Preface

Thirty years ago derivatives was an esoteric and specialized subject. Today it is a basic part of modern finance: Corporations routinely hedge and insure using derivatives, finance their activities with structured products, and use derivatives models in capital budgeting. Any financially literate business student must understand the basics of derivatives. This book is intended for anyone who wants to better understand the derivative instruments that exist, how they are used, who sells them, how they are priced, and how the tools and concepts are useful more broadly in finance.

If you flip through the book, you will see a lot of formulas, but I hope that you do *not* come away with the idea that studying derivatives only entails studying an assortment of pricing formulas. Instead, the subject of derivatives provides a unified, systematic, and common-sense way of thinking about an important class of problems. I hope this book conveys both the applicability as well as the logical elegance of the subject. I also hope it conveys that the subject is just plain fun. (It is, admittedly, a structured kind of fun.)

Although much of the material is mathematical, I have tried to emphasize intuition. I assume that a reader of this book already understands basic financial concepts such as present value and elementary statistical concepts such as mean and standard deviation. Thus, the important ideas should be accessible to anyone who has studied elementary finance. For those who want to understand the subject at a deeper level, the last part of the book develops the Black-Scholes *approach* to pricing derivatives and presents some of the standard mathematical tools used in option pricing, such as Itô's Lemma.

I use a "tiered" approach to the mathematics. Chapters 1–9 use only present value calculations, and there is no calculus until Chapter 18. The goal is to make the book accessible to readers with widely varying backgrounds and experiences. There are also chapters dealing with applications: Corporate applications, financial engineering, and real options.

As you read through the book, you will want to experiment with the pricing models and perhaps build your own spreadsheets. Most of the calculations in this book can be replicated using a spreadsheet. This book comes with an Excel spreadsheet containing option pricing functions, written in Visual Basic. These functions are "user-defined functions," which means that you can easily incorporate them into your own spreadsheets. You can also examine and modify the Visual Basic code for the functions. Appendix D explains how to write such functions in Excel, and Appendix E lists the option pricing

functions that come with the book. Relevant built-in Excel functions are also mentioned throughout the book.

PLAN OF THE BOOK

This book grew from my teaching notes for two MBA derivatives courses at Northwestern University's Kellogg School of Management. The two courses roughly correspond to the first two-thirds and last third of the book. The first course is a general introduction to derivative products (principally futures, options, swaps, and structured products), the markets in which they trade, and applications. The second course is for those wanting a deeper understanding of the pricing models and the ability to perform their own analysis.

The two courses share the goals that students should understand standard derivatives products and their pricing formulas, comprehend how such products are used and how they are created by market-makers, and appreciate how concepts and tools from derivatives are useful in corporate finance and investment decision making. Additional goals for the advanced course include an understanding of more sophisticated derivatives products; increased computational skills, such as the ability to compute prices and perform Monte Carlo simulations using a spreadsheet; and the facility to read advanced practitioner literature and communicate with financial rocket scientists. This last point is important: No one expects that a 10-week MBA-level course will produce rocket scientists! However, mathematics is the language of derivatives and it would be cheating students to pretend otherwise. Thus, the advanced course assumes that students know basic statistics and have seen calculus, and from that point develops the Black-Scholes option-pricing framework as fully as possible. The aim is to use mathematics to illuminate, without becoming needlessly complex.

You may want to cover the material in a different order than it occurs in the book, so I wrote chapters to allow flexible use of the material. I will indicate several possible paths through the material below. Of course there are dependencies, but it is possible to hop around in the material. For example, I wrote the book expecting that the chapters on lognormality and Monte Carlo simulation might be used in a first derivatives course.

This book has five parts. **Part 1** introduces the basic building blocks of derivatives: Forward contracts and call and put options. Chapters 2 and 3 examine these basic instruments and some common hedging and investment strategies. Chapter 4 illustrates the use of derivatives as risk management tools and discusses why firms might care about risk management. These chapters focus on understanding the contracts and strategies, but not on pricing.

Part 2 considers the pricing of forward, futures, and swaps contracts. In these contracts, you are obligated to buy an asset at a pre-specified price, at a future date. The main question is: What is the pre-specified price, and how is it determined? Chapter 5 examines forwards and futures on financial assets, Chapter 6 discusses commodities, and Chapter 7 looks at bond and interest rate forward contracts. Swaps are just forward contracts with multiple delivery dates and on which multiple payments are made. Chapter 8 shows how swap prices can be deduced from forward prices.

Part 3 studies option pricing. Chapter 9 develops intuition about options prior to delving into the mechanics of option pricing. Chapters 10 and 11 cover binomial option pricing and Chapter 12, the Black-Scholes formula and option Greeks. Chapter 13 explains delta-hedging, which is the technique used by market-makers when managing the risk of an option position. This chapter also introduces the most important pricing result in the book. When you see a complicated option pricing formula, you might wonder how anyone could know that the formula is correct. This chapter begins to explain the answer to that question. Chapter 14 looks at a few important exotic options, including Asian options, barrier options, compound options, and exchange options.

The techniques and formulas in earlier chapters are applied in **Part 4.** Chapter 15 covers financial engineering, which is the creation of new financial products from the derivatives building blocks in earlier chapters. Debt and equity pricing, compensation options, and mergers are covered in Chapter 16. Chapter 17 studies real options—the application of derivatives models to the valuation and management of physical investments.

Finally, **Part 5** explores pricing and hedging in depth. The material in this part explains in more detail the structure and assumptions underlying the standard derivatives models. Chapter 18 covers the lognormal model and shows how the Black-Scholes formula is an expected value. Chapter 19 discusses Monte Carlo valuation, a powerful and commonly used pricing technique. Chapter 20 explains what it means to say that stock prices follow a diffusion process, and also covers Itô's Lemma, which is a key result in the study of derivatives. (At this point you will discover that Itô's Lemma has already been developed intuitively in Chapter 13, using a simple numerical illustration of market-making.)

Chapter 21 derives the Black-Scholes partial differential equation (PDE). Although the Black-Scholes *formula* is famous, the Black-Scholes *equation*, discussed in this chapter, is the more profound result. Chapter 22 covers exotic options in more detail than Chapter 14, including digital barrier options and quantos. Chapter 23 shows how the Black-Scholes and binomial analysis apply to bonds and interest rate derivatives. Finally, Chapter 24 covers risk assessment, including VaR and credit risk.

NAVIGATING THE MATERIAL

There are potentially many ways to cover the material in this book. Although the subject is cumulative, I have tried to make chapters self-contained where feasible. The material is presented in order of increasing mathematical difficulty, which means that related material is sometimes split across distant chapters. For example, fixed income is covered in Chapters 7 and 23, and exotic options in Chapters 14 and 22. Each of these chapters is at the level of the neighboring chapters. As an illustration of one way to use the book, here is the material I cover in the courses I teach (within the chapters I skip some specific topics due to time constraints):

- Introductory course: 1–6, 7.1, 8–10, 11.1–11.2, 12, 13.1–13.3, 14, 15.4–15.5, 16, 17.

- Advanced course: 13, 18–22, 7, 8, 15.1–15.3, 23, 24.

You will note that some material appears in both courses. I do this to emphasize connections within the material. The second time through can be quick, but I find that students appreciate the material at a deeper level the second time.

Table 1 outlines some possible sets of chapters to use in courses that have different emphases. There are a few sections of the book that provide background on topics

TABLE 1

Possible chapters for different courses. Chapters marked with a "y" are strongly recommended, those marked with a "*" are recommended, and those with a "†" fit with the track, but are optional. The advanced course assumes students have already taken a basic course. Sections 1.4, 5.1, 5.2, 7.1, and Appendix B are recommended background for all introductory courses.

	Introductory				
	General	Futures	Options	Risk Management	Advanced
1. Introduction	y	y	y	y	
2. Intro. to Forwards and Options	y	y	y	y	
3. Insurance, Collars, and Other Strategies	y	y	y	y	
4. Intro. to Risk Management	*	*	y	y	
5. Financial Forwards and Futures	y	y	y	y	
6. Commodity Forwards and Futures	*	y	†	*	
7. Interest Rate Forwards and Futures	*	y		*	y
8. Swaps	y	y	†	y	y
9. Parity and Other Option Relationships	*	†	y	†	
10. Binomial Option Pricing: I	y	*	y	y	
11. Binomial Option Pricing: II	*		*		
12. The Black-Scholes Formula	y	*	y	y	
13. Market-Making and Delta-Hedging	†		y	*	y
14. Exotic Options: I	†		y	*	
15. Financial Engineering	*	*	*	y	*
16. Corporate Applications	†		*	*	
17. Real Options	†		*	*	
18. The Lognormal Distribution	†		*	*	y
19. Monte Carlo Valuation	†		*	*	y
20. Brownian Motion and Itô's Lemma					y
21. The Black-Scholes Equation					y
22. Exotic Options: II					y
23. Interest Rate Models					y
24. Risk Assessment				*	y

every reader should understand. These include short-sales (Section 1.4), continuous compounding (Appendix B), prepaid forward contracts (Sections 5.1 and 5.2), and zero-coupon bonds and implied forward rates (Section 7.1).

A NOTE ON EXAMPLES

Many of the numerical examples in this book display intermediate steps to assist you in following the calculations. In most cases it will also be possible for you to create a spreadsheet and compute the same answers starting from the basic assumptions. This creates the following dilemma: Should the answers in the book match the results you would obtain by computing the displayed numbers, which are rounded to a few significant digits, or should they match the results you would obtain by entering the equations directly in a spreadsheet, which are rounded with many more significant digits?

In most cases, the results should match what you would obtain in a spreadsheet. Consequently, you will sometimes encounter displayed calculations that result in a slightly different answer from that in the book. This problem can be more severe the more intermediate steps are displayed, since there is rounding at each step. The problem also arises when there are different ways to compute the same answer. You should not be concerned if an answer you compute from the displayed calculations differs slightly from the answer displayed in the book.

A different issue arises when real companies appear in examples. Some of these companies were subsequently acquired or failed. For example, Times Mirror was acquired by the Tribune Company; Netscape was acquired by AOL Time Warner; Cincinnati Bell is now part of Broadwing, Inc.; and WorldCom was on the verge of failure in June 2002. The moral is that you should bet against the continued independent existence of any company used as an example in this book.

SUPPLEMENTS

A robust package of ancillary materials for both instructors and students accompanies the text.

Instructor's Resources

The derivatives instructor will find a wide variety of materials online at a dedicated **website** (**www.aw.com/mcdonald**) to facilitate and enhance teaching.

An **Instructor's Solutions Manual** by Mark Cassano, University of Calgary, and Ruediger Fahlenbrach, The Wharton School, University of Pennsylvania, contains complete solutions to all end-of-chapter questions in the text and spreadsheet solutions to selected questions.

The **Test Bank** by Matthew W. Will, University of Indianapolis, features approximately ten to fifteen multiple-choice questions, five short-answer questions, and one longer essay question for each chapter of the book.

PowerPoint slides, developed by Ufuk Ince, University of Washington, and Ekaterina Emm, Georgia State University, provide lecture outlines and selected art from the book. Copies of the slides can be downsized and distributed to students to facilitate note taking during class.

Student Resources

A printed **Student Solutions Manual** by Mark Cassano, University of Calgary, and Ruediger Fahlenbrach, The Wharton School, University of Pennsylvania, provides answers to all the even-numbered questions in the textbook.

Three **spreadsheets** with user-defined option pricing functions in Excel are included on a CD-ROM packaged with the book. These Excel functions are written in VBA, with the code accessible and modifiable via the Visual Basic editor built into Excel. These spreadsheets and any updates are also posted on the book's website.

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Numerous students over the course of several years contributed to this book, offering complaints, praise, and corrections. Kellogg student Tejinder Singh catalyzed the book in 1994 by persuading colleague Kathleen Hagerty and me that MBA students at Kellogg were interested in an advanced derivatives course. Kathleen and I initially co-taught that course. My part of the course notes (developed with Kathleen's help and feedback) evolved into the last third of this book.

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With any book, there are many long-term intellectual debts. From the many, I want to single out two. I had the good fortune to take several classes from Robert Merton at MIT while I was a graduate student. Every derivatives book is deeply in his debt, and this one is no exception. His classic papers from the 1970s, as well as his recent writings on the role of derivatives and functional regulation, are essential reading. I also learned an enormous amount working with Dan Siegel, with whom I wrote several papers on real options. Dan's death in 1991 at the age of 35 was a great loss to the profession as well as to me personally.

I am very pleased to have worked with the Addison Wesley team, who made it clear from the outset that their goal was not just to produce a book but to produce a high-quality book. Mary Clare McEwing juggled many balls, offered excellent advice, and answered numerous questions while expertly overseeing the project. Among her thankless tasks was calling me to ask whether I was adhering to the schedule. (The answer, of course, was always "no.") Development editor Marjorie Singer Andersen offered innumerable suggestions, improving the manuscript significantly. Nancy Fenton, the production supervisor, marshalled forces (including the excellent team at Elm Street Publishing Services) to produce a physical book in (what I can only assume will be) an astonishingly short period of time. It has also been a pleasure to work with the exceptional Finance Editor Donna Battista and Editor-in-Chief Denise Clinton.

The Addison Wesley team and I have tried hard to minimize errors, including the use of the accuracy checkers noted above. Nevertheless, of course, I alone bear responsibility for remaining errors. Errata and software updates will be available at **www.aw.com/mcdonald.** Please let us know if you do find errors so we can update the list.

I wrote this book using Gnu Emacs and MikTeX (a Windows implementation of LaTeX), and produced the graphs and figures using Matlab and XFig. Except for Matlab, all of this extraordinary, high-quality software is open source. I am indebted to the Free Software Foundation (**www.fsf.org**) for Emacs and to Christian Schenk for MikTeX

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