19, the identification of exposures [1] leads to the formulation of an appropriate managerial response [2]. This is then implemented at the business unit and functional levels, with the appropriate set of controls and evaluation criteria [3] to determine the policy's effectiveness [4]. The results of the implementation stage are then reviewed in the light of the firm's overall corporate performance [5], changes in strategic objectives, and the changing business environment, which in turn restarts the evaluation process, leading to changes in policy [1]. The process is continuous as in step 6 in our decision approach the risks are kept under constant review. This is because the nature of the firm changes over time, as do the risks it faces.

The risk management process is, therefore, a continual adjustment of the firm's exposures in the light of changing conditions, the firm's own capacity to operate its hedging and insurance programme, and the cost–benefit trade-offs involved.

1.5 Top-Down and Building-Block Approaches to Risk Management

The senior management of an organisation will view the risk management process by looking at the overall risk from all sources. It is their responsibility to put in place a policy that will govern how much risk is acceptable. Indeed, in countries such as the United Kingdom companies are legally obliged to undertake a risk review and publish this in the annual report.

Within an organisation, the amount of risk that the firm considers acceptable will be translated into a hierarchy of risk limits. A commonly accepted criterion is for firms to seek to 'maximise shareholder value'. This would suggest concentrating on the impact of risk on a firm's **market value** or **equity value**.*

Senior management may also decide on the overall exposures and the anticipated movements in the risk factors. For instance, concerns about the likely direction of changes in interest rates and their impact on profitability may lead to decisions about the type and maturity of debt in the balance sheet. However, because senior management may experience difficulties in reacting to changes within an appropriate timescale, such decisions are normally delegated to a specialist committee or individual. For instance, a common approach in banks is to delegate decisions about the right level of sensitivity to interest rates and choices about funding to an Asset Liability Management Committee (ALMAC). Given the objectives of a particular firm, senior management will have to decide to what level to delegate responsibility.

There are three distinct approaches that can be adopted; these will be discussed in the later modules on the techniques for modelling and measuring risk. They can be termed an **equity–value approach**, an **asset–liability approach** and a transactional or **cash flow approach**. The different methods provide different insights and require differing amounts of information about the firm and its operations.

1.5.1 Equity Value

It is a tenet of finance that liquid capital markets are information efficient; that is, the price of financial instruments reflects known facts about the issuer. The market price of a security is a reflection of the consensus view on the worth of the asset. As new information arrives, market participants revise their assessment on the basis of the new information and act accordingly. This will cause prices to move; that is, to reflect the impact of the new information on the firm or the security's cash flows. We can use this fact (even without being certain about the degree of market efficiency – a subject still very much debated by financial economists) to measure the effects of changes to equity values from our risk factors using standard statistical techniques (in this case multiple regression). The greater the price movement (or sensitivity) for a given change in the risk factor, the greater the market's estimate of the firm's exposure to the particular risk. Of course, such estimates are historical since they measure the impact after the fact.

* This section draws on the insights from Rawls and Smithson (1990) and Smith *et al.* (1995).

1.5.2 Asset–Liability Management

Organisations have access to information that is not generally available to outsiders. This can be used for assessing their financial risks. The degree of sophistication used in measuring exposure in this way will depend on the availability, quality and cost of suitable data. The traditional approach is to focus on the accounting numbers through the budgeting and reporting process, although for risk management purposes this type of information may not be sufficiently timely, detailed or accurate to give exact measurements. Organisations can and do collect other data that is not strictly accounting information but that forms part of the information that these organisations collect on their operations and related outside parties, such as suppliers and customers.

