CHAPTER 1
Introduction

1.1 LESSONS FROM A CRISIS

I began the first edition of this book with a reference to an episode of the television series *Seinfeld* in which the character George Costanza gets an assignment from his boss to read a book titled *Risk Management* and then give a report on this topic to other business executives. Costanza finds the book and topic so boring that his only solution is to convince someone else to read it for him and prepare notes. Clearly, my concern at the time was to write about financial risk management in a way that would keep readers from finding the subject dull. I could hardly have imagined then that eight years later Demi Moore would be playing the part of the head of an investment bank's risk management department in a widely released movie, *Margin Call*. Even less could I have imagined the terrible events that placed financial risk management in such a harsh spotlight.

My concern now is that the global financial crisis of 2007–2008 may have led to the conclusion that risk management is an exciting subject whose practitioners and practices cannot be trusted. I have thoroughly reviewed the material I presented in the first edition, and it still seems to me that if the principles I presented, principles that represented industry best practices, had been followed consistently, a disaster of the magnitude we experienced would not have been possible. In particular, the points I made in the first edition about using stress tests in addition to value at risk (VaR) in determining capital adequacy (see the last paragraphs of Section 7.3 in this edition) and the need for substantial reserves and deferred compensation for illiquid positions (see Sections 6.1.4 and 8.4 in this edition) still seem sound. It is tempting to just restate the same principles and urge more diligence in their application, but that appears too close to the sardonic definition of insanity: "doing the same thing and expecting different results." So I have looked for places where these principles need strengthening (you'll find a summary in Section 5.4). But I have also reworked the organization of the book to emphasize two core doctrines that I believe are the keys to the understanding and proper practice of financial risk management.

The first core principle is that financial risk management is not just risk management as practiced in financial institutions; it is risk management that makes active use of trading in liquid markets to control risk. Risk management is a discipline that is important to a wide variety of companies, government agencies, and institutions—one need only think of accident prevention at nuclear power plants and public health measures to avoid influenza pandemics to see how critical it can be. While the risk management practiced at investment banks shares some techniques with risk management practiced at a nuclear facility, there remains one vital difference: much of the risk management at investment banks can utilize liquid markets as a key element in risk control; liquid markets are of virtually no use to the nuclear safety engineer.

My expertise is in the techniques of financial risk management, and that is the primary subject of this book. Some risks that financial firms take on cannot be managed using trading in liquid markets. It is vitally important to identify such risks and to be aware of the different risk management approaches that need to be taken for them. Throughout the book I will be highlighting this distinction and also focusing on the differences that degree of available liquidity makes. As shorthand, I will refer to risk that cannot be managed by trading in liquid markets as *actuarial risk*, since it is the type of risk that actuaries at insurance companies have been dealing with for centuries. Even in cases that must be analyzed using the actuarial risk approach, financial risk management techniques can still be useful in isolating the actuarial risk and in identifying market data that can be used as input to actuarial risk calculations. I will address this in greater detail in Section 1.2.

The second core principle is that the quantification of risk management requires simulation guided by both historical data and subjective judgment. This is a common feature of both financial risk and actuarial risk. The time period simulated may vary greatly, from value at risk (VaR) simulations of daily market moves for very liquid positions to simulations spanning decades for actuarial risk. But I will be emphasizing shared characteristics for all of these simulations: the desirability of taking advantage of as much historical data as is relevant, the need to account for nonnormality of statistical distributions, and the necessity of including subjective judgment. More details on these requirements are in Section 1.3.

1.2 FINANCIAL RISK AND ACTUARIAL RISK

The management of financial risk and the management of actuarial risk do share many methodologies, a point that will be emphasized in the next section. Both rely on probability and statistics to arrive at estimates of the distribution of possible losses. The critical distinction between them is the matter of time. Actuarial risks may not be fully resolved for years, sometimes even decades. By the time the true extent of losses is known, the accumulation of risk may have gone on for years. Financial risks can be eliminated in a relatively short time period by the use of liquid markets. Continuous monitoring of the price at which risk can be liquidated should substantially lower the possibility of excessive accumulation of risk.

