CHAPTER 1

Setting the Stage

Since the seminal Black-Scholes and Merton papers in 1973, the derivatives market has exploded by leaps and bounds. Derivatives are now being traded in esoteric asset classes like weather, mortality, credit, and real estate—just to name a few. While reasons for this development can be attributed to a myriad of factors, including taxes, market inefficiencies, creativity in product development, advances in financial modeling, investor sophistication, and so on, it is undeniable that the single biggest motivation for the existence of the current state of affairs in the derivatives market is the existence of sophisticated market participants. This, fueled by a flurry of publications on risk-quantification techniques, led investment banks in the late 1970s and early 1980s to employ mathematicians, physicists, and engineers with PhDs as their in-house rocket scientists or quants or eggheads. Thus began the migration of academics to the lucrative world of finance (who, at that time, were struggling to find decent university positions in their respective fields of mathematics, physics, and engineering). As a consequence, the field of financial economics grew exponentially in mathematical complexity, with practitioners beginning to question the assumptions underlying the Black-Scholes model in the hope of building a more realistic model that would give them a better competitive advantage.

After the 1987 stock market crash and a series of highly publicized derivatives-based bankruptcies in the 1990s, the use of the derivatives as useful risk-management tools has been constantly questioned and criticized. Even the legendary investor Warren Buffett labeled derivatives as the financial weapons of mass destruction. The irony of this undeserving bad press is that many of these losses could have easily happened even when trading cash instruments, since the primary reason for the bulk of these financial
disasters has been the lack of proper controls and corporate governance.\textsuperscript{1} Despite many of these unfounded criticisms, the derivatives markets has and will continue to flourish as financial markets become more globalized and bankers are constantly looking at innovative ways to strip and repackage risks to provide more effective, efficient, and customized solutions to the hedging-and-speculating clientele.

Given the above backdrop, it is not surprising to see quantitative tools deployed by derivatives practitioners finding their way (over the years) to the quantification of nonfinancial risks, as risk managers try to better understand the interdependence between financial market risks and nonfinancial market risks. The consequence of trying to better quantify and understand this risk interdependence is the ability to optimize the way resources are manipulated and deployed (or allocated) so as to maximize the value to the firm. This also explains the popularity of the growing discipline of Real Options\textsuperscript{2} in which quantitative tools borrowed from the financial engineering world are integrated with those from other disciplines (e.g., engineering, actuarial science, manufacturing, or airline operations management) to create an integrated platform that can be used to better assess the impact of the operations’ management on financial market risks, which, in turn, impacts the costs and ways the operations are run.

**WHY IS THIS BOOK DIFFERENT?**

There are many good technical books written on derivatives-related topics. With the exception of a few, many of them assume a certain level of mathematical familiarity and maturity with stochastic calculus—thereby making the materials almost nonaccessible or in comprehensible to practitioners (or wannabe practitioners) coming fresh out from an MBA or an undergraduate program, or who are eager to roll up their sleeves to learn such tools themselves. On the other hand, the books that provide a good foundation on derivatives (with very little emphasis on stochastic calculus), do not go far enough to provide the mathematical tools that are often necessary to

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\textsuperscript{1}There have been numerous examples of such incidences during the past few decades. One example of such an incident occurred in 2008 when Jerome Kerviel (Société Générale) hid his losses of USD$7 billion. As a consequence of being found guilty, Jerome was handed down a five-year prison sentence in addition to a permanent ban from working in the financial services industry. Another example is Bruno Iksil (also known as the London Whale) from JP Morgan. In this 2012 incident, JP Morgan lost about USD$7 billion.

\textsuperscript{2}Myers in 1977 used the methods advocated by Black-Scholes and Merton (in their 1973 papers) to quantify corporate liabilities.
solve the practical problems encountered by a risk manager, analyst, or an operations manager.

The quantitative tools required by a risk practitioner are unique compared to the tools required by practitioners in other disciplines; these tools heavily borrow from and combine fields of pure mathematics, applied mathematics, probability, statistics, computer science, and so on—very much akin to the operations research field. As a consequence, any beginner without a good grasp of the tools can easily get lost in this quantitative maze. Based on my extensive risk-modelling experience across different businesses, I have found that while it is good for any aspiring professional to understand the mathematical rigor motivating these tools, it is more important for someone to be able to understand the tools that are available, the strengths and weaknesses (limitations) of such tools, know how to apply the tools effectively, and fully comprehend what the risks are—all the while being able to ask the right questions without losing sight of common sense. As a consequence, given the power of personal computers and the ready availability of good quantitative commercial software packages like Microsoft Excel, @RISK, Matlab, and so on, it suffices for practitioners to understand the heuristics associated with the applications of these tools and how these tools can be adapted and customized for the needs of solving the particular problem.

Since this book is targeted to practitioners (and wannabe practitioners), I have kept the contents of this book to the discussion of practical issues and how quantitative tools are used to solve these problems, while leaving the review of such quantitative tools to the website accompanying this book. I have also had the luxury of using parts of this book to teach undergraduate and graduate students in business and financial engineering programs, as well as professionals on quantitative and modeling techniques. Given the number of students that I have taught over the decades with versions of this material, I think it is fairly safe to say that for readers to extract maximum value from this book they should have some level of familiarity with basic derivatives and financial concepts, undergraduate calculus, probability, and statistics. Although this book should be useful to any practitioner on a stand-alone basis, it can easily complement many of the widely used textbooks on derivatives, finance, and operations research.

**ROAD MAP OF THE BOOK**

To reiterate: The objective of this book is to illustrate the use of quantitative methods and techniques in business, finance, and operations management.

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3Examples of this would be the study of measure theory and diffusion processes using stochastic calculus.
Despite the fact that there are numerous practical examples of how these methods are applied to solve real-world problems, due to time constraints I was unfortunately only able to find the time to discuss a few of such examples in this edition of the book.\footnote{It is my desire to add to these examples in subsequent editions of the book so as to eventually end up with a compendium of examples spanning across industries.}

The book can be intuitively and broadly partitioned into the following four sections:

- **First Section:** Comprising Chapter 2, this section focuses on the basic building block of finance that is associated with the present valuing and future valuing of cash flows. More precisely, Chapter 2 discusses examples of market instruments and the use of these instruments to construct a zero (or discount) curve that can be used for present or future value cash flows.

- **Second Section:** Comprising Chapters 3, 4, and 5, this section focuses on the valuation of financial derivatives. The section starts by discussing the valuation of simple financial options with and without early exercise in Chapter 3. Given the predominant use of simulations in nearly all types of analysis that are carried out today, and the age of cheap computer hardware, it is important for any practitioner to have a good working knowledge of implementing simulations (despite them not being highly efficient!). Chapter 4 introduces the reader to simulations and walks the reader through various issues encountered when using simulations to solve a problem. It concludes with examples of applications of the simulation method in practice. The final chapter of this section uses the ideas discussed in Chapters 3 and 4 to value complex path-dependent options.

- **Third Section:** Comprising Chapters 6 and 7, this section focuses on the estimation of parameters in a model and the risks arising from the mis-estimation of these parameters. Chapter 6 kicks off this section by discussing the estimation of the parameters in trading models. As any trader would appreciate, the bulk of trading that is done using models revolves around the view on the correctness of the model parameters. Chapter 7 discusses ways of managing such risks and, more importantly, quantifying the effectiveness of hedging strategies used to manage the risks before implementing them.

- **Fourth Section:** The last section of the book discusses further applications of quantitative methods as they relate to specific industry
problems—taking into consideration the nuances of appropriate business specifics. Starting with Chapter 8 on the valuation of variable annuities (an investment-based insurance product), the section concludes with the chapter on real options.

As mentioned earlier, the use of quantitative methods in daily business and financial affairs is becoming increasingly prevalent. Thus, the more one gets comfortable with the use and manipulation of the software (e.g., Microsoft Excel, @RISK, Matlab), one’s ability to quantify the risks, value decisions, consumer behavior, revenues, profits, and so on using appropriate techniques and models becomes better and easier.

In writing this book, I cannot reiterate enough that these examples are far from exhaustive. As such, I welcome readers to submit suggestions (or examples) they want to be discussed in future editions of the book.

REFERENCES