Accounting methods have tended to involve scenario-building or maturity-gap and funding-gap type analyses based on accounting entries. Maturity- and funding-gap methods break up future assets and liabilities into discrete time intervals (for instance, by quarter years), and the mismatch between receipts and payments is used to determine the net amount of risk in any single period. This method is relatively simple to apply since it is often easier for firms to collect information on their assets and liabilities, which only change relatively slowly over time, than to have accurate forecasts of their future transactions or cash flows. Various measures of risk, for instance payback measures and so forth, can then be applied to the result to determine the firm's sensitivity to changes in risk factors. For some kinds of organisations, non-accounting data are more useful than those present in the financial statements. Take an insurance company: the history of past claims and the characteristics of those insured provide the raw data for pricing insurance policies and setting premiums.

1.5.3 Transactions and the Cash Flow Approach

The standard textbook finance approach focuses on changes to cash flows as the key sensitivity measure. A transactions-based approach usually starts at the level of the single transaction, building up individual exposures and netting the differences where applicable in order to build an overall (net) position to be managed from the ground up. This is often done in large organisations, for instance in foreign exchange management, through factoring arrangements between subsidiaries in different countries. The different currency exposures are pooled, and only the net residual difference has to be hedged. Using this method to manage contingent and economic risks has the disadvantage that it requires knowledge of the future cash flows from the business. In most instances, this will be impossible to determine since such cash flows will not be known with certainty. Organisations could find themselves overhedging their risks.

Learning Summary

This module has introduced the concept of risk as an unavoidable consequence of human activity. The increased risks facing firms from changes in economic variables have meant a greater focus on risk management activities.

Risk can be variously defined, no two definitions being identical. Generally, we can define risk as the variability of future outcomes. This variability is in some way

measurable, rather than being pure uncertainty, where measurement is not possible or is inaccurate. Financial risk is that part of a wider risk management process concerned with managing changes in, among other areas, the business, social, economic, political, technological and legal environment.

Corporate risk management is a natural response to an uncertain future. These risks can be measured in different ways: using accounting information, future cash flows, contingent and economic exposures. The risk management process is simple to define, and it follows a series of simple steps that involve the firm in (a) becoming aware of the risks; (b) measuring the risks; and (c) adjusting the risk, if necessary.

There are a number of different approaches that can be used to measure risk, either taking an equity view or building up the relevant exposures from the basic unit level. Risk can also be related to the asset and liability obligations of the organisation. In practice, organisations tend to use a combination of methods depending on the quality and timeliness of the information available.

Appendix to Module 1: What Risks Are We Taking?

The story in Section 1.1 about converting the British pound into US dollar traveller's cheques raises some issues about whether, in doing so, more risk has been assumed than is necessary. Reviewers of this module described the example as 'flawed'. They took the view that there was cross-rate parity; that is, that the risk of a DM/£ fluctuation equals the combined risk of a \$/£ fluctuation plus a DM/\$ fluctuation. They also made the point that the DM/\$ risk may be higher than the DM/£ risk. Once you have exchanged pounds for dollars, you will no longer have any \$/£ risk, unless of course you have some money left over in dollars that you want to take back and reconvert to British pounds.

In the earlier analysis, the decision to buy dollars for use in Germany may have been motivated by a view that the dollar was likely to appreciate against the Deutschmark in the immediate future (although at the time this was not the case).

As a transaction, buying US dollar traveller's cheques is equivalent to a two-leg transaction in foreign exchange. In making this transaction, I may have expected the DM to depreciate relative to the dollar. I therefore sold pounds for dollars. In terms of what is happening, the future relationship of the three currencies and their exchange rates can be expressed as follows.

$$FV(\text{DM}/\text{£}) = \frac{FV(\text{DM}/\$)}{FV(\$/\text{£})}$$

where FV is future value of the money, expressed as the ratio of the two currencies.

This synthetic position will be profitable if:

- both the British pound and the US dollar appreciate relative to the DM, but the US dollar appreciates more; or
- the British pound and the US dollar depreciate relative to the DM, but the British pound depreciates more; or
- the British pound depreciates against the DM, but the US dollar appreciates.

If the opposite result occurs, the transaction will lead to losses.