Two caveats need to be offered to this relatively benign picture of financial risk. The first is that taking advantage of the shorter time frame of financial risk requires constant vigilance; if you aren't doing a good job of monitoring how large your risks are relative to liquidation costs, you may still acquire more exposure than desired. This will be described in detail in Chapter 6. The second is the need to be certain that what is truly actuarial risk has not been misclassified as financial risk. If this occurs, it is especially dangerous—not only will you have the potential accumulation of risk over years before the extent of losses is known, but in not recognizing the actuarial nature, you would not exercise the caution that the actuarial nature of the risk demands. This will be examined more closely in Sections 6.1.1 and 6.1.2, with techniques for management of actuarial risk in financial firms outlined in Section 8.4. I believe that this dangerous muddling of financial and actuarial risk was a key contributor to the 2007–2008 crisis, as I argue in Section 5.2.5.

Of course, it is only an approximation to view instruments as being liquid or illiquid. The volume of instruments available for trading differs widely by size and readiness of availability. This constitutes the depth of liquidity of a given market. Often a firm will be faced with a choice between the risks of replicating positions more exactly with less liquid instruments or less exactly with more liquid instruments.

One theme of this book will be the trade-off between liquidity risk and basis risk. *Liquidity risk* is the risk that the price at which you buy (or sell) something may be significantly less advantageous than the price you could have achieved under more ideal conditions. *Basis risk* is the risk that occurs when you buy one product and sell another closely related one, and the two prices behave differently. Let's look at an example. Suppose you are holding a large portfolio of stocks that do not trade that frequently and your outlook for stock prices leads to a desire to quickly terminate the position. If you try selling the whole basket quickly, you face significant liquidity risk since your selling may depress the prices at which the stocks trade. An alternative would be to take an offsetting position in a heavily traded stock futures contract, such as the futures contract tied to the Standard & Poor's™ S&P 500 stock index. This lowers the liquidity risk, but it increases the basis risk since changes in the price of your particular stock basket will probably differ from the price changes in the stock index. Often the only way in which liquidity risk can be reduced is to increase basis risk, and the only way in which basis risk can be reduced is to increase liquidity risk.

The classification of risk as financial risk or actuarial risk is clearly a function of the particular type of risk and not of the institution. Insurance against hurricane damage could be written as a traditional insurance contract by Metropolitan Life or could be the payoff of an innovative new swap contract designed by Morgan Stanley; in either case, it will be the same risk. What is required in either case is analysis of how trading in liquid markets can be used to manage the risk. Certainly commercial banks have historically managed substantial amounts of actuarial risk in their loan portfolios. And insurance companies have managed to create some ability to liquidate insurance risk through the reinsurance market. Even industrial firms have started exploring the possible transformation of some actuarial risk into financial risk through the theory of *real options*. An introduction to real options can be found in Hull (2012, Section 34) and Dixit and Pindyck (1994).

A useful categorization to make in risk management techniques that I will sometimes make use of, following Gumerlock (1999), is to distinguish between risk management through risk aggregation and risk management through risk decomposition. *Risk aggregation* attempts to reduce risk by creating portfolios of less than completely correlated risk, thereby achieving risk reduction through diversification. *Risk decomposition* attempts to reduce a risk that cannot directly be priced in the market by analyzing it into subcomponents, all or some of which can be priced in the market. Actuarial risk can generally be managed only through risk aggregation, whereas financial risk utilizes both techniques. Chapter 7 concentrates on risk aggregation, while Chapter 8 primarily focuses on risk decomposition; Chapter 6 addresses the integration of the two.

1.3 SIMULATION AND SUBJECTIVE JUDGMENT

Nobody can guarantee that all possible future contingencies have been provided for—this is simply beyond human capabilities in a world filled with uncertainty. But it is unacceptable to use that platitude as an excuse for complacency and lack of meaningful effort. It has become an embarrassment to the financial industry to see the number of events that are declared "once in a millennium" occurrences, based on an analysis of historical data, when they seem in fact to take place every few years. At one point I suggested, only half-jokingly, that anyone involved in risk management who used the words *perfect* and *storm* in the same sentence should be permanently banned from the financial industry. More seriously, everyone involved in risk management needs to be aware that historical data has a limited utility, and that subjective judgment based on experience and careful reasoning must supplement data analysis. The failure of risk managers to apply critical subjective judgment as a check on historical data in the period leading to the crisis of 2007–2008 is addressed in Section 5.2.5.

