

EXCEL™ MODELING IN INVESTMENTS

Fifth Edition

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CONTENTS

Preface	vii
Fifth Edition Changes	vii
Ready-To-Build Spreadsheets	vii
What is Unique about This Book	xi
Conventions Used in This Book.....	xii
Craig’s Challenge	xiv
Excel™ Modeling Books	xiv
Suggestions for Faculty Members	xiv
Acknowledgments.....	xv
About The Author	xvi
PART 1 BONDS / FIXED INCOME SECURITIES	1
Chapter 1 Bond Pricing	1
1.1 Annual Payments.....	1
1.2 EAR, APR, and Foreign Currencies	2
1.3 Duration and Convexity	7
1.4 Price Sensitivity	9
1.5 Immunization.....	11
1.6 System of Five Bond Variables.....	17
Problems.....	18
Chapter 2 The Yield Curve	21
2.1 Obtaining It From Treasury Bills and Strips.....	21
2.2 Using It To Price A Coupon Bond.....	22
2.3 Using It To Determine Forward Rates	23
Problems.....	24
Chapter 3 Affine Yield Curve Models	25
3.1 US Yield Curve Dynamics	25
3.2 The Vasicek Model	30
3.3 The Cox-Ingersoll-Ross Model	32
Problems.....	34
PART 2 PORTFOLIO MANAGEMENT	35
Chapter 4 Portfolio Optimization	35
4.1 Two Risky Assets and a Riskfree Asset	35
4.2 Descriptive Statistics	38
4.3 Many Risky Assets and a Riskfree Asset.....	42
4.4 Any Number of Risky Assets	52
Problems.....	57
Chapter 5 Constrained Portfolio Optimization	58
5.1 No Short Sales, No Borrowing, and Other Constraints	58
5.2 Any Number of Risky Assets	68
Problems.....	77
Chapter 6 Portfolio Performance	78
6.1 Evaluation Measures	78
Problems.....	80


Chapter 7 Portfolio Diversification Lowers Risk	81
7.1 Basics	81
7.2 International	82
Problems.....	84
PART 3 SECURITY ANALYSIS	85
Chapter 8 Stock Valuation.....	85
8.1 Dividend Discount Model.....	85
Problems.....	86
Chapter 9 Du Pont System Of Ratio Analysis.....	87
9.1 Basics	87
Problems.....	88
PART 4 STOCKS	89
Chapter 10 Asset Pricing.....	89
10.1 Static CAPM Using Fama-MacBeth Method	89
10.2 APT or Intertemporal CAPM Using Fama-McBeth Method	93
Problems.....	98
Chapter 11 Market Microstructure	100
11.1 National Best Bid and Offer (NBBO).....	100
11.2 Transaction Cost By Exchange Using TAQ Data	100
11.3 Limit Order Book Vs. Call Market.....	106
11.4 Transaction Cost Measures	108
11.5 Transaction Cost Components	110
11.6 Probability of Informed Trading (PIN).....	111
Problems.....	113
Chapter 12 Life-Cycle Financial Planning	114
12.1 Taxable Vs. Traditional Vs. Roth Savings.....	114
12.2 Basic Life-Cycle Planning	116
12.3 Full-Scale Life-Cycle Planning	118
Problems.....	125
PART 5 INTERNATIONAL INVESTMENTS	126
Chapter 13 International Parity.....	126
13.1 System of Four Parity Conditions	126
13.2 Estimating Future Exchange Rates.....	128
Problems.....	129
Chapter 14 Swaps	130
14.1 Valuation of Interest Rate Swaps.....	130
14.2 Valuation of Currency Swaps.....	132
Problems.....	133
PART 6 OPTIONS, FUTURES, AND OTHER DERIVATIVES	135
Chapter 15 Option Payoffs and Profits	135
15.1 Basics	135
Problems.....	136






