As a transaction, this trade will make most sense if the prognosis is that the dollar will appreciate relative to the DM, while the British pound loses ground relative to the DM. From a risk management perspective, I now have to forecast not just the DM/£ exchange rate but also the DM/$ rate. If my ability to forecast currency movements is 50:50, then adding another currency leg requires success on two fronts!

Although, as the reviewers consider, I may have eliminated my British pound currency risk, instead of just the DM/£ cross-rate, the denomination of my traveller's cheques in US dollars does increase the potential for risk, especially as my base currency was British pounds – and not the dollar.

What do you think?

Review Questions

Multiple Choice Questions

1.1 Risk is:

I. the natural consequence of change in the world.
II. the interaction of unpredictable events upon one another.
III. the interaction of events upon one another that we can anticipate but not predict.
IV. the unexpected.

Which of the following is correct?

A. I and II.
B. I and III.
C. II and III.
D. III and IV.

1.2 For a firm, risk management is the responsibility of which of the following executives?

A. The managing director.
B. The financial function of the firm.
C. The firm's advisers.
D. The firm as a whole.

1.3 Which of the following is correct? The task for risk management is to:

A. eliminate all risks.
B. reduce risks to an acceptable level.
C. eliminate unacceptable risks.
D. monitor risks and take action as required.

1.4 Which of the following is correct? A key factor in the modern development and practice of risk management is:

A. the breakdown of the Bretton Woods Agreement.
B. the development of financial markets where risks can be exchanged.
C. an increasingly uncertain future.
D. all of A, B and C.

1.5 What effect does a change in the external value of the currency have on exporters?

A. It increases the price of their products and services in foreign terms.
B. It decreases the price of their products and services in foreign terms.
C. Neither A nor B.
D. No effect.

1.6 Which of the following are the consequences of significant swings in interest rates?

A. On average, the cost of borrowing has been higher.
B. Lenders have refused to make long-term fixed lending commitments.
C. Savers have benefited from higher interest rates.
D. Volatility has increased.

1.7 Firms react to uncertainty about future interest rates by which of the following?

A. They increase the required rate of return, or hurdle rates, on investments.
B. They shorten the payback period.
C. They devote more resources to managing interest rate risk.
D. All of A, B and C.

1.8 The introduction by exchanges in the early 1970s, such as the Chicago Mercantile Exchange (CME), of financial instruments to manage risk addressed the following issues:

I. Problems of liquidity with over-the-counter (OTC) contracts.
II. The need for new instruments to manage financial risks.
III. The need to open the market in financial risk management products to all users.
IV. A requirement to trade risk management products on an exchange.

Which of the following is correct?

A. I and III.
B. I and II.
C. II and IV.
D. II and III.

1.9 The financial engineer seeks to help firms to manage their risk by which of the following methods?

A. Selling the user a forward, future, swap or option.
B. Designing new securities for sale to investors.
C. Splitting risks into their constituent parts.
D. Designing special hedge programmes.

1.10 Which of the following is correct? A fair definition of 'risk' is:

A. a situation where we are likely to be disappointed by an uncertain outcome.
B. an unexpected or unintended outcome.
C. a measure of the deviation from an anticipated or expected result.
D. all of A, B and C.

1.11 Which of the following is correct? The difference between risk and uncertainty is that:

A. there is no difference and the two terms are used interchangeably for the same thing.
B. one can measure risks but only establish conditions of uncertainty.
C. uncertainty is a product of the human condition while risk is our perception of man-made and natural hazards.
D. risk is objective in that it measures the range of outcomes in a given situation whereas uncertainty is the result of the decision maker's inability to choose a course of action.

1.12 Which of the following is correct? The difference between uncertainty and indeterminacy is:

A. that with an uncertain outcome the main parameters are known but not measurable, whereas with indeterminacy the causation is unknown.
B. that uncertainty is another term for risk whereas indeterminacy means that causal factors are unknown.
C. that uncertainty is another term for risk whereas indeterminacy means that the range of the outcomes is unknown.
D. that with an uncertain outcome the risk taker knows the direction but not the magnitude of the outcomes, whereas with indeterminacy the direction is unknown but not the magnitude.

1.13 Which of the following is correct? A cost–benefit approach to risk proposes that:

A. the benefit of not analysing risk is measured against the cost of risk analysis before a decision is made as to whether to assume the risk.
B. the benefit of analysing risk is measured against the cost of risk analysis before a decision is made as to whether to assume the risk.
C. the benefits of not assuming the risk are weighed against the potential losses according to predetermined criteria before a decision is made as to whether to assume the risk.
D. the benefits of assuming the risk are weighed against the potential losses according to predetermined criteria before a decision is made as to whether to assume the risk.

1.14 In analysing risk, the decision maker is often more concerned with the capacity for losses or the downside than potential gains. Which of the following explains this phenomenon?

A. Individuals and firms are risk averse and feel losses more than possible gains from assuming risks.
B. Methodologies for analysing risk are better suited to measuring losses than potential gains.
C. Losses arise before gains in any given situation.
D. All of A, B and C.

1.15 Which of the following is correct? Price risk is:

A. the risk that the market price of an asset, security, etc. will change over time.
B. the risk that the price required to be paid by buyers will change over time.
C. the risk that the price required to be paid by sellers will change over time.
D. all of A, B and C.

1.16 Which of the following is correct? Liquidity risk is:

A. the risk that market trading will be interrupted by the breakdown of market systems, such as computer malfunction, power failures and other parts of the mechanics of trading.
B. the difficulty a seller has in finding a buyer.
C. the problem of market price movements between a decision to buy or sell and being able to carry out the transaction.
D. problems companies have in buying and selling currencies of some Central African states.

1.17 Which of the following is correct? The risk profile is defined as:

A. the total risk of a given situation; that is, the sum of all the individual component risks.
B. the analysis of a given situation by risk types, so that each risk is then categorised, the total of these being known as the risk profile.
C. the amount of a particular risk in a given situation. Thus it is the individual element of the total risk.
D. the sequence and payoffs from a given risk in a situation.

1.18 Exposure is:

I. the risk times the amount at risk.
II. the value at risk.
III. the sum of all the individual risks.
IV. the sensitivity times the amount at risk.

The correct definition includes which of the following?

A. I and II.
B. I and III.
C. II and III.
D. II and IV.

1.19 Which of the following is correct? Speculation is:

A. taking actions designed to make a profit from reducing risks.
B. taking actions designed to make a profit from increased risks.
C. structured risk management actions designed to benefit from reducing risks.
D. structured risk management actions designed to benefit from increasing risks.

1.20 We can adjust risk in which of the following ways? We can:

A. sell the risk to another party.
B. enter into transactions that have the opposite risk to the current risk.
C. follow policies that seek to take risks into account.
D. do all of A, B and C.

1.21 Transaction exposure arises from which of the following?

A. Companies undertaking purchases and sales of products and services for immediate payment.
B. Companies reporting purchases and sales in their accounting books and ledgers.
C. Companies reporting purchases and sales in their income statement and balance sheet.
D. Companies undertaking to buy and sell products and services for deferred payment.

1.22 Which of the following is correct? Contingent exposures arise from:

A. non-contractual agreements that cannot be enforced in law.
B. various expected but not guaranteed future receipts and payments.
C. any bids or tenders where the company is not sure it will get the business.
D. all of A, B and C.

1.23 We can say the following about 'economic exposure':

I. It arises from changes in the balance sheet and income statement in a company.
II. It is the result of management decisions about the nature and type of business activities pursued by the firm.
III. It arises from changes in exchange rates, interest rates and commodity prices.
IV. It is the result of management decisions about the nature and type of business activities pursued by competing firms.

Which of the following is correct?

A. I, II and III.
B. I, II and IV.
C. I, III and IV.
D. II, III and IV.

1.24 Which of the following is correct? The insurance approach to risk management involves:

A. transferring a risk to another party better able to accept the risk.
B. entering into transactions that have offsetting characteristics to the risk.
C. changing the nature of a firm's operations to reduce the risk.
D. all of A, B and C.

1.25 Which of the following is correct? Operational hedging is the term given to:

A. how a risk manager carries out his duties.
B. transactions using financial instruments, such as forwards, futures, swaps and options.
C. transactions that change the firm's balance sheet, such as foreign currency debt.
D. how the financial function within a firm reports its risk management transactions.

1.26 Firms seek to manage their risks by looking at the risks in the firm's:

I. assets.
II. liabilities.
III. balance sheet.
IV. income statement.
V. cash flows.

Which of the following is correct?

A. I and II.
B. III and IV.
C. IV and V.
D. All of I, II, III, IV and V.

1.27 The risk management task follows a series of logical steps that are undertaken to carry out the process. These involve initially identifying the risks facing the firm. Which of the following represents the major difficulty that arises in this identification process?

A. There are insufficient data for the analysis.
B. Risks are ignored because they are seen as unimportant.
C. There is no consensus over which risks are to be included.
D. Some factors are included that are not risks.

1.28 There are many dimensions to risk. A firm will seek to manage some or all of these, and the most appropriate combination of methods will be to:

I. manage each risk separately.
II. manage the sum of all the risks.
III. manage those risks that are considered important.
IV. manage those risks that exceed a given exposure.

Which of the following is correct?

A. I and III.
B. I and IV.
C. II and III.
D. II and IV.

Case Study 1.1: Attitudes to Risk

A family reunion has brought together three generations of a family. At this gathering are the grandparents, the parents and their children. It is a cold winter's day and, after lunch, they decide to go for a walk. As they progress along they find that the route they wish to take is thickly covered over a considerable area by ice from a broken water pipe.

1 Consider the attitudes that the different members of this family might have towards the idea of crossing the ice.

References

Bauman, J., Saratore, S. and Liddle, W. (1994) 'A Practical Framework for Corporate Exposure Management', *Journal of Applied Corporate Finance*, 7 (3), 66–72.

Bernstein, P.L. (1996) *Against the Gods: The Remarkable Story of Risk*. New York: John Wiley & Sons.

Black, F. and Scholes, M. (1972) 'The Valuation of Option Contracts and a Test of Market Efficiency', *Journal of Finance*, 27 (May), 399–418.

Black, F. and Scholes, M. (1973) 'The Pricing of Options and Corporate Liabilities', *Journal of Political Economy*, 81 (May–June), 637–54.

Casserley, D. (1993) *Facing up to the Risks*. New York: John Wiley & Sons.

Fischhoff, B. (2012) *Risk Analysis and Human Behaviour*. New York: Routledge.

Lintner, J. (1965) 'The Valuation of Risky Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets', *Review of Economics and Statistics*, 47 (February), 13–37.

MacCrimmon, K.R. and Wehrung, D.A. (1986) *Taking Risks: The Management of Uncertainty*. London: Collier Macmillan.

Miller, M. (1991) *Financial Innovation and Market Volatility*. Oxford: Blackwell.

Rawls, S.W. III and Smithson, C. (1990) 'Strategic Risk Management', *Journal of Applied Corporate Finance*, 2 (4), 6–18.

Ross, S. (1976) 'The Arbitrage Theory of Capital Asset Pricing', *Journal of Economic Theory*, 13 (December), 341–60.

Sharpe, W. (1964) 'Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk', *Journal of Finance*, 19 (September), 425–42.

Smith, C. Jr, Smithson, C. and Wilford, D.S. (1995) *Managing Financial Risk: A Guide to Derivative Products, Financial Engineering and Value Maximization*. Chicago: Irwin Professional Publishing.

Wynne, B. (1992) 'Science and Social Responsibility', in Ansell, J. and Wharton, F. (eds) *Risk: Analysis, Assessment and Management*. Chichester: John Wiley & Sons.