This by no means implies that historical data should not be utilized. Historical data, at a minimum, supplies a check against intuition and can be used to help form reasoned subjective opinions. But risk managers concerned with protecting a firm against infrequent but plausible outcomes must be ready to employ subjective judgment.

Let us illustrate with a simple example. Suppose you are trying to describe the distribution of a variable for which you have a lot of historical data that strongly supports a normal distribution with a mean of 5 percent and standard deviation of 2 percent. Suppose you suspect that there is a small but nonnegligible possibility that there will be a regime change that will create a very different distribution. Let's say you guess there is a 5 percent chance of this distribution, which you estimate as a normal distribution with a mean of 0 percent and standard deviation of 10 percent.

If all you cared about was the mean of the distribution, this wouldn't have much impact—lowering the mean from 5 percent to 4.72 percent. Even if you were concerned with both mean and standard deviation, it wouldn't have a huge impact: the standard deviation goes up from 2 percent to 3.18 percent, so the Sharpe ratio (the ratio of mean to standard deviation often used in financial analysis) would drop from 2.50 to 1.48. But if you were concerned with how large a loss you could have 1 percent of the time, it would be a change from a gain of 0.33 percent to a loss of 8.70 percent. Exercise 1.1 will allow you to make these and related calculations for yourself using the Excel spreadsheet **MixtureOfNormals** supplied on the book's website.

This illustrates the point that when you are concerned with the tail of the distribution you need to be very concerned with subjective probabilities and not just with objective frequencies. When your primary concern is just the mean—or even the mean and standard deviation, as might be typical for a mutual fund—then your primary focus should be on choosing the most representative historical period and on objective frequencies.

While this example was drawn from financial markets, the conclusions would look very similar if we were discussing an actuarial risk problem like nuclear safety and we were dealing with possible deaths rather than financial losses. The fact that risk managers need to be concerned with managing against extreme outcomes would again dictate that historical frequencies need to be supplemented by informed subjective judgments. This reasoning is very much in line with the prevailing (but not universal) beliefs among academics in the fields of statistics and decision theory. A good summary of the current state of thinking in this area is to be found in Hammond, Keeney, and Raiffa (1999, Chapter 7). Rebonato (2007) is a thoughtful book-length treatment of these issues from an experienced and respected financial risk manager that reaches conclusions consistent with those presented here (see particularly Chapter 8 of Rebonato).

The importance of extreme events to risk management has two other important consequences. One is that in using historical data it is necessary to pay particular attention to the shape of the tail of the distribution; all calculations must be based on statistics that take into account any nonnormality displayed in the data, including nonnormality of correlations. The second consequence is that all calculations must be carried out using simulation. The interaction of input variables in determining prices and outcomes is complex, and shortcut computations for estimating results work well only for averages; as soon as you are focused on the tails of the distribution, simulation is a necessity for accuracy.

The use of simulation based on both historical data and subjective judgment and taking nonnormality of data into account is a repeated theme throughout this book—in the statement of general principles in Section 6.1.1, applied to more liquid positions throughout Chapter 7, applied to positions involving actuarial risk in Section 8.4, and applied to specific risk management issues throughout Chapters 9 through 14.

EXERCISE

1.1 The Impact of Nonnormal Distributions on Risk

Use the **MixtureOfNormals** spreadsheet to reproduce the risk statistics shown in Section 1.3 (you will not be able to reproduce these results precisely, due to the random element of Monte Carlo simulation, but you should be able to come close). Experiment with raising the probability of the regime change from 5 percent to 10 percent or higher to see the sensitivity of these risk statistics to the probability you assign to an unusual outcome. Experiment with changes in the mean and standard deviation of the normal distribution used for this lower-probability event to see the impact of these changes on the risk statistics.