Chapter 16 Option Trading Strategies	137
16.1 Two Assets.....	137
16.2 Four Assets.....	140
Problems.....	143
Chapter 17 Put-Call Parity	146
17.1 Basics	146
17.2 Payoff Diagram.....	146
Problems.....	148
Chapter 18 Binomial Option Pricing	149
18.1 Estimating Volatility	149
18.2 Single Period	150
18.3 Multi-Period.....	153
18.4 Risk Neutral	157
18.5 Average of N and N-1	160
18.6 Convergence to Normal.....	162
18.7 American With Discrete Dividends.....	164
18.8 Full-Scale.....	168
Problems.....	173
Chapter 19 Black-Scholes Option Pricing.....	175
19.1 Basics	175
19.2 Continuous Dividend.....	176
19.3 Greeks.....	180
19.4 Daily Delta Hedging	184
19.5 Trading Strategies Over Any Horizon.....	187
19.6 Implied Volatility.....	192
19.7 Exotic Options.....	194
Problems.....	199
Chapter 20 Futures	201
20.1 Spot-Futures Parity (Cost of Carry)	201
20.2 Margin	203
Problems.....	204
Chapter 21 Pricing By Simulation	205
21.1 Path-Independent Derivatives	205
21.2 Path-Independent Derivatives With Jumps	206
21.3 Path-Independent Derivatives With Stratified Sampling	208
21.4 Path-Dependent Derivatives	209
21.5 Path-Dependent Derivatives With Jumps	210
Problems.....	211
Chapter 22 Corporate Bonds.....	213
22.1 Two Methods.....	213
22.2 Impact of Risk.....	215
Problems.....	216
PART 7 EXCEL SKILLS	217
Chapter 23 Useful Excel Tricks	217
23.1 Quickly Delete The Instruction Boxes and Arrows	217
23.2 Freeze Panes.....	217
23.3 Spin Buttons and the Developer Tab	218
23.4 Option Buttons and Group Boxes	219
23.5 Scroll Bar.....	221
23.6 Install Solver or the Analysis ToolPak.....	222
23.7 Format Painter.....	222

23.8 Conditional Formatting	223
23.9 Fill Handle.....	224
23.10 2-D Scatter Chart	224
23.11 3-D Surface Chart.....	226

DOWNLOADABLE CONTENTS

 **Excel Modeling in Investments Fifth Edition.pdf**

 **Ready-To-Build spreadsheets available in both XLSX and XLS file formats:**

-  Ch 01 Bond Pricing - Ready-To-Build.xlsx
-  Ch 02 The Yield Curve - Ready-To-Build.xlsx
-  Ch 03 Affine Yield Curve Models - Ready-To-Build.xlsx
-  Ch 04-05 Portfolio Optimization - Ready-To-Build.xlsm
-  Ch 06 Portfolio Performance - Ready-To-Build.xlsx
-  Ch 07 Portfolio Diversification Lowers Risk - Ready-To-Build.xlsx
-  Ch 08 Stock Valuation - Ready-To-Build.xlsx
-  Ch 09 Du Pont System of Ratio Analysis - Ready-To-Build.xlsx
-  Ch 10 Asset Pricing - Ready-To-Build.xlsx
-  Ch 11 Market Microstructure - Ready-To-Build.xlsx
-  Ch 12 Life-Cycle Financial Planning - Ready-To-Build.xlsx
-  Ch 13 International Parity - Ready-To-Build.xlsx
-  Ch 14 Swaps - Ready-To-Build.xlsx
-  Ch 15 Option Payoffs and Profits - Ready-To-Build.xlsx
-  Ch 16 Option Trading Strategies - Ready-To-Build.xlsx
-  Ch 17 Put-Call Parity - Ready-To-Build.xlsx
-  Ch 18 Binomial Option Pricing - Ready-To-Build.xlsx
-  Ch 19 Black-Scholes Option Pricing - Ready-To-Build.xlsx
-  Ch 20 Futures - Ready-To-Build.xlsx
-  Ch 21 Pricing By Simulation - Ready-To-Build.xlsx
-  Ch 22 Corporate Bonds - Ready-To-Build.xlsx

Preface

For more than 30 years, since the emergence of Lotus 1-2-3 and Microsoft Excel™ in the 1980s, spreadsheet models have been the dominant vehicles for finance professionals in the business world to implement their financial knowledge. Yet even today, most Investments textbooks have very limited coverage of how to build Excel models. This book fills that gap. It teaches students how to build financial models in Excel. It provides step-by-step instructions so that students can build and estimate models themselves (active learning), rather than being handed already-completed spreadsheets (passive learning). It progresses from simple examples to practical, real-world applications. It spans nearly all quantitative models in investments, including nearly all niche areas of investments.

My goal is simply to *change finance education from limited treatment of the most basic Excel models to comprehensive treatment of both simple and sophisticated Excel models*. This change will better prepare students for their future business careers. It will increase student evaluations of teacher performance by enabling more practical, real-world content and by allowing a more hands-on, active learning pedagogy.

Fifth Edition Changes

The Fifth Edition adds great new investments content:

- Market microstructure including:
 - Compute the National Best Bid and Offer (NBBO),
 - Determine how a set of market orders and limit orders will execute in a limit order book market vs. a call market,
 - Compute five alternative transaction cost measures,
 - Decompose transaction costs into four components, and
 - Estimate the Probability of Informed Trade (PIN),
- Portfolio performance evaluation including Jensen’s Alpha, the Sharpe Ratio, the Treynor Ratio, the M^2 measure, the T^2 measure, and the Information measure
- Taxable vs. traditional vs. Roth savings plans

All of the real-world data, including bond prices, the yield curve, intraday trades and quotes, asset returns, exchange rates, and options prices, have been updated.

Ready-To-Build Spreadsheets

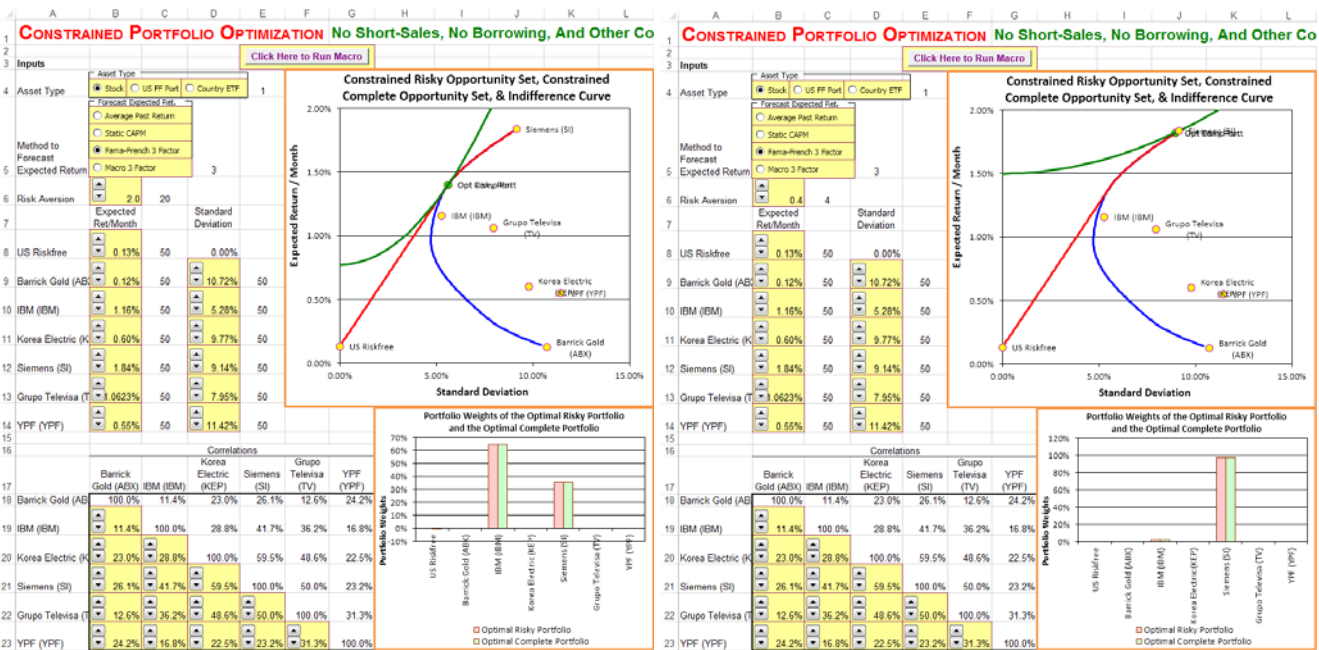
This product includes **Ready-To-Build spreadsheets**, which can be downloaded from the Pearson web site. The spreadsheets are available in both “**XLSX**” and “**XLS**” file formats. By default, the screen shots and instructions in the book are based on **Excel 2013**. For the items explained in this book, there are no significant differences relative to Excel 2010. There are few places where there

are differences relative to Excel 2007. In those instances “Excel 2007 Equivalent” boxes have been added in the margin to explain how to do the equivalent step in Excel 2007.

The instruction boxes on the Ready-To-Build spreadsheets are *bitmapped images* so that the formulas cannot just be copied to the spreadsheet. Both the instruction boxes and arrows are *objects*, so that they can easily be deleted when the spreadsheet is complete. Just select the boxes and arrows and press delete. This leaves a clean spreadsheet for future use.

The book contains a significant number of sensitivity exercises (e.g., how does a change in risk aversion affect the optimal portfolio allocation?) and explores a variety of optional choices (alternative models to forecast expected return, alternative spreads and combinations, etc.). In each case, a picture is shown of how things change and there is a discussion of what this means in economic terms. For example, below is Figure 5.14 which explores what happens to the optimal portfolio when risk aversion is lowered?

FIGURE 5.14 Risk Aversion of 2 and 0.4



Ready-To-Build Spreadsheets for every chapter provide:

A model setup, such as input values, labels, and graphs

Step-by-step instructions for building the model on the spreadsheet itself

	A	B	C	D	E	F	G	H	I	J
1	BOND PRICING	Annual Payments								
2										
3										
4										
5										
6										
7	Inputs									
8	Number of Periods to Maturity (T)	8	8							
9	Face Value (PAR)	\$1,000	20							
10										
11										
12	Discount Rate / Period (r)	2.35%	4							
13	Coupon Payment (PMT)	\$20.00	4							
14										
15	Bond Price using a Timeline									
16	Period	0	1	2	3	4	5	6	7	8
17										
18	Cash Flows									
19	Present Value of Cash Flows									
20	Bond Price									
21										
22	Bond Price using the Formula									
23	Bond Price (P)									
24										
25	Bond Price using the PV Function									
26	Bond Price									
27										
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										

(1) Coupon Payment
Enter =\$B\$13 and copy to the range D18:I18

(2) Coupon Payment + Face Value
Enter =B13+B9

(3) (Cash Flow) / ((1+Discount Rate/Period)^Period)
Enter =C18/((1+\$B\$12)^C16) and copy across

(4) Sum of all the Present Value of Cash Flows
Enter =SUM(C19:J19)

(5) The Bond Price Formula is

$$P = \frac{PMT \cdot (1 - ((1+r)^{-T}))}{r} + \frac{PAR}{(1+r)^T}$$
 Enter =B13*(1-((1+B12)^(-B8)))/B12+B9/((1+B12)^B8)

(6) -PV(Discount Rate / Period, Number of Periods to Maturity, Coupon Payment, Face Value)
Enter =-PV(B12,B8,B13,B9)

All instructions are explained twice: once in English and a second time as an Excel formula

Students enter the formulas and copy them as instructed to build the spreadsheet

Many spreadsheets use real-world data

ASSET PRICING		Static CAPM Using Fama-MacBeth Method				
Inputs						
Market Portfolio Benchmark	<input checked="" type="radio"/> US S&P 500 (SPY) <input type="radio"/> CRSP VWMR <input type="radio"/> DJ World (DWG)					1
Asset Type	<input checked="" type="radio"/> Stock <input type="radio"/> US FF Port <input type="radio"/> Country ETF					1
	Stock	Stock	Stock	Stock	Stock	Stock
	Barick Gold (ABX)	IBM (IBM)	Korea Electric (KEP)	Siemens (SI)	Grupo Televisa (TV)	YPF (YPF)
Monthly Excess Returns	(1) Monthly Return(Asset i, Month t) - Riskfree Rate(Month t) Enter =B10-\$AC10 and copy to B133:V252					
Dec 2012	1.39%	0.78%	13.85%	5.76%	12.29%	27.96%
Nov 2012	-14.26%	-1.87%	-4.82%	2.56%	4.72%	3.22%
Oct 2012	-3.03%	-6.24%	3.78%	0.75%	-3.88%	-14.09%
Sep 2012	8.40%	6.46%	15.96%	6.22%	2.30%	3.91%
Aug 2012	17.75%	-0.15%	-3.08%	11.32%	0.83%	9.63%
Jul 2012	-12.49%	0.20%	-1.17%	0.73%	6.09%	-7.62%
Jun 2012	-3.82%	1.39%	18.93%	1.78%	13.11%	-3.44%

Spin buttons, option buttons, and graphs facilitate visual, interactive learning

BLACK SCHOLES OPTION PRICING			Continuous Dividend Yield and Alternative Underlying Assets			
Inputs						
Option Type	<input checked="" type="radio"/> Call <input type="radio"/> Put		1			
Underlying Asset Type	<input checked="" type="radio"/> Stock <input type="radio"/> Stock Index <input type="radio"/> Futures <input type="radio"/> Foreign Currency					1
Stock Price Now (S(0))	\$49.11	49				
Standard Dev - Annual (σ)	74.73%	7				
Riskfree Rate- Annual (r)	0.12%	0				
Exercise Price (X)	\$45.00	45				
Time To Maturity - Yrs (T)	0.4472	4				
Underlying Asset Yield is Stock Dividend Yield (d)	1.00%	1				
Outputs						
d ₁	0.417					
d ₂	-0.083					
N(d ₁)	0.662					
N(d ₂)	0.467					
Call Price (C ₀)	\$11.34					
-d ₁	-0.417					
-d ₂	0.083					
N(-d ₁)	0.338					
N(-d ₂)	0.533					
Put Price (P ₀)	\$7.43					

Continuous Dividend and Alternative Underlying Assets

(1) Copy the basic Black-Scholes formulas from the previous sheet
Copy the range B15:B25 from the previous sheet to the range

(2) Add dividend yield (d) to the d₁ formula:

$$d_1 = \frac{\ln(S_0/X) + (r - d + \sigma^2/2) \cdot T}{\sigma \cdot \sqrt{T}}$$
 Enter =LN(B6/B9)+(B8-B11+B7^2/2)*B10)/(B7*SQRT(B10))

(3) Add dividend yield (d) to the call formula:

$$C_0 = S_0 e^{-dt} N(d_1) - X e^{-rT} N(d_2)$$
 Enter =B6*EXP(-B11*B10)*B17-B9*EXP(-B8*B10)*B18

(4) Add dividend yield (d) to the put formula:

$$P_0 = -S_0 e^{-dt} N(-d_1) + X e^{-rT} N(-d_2)$$
 Enter =-B6*EXP(-B11*B10)*B23+B9*EXP(-B8*B10)*B24

What is Unique about This Book

There are many features which distinguish this book from any other:

- **Plain Vanilla Excel.** Other books on the market emphasize teaching students programming using Visual Basic for Applications (VBA) or using macros. By contrast, this book does nearly everything in plain vanilla Excel.¹ Although programming is liked by a minority of students, it is seriously disliked by the majority. Excel has the advantage of being a very intuitive, user-friendly environment that is comprehensible to all. It is fully capable of handling a wide range of applications, including quite sophisticated ones. Further, the only assumption is that your students already know the basics of Excel, such as entering formulas in a cell and copying formulas from one cell to another. All other features of Excel (such as built-in functions, Data Tables, Solver, etc.) are explained as they are used.
- **Build from Simple Examples to Practical, Real-World Applications.** The general approach is to start with a simple example and build up to a practical, real-world application. In many chapters, the previous Excel model is carried forward to the next, more complex model. For example, the chapter on binomial option pricing carries forward Excel models as follows: (a.) single-period model with replicating portfolio, (b.) eight-period model with replicating portfolio, (c.) eight-period model with risk-neutral probabilities, (d.) eight-period model with risk-neutral probabilities for American or European options with discrete dividends, (e.) full-scale, fifty-period model with risk-neutral probabilities for American or European options with discrete dividends. Whenever possible, this book builds up to full-scale, practical applications using real data. Students are excited to learn practical applications that they can actually use in their future jobs. Employers are excited to hire students with Excel modeling skills, who can be more quickly productive.
- **Supplement for All Popular Investments Textbooks.** This book is a supplement to be combined with a primary textbook. This means that you can keep using whatever textbook you like best. You don't have to switch. It also means that you can take an incremental approach to incorporating Excel modeling. You can start modestly and build up from there.
- **A Change in Content, Too.** Excel modeling is not merely a new medium, but an opportunity to cover some unique content items which require computer support to be feasible. For example, the Portfolio Optimization chapter uses 10 years of monthly returns for individual stocks, U.S. Fama-French portfolios, and country ETFs to estimate the (unconstrained) Risky Opportunity Set and the (unconstrained) Complete Opportunity Set. The

¹ I have made one exception. The Constrained Portfolio Optimization spreadsheet uses a macro to repeatedly call Solver to map out the Constrained Risky Opportunity Set and the Constrained Complete Opportunity Set.

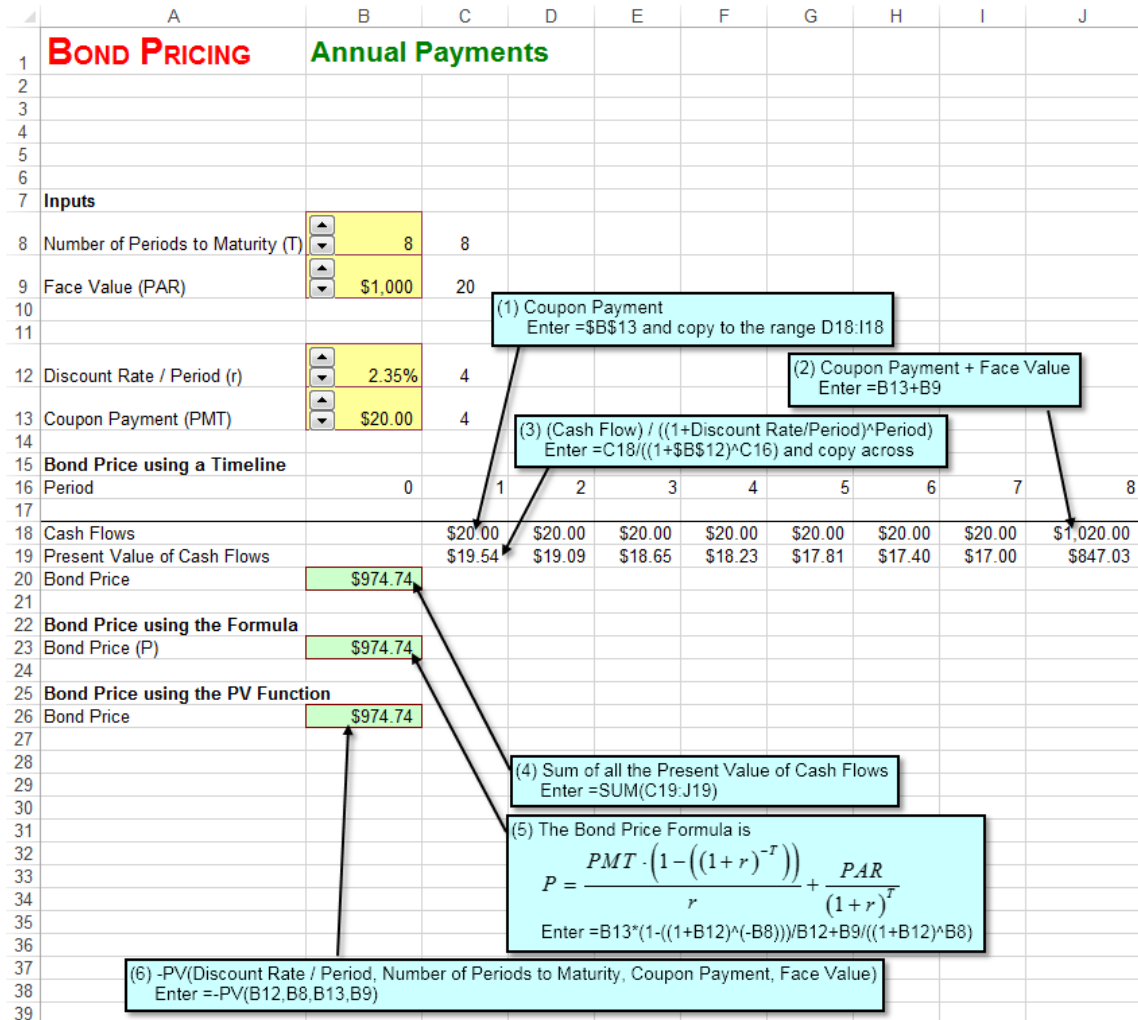
same data is used by Solver to numerically solve for the Constrained Risky Opportunity Set and the Constrained Complete Opportunity Set. The same data is used to estimate the Static CAPM using the Fama-MacBeth method and to estimate the APT or Intertemporal CAPM using the Fama-MacBeth method. The Market Microstructure chapter uses current Trade and Quote (TAQ) data to compute the National Best Bid and Offer (NBBO), the quoted spread, the effective spread, and to determine which exchange has the lowest cost of trading. The Excel model in US Yield Curve Dynamics shows 40 years of monthly US yield curve history in just a few minutes. Real call and put prices are fed into the Black-Scholes Option Pricing model and Excel's Solver is used to back-solve for the implied volatilities. Then the "smile" pattern (or more like a "scowl" pattern) of implied volatilities is graphed. As a practical matter, all of these sophisticated applications require Excel.

Conventions Used in This Book

This book uses a number of conventions.

- **Time Goes Across the Columns and Variables Go Down the Rows.** When something happens over time, I let each column represent a period of time. For example, in life-cycle financial planning, date 0 is in column B, date 1 is in column C, date 2 is in column D, etc. Each row represents a different variable, which is usually labeled in column A. This manner of organizing Excel models is common because it is how financial statements are organized.
- **Color Coding.** A standard color scheme is used to clarify the structure of the Excel models. The Ready-To-Build spreadsheets available for download use: (1) yellow shading for input values, (2) no shading (i.e. white) for throughput formulas, and (3) green shading for final results ("the bottom line"). A few Excel models include choice variables with blue shading. The Constrained Portfolio Optimization spreadsheet includes constraints with pink shading.

- The Timeline Technique.** The most natural technique for discounting cash flows in an Excel model is the timeline technique, where each column corresponds to a period of time. As an example, see the section labeled “Bond Price using a Timeline” in the figure below.



- Using as Many Different Techniques as Possible.** In the figure above, the bond price is calculated using as many different techniques as possible. Specifically, it is calculated three ways: (1) discounting each cash flow on a time line, (2) using the closed-form formula, and (3) using Excel’s PV function. This approach makes the point that all three techniques are equivalent. This approach also develops skill at double-checking these calculations, which is a very important method for avoiding errors in practice.
- Symbolic Notation is Self-Contained.** Every spreadsheet that contains symbolic notation in the instruction boxes is self-contained (i.e., all symbolic notation is defined on the spreadsheet).

Craig's Challenge

I challenge the reader of this book to dramatically improve your finance education by personally constructing all of the Excel models in this book. This will take you about 10–20 hours depending on your current Excel modeling skills. Let me assure you that it will be an excellent investment. You will:

- gain a practical understanding of the core concepts of Investments
- develop hands-on, Excel modeling skills
- build an entire suite of finance applications, which you fully understand

When you complete this challenge, I invite you to e-mail me at cholden@indiana.edu to share the good news. Please tell me your name, school, (prospective) graduation year, and which Excel modeling book you completed. I will add you to a web-based honor roll at:

<http://www.excelmodeling.com/honor-roll.htm>

We can celebrate together!

Excel™ Modeling Books

This book is one of two *Excel Modeling* books by Craig W. Holden, published by Pearson. The other book is *Excel Modeling in Corporate Finance*. Both books teach value-added skills in constructing financial models in Excel. Complete information about my *Excel Modeling* books is available at my web site:

<http://www.excelmodeling.com>

If you have any suggestions or corrections, please e-mail them to me at cholden@indiana.edu. I will consider your suggestions and will implement any corrections in the next edition.

Suggestions for Faculty Members

There is no single best way to use *Excel Modeling in Investments*. There are as many different techniques as there are different styles and philosophies of teaching. You need to discover what works best for you. Let me highlight several possibilities:

1. **Out-of-class individual projects with help.** This is a technique that I have used and it works well. I require completion of several short Excel modeling projects of every individual student in the class. To provide help, I schedule special “help lab” sessions in a computer lab during which time I and my graduate assistant are available to answer questions while students do each assignment in about an hour. Typically about half the questions are Excel questions and half are finance questions. I have always graded such projects, but an alternative approach would be to treat them as ungraded homework.

2. **Out-of-class individual projects without help.** Another technique is to assign Excel modeling projects for individual students to do on their own out of class. One instructor assigns seven Excel modeling projects at the beginning of the semester and has individual students turn in all seven completed Excel models for grading at the end of the semester. At the end of each chapter are problems that can be assigned with or without help. Faculty members can download the completed Excel models and answers to end-of-chapter problems at <http://www.pearsonhighered.com/irc>. See your local Pearson representative to gain access.
3. **Out-of-class group projects.** A technique that I have used for the last fifteen years is to require students to do big Excel modeling projects in groups. I have students write a report to a hypothetical boss that intuitively explains their method of analysis, key assumptions, and key results.
4. **In-class reinforcement of key concepts.** The class session is scheduled in a computer lab or students are asked to bring their laptop computers to class. I explain a key concept in words and equations. Then I turn to a 10–15 minute segment in which students open a Ready-To-Build spreadsheet and build the Excel model in real-time in the class. This provides real-time, hands-on reinforcement of a key concept. This technique can be done often throughout the semester.
5. **In-class demonstration of Excel modeling.** The instructor can perform an in-class demonstration of how to build Excel models. Typically, only a small portion of the total Excel model would be demonstrated.
6. **In-class demonstration of key relationships using Spin Buttons, Option Buttons, and Charts.** The instructor can dynamically illustrate comparative statics or dynamic properties over time using visual, interactive elements. For example, one spreadsheet provides a “movie” of 43 years of U.S. term structure dynamics. Another spreadsheet provides an interactive graph of the sensitivity of bond prices to changes in the coupon rate, yield-to-maturity, number of payments/year, and face value.

I’m sure I haven’t exhausted the list of potential teaching techniques. Feel free to send an e-mail to cholden@indiana.edu to let me know novel ways in which you use this book.

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About The Author

CRAIG W. HOLDEN



Craig W. Holden is a Professor of Finance at the Kelley School of Business at Indiana University. His M.B.A. and Ph.D. are from the Anderson School at UCLA. He is the winner of many teaching and research awards, including a Fama/DFA Prize. His research on market microstructure has been published in leading academic journals. He has written *Excel Modeling in Investments* and *Excel Modeling in Corporate Finance*. The Fifth Editions in English are published by Pearson and there are International, Chinese, and Italian editions. He has chaired 20 dissertations, been a member or chair of 58 dissertations, serves as the Secretary-Treasurer of the *Society for Financial Studies*, serves as an associate editor of the *Journal of Financial Markets*, and serves on the program committees of the *Western Finance Association* and the *European Finance Association*. He chaired the department undergraduate committee for thirteen years, chaired the department doctoral committee for four years, chaired three different schoolwide committees for a combination of six years, and currently serves for a third year on the campus tenure advisory committee. He has led several major curriculum innovations in the finance department. More information is available at Craig's home page: www.kelley.iu.edu/cholden.

Chapter 19 Black-Scholes Option Pricing

19.1 Basics

Problem. At the close of trading on **October 11, 2013**, the stock price of Facebook (FB) was **\$49.11**, the standard deviation of daily returns is **74.73%**, the yield on a six-month U.S. Treasury Bill was **0.12%**, the exercise price of an March 45 call on Facebook was **\$45.00**, the exercise price of an March 45 put on Facebook was **\$45.00**, and the time to maturity for both **March 22, 2014** maturity options was **0.4472** years. What is the price of a March 45 call and a March 45 put on Facebook?

FIGURE 19.1 Excel Model for Black-Scholes Option Pricing - Basics.

	A	B	C	D	E	F	G	H	I
1	BLACK SCHOLES OPTION PRICING				Basics				
2									
3									
4									
5	Inputs								
6	Stock Price Now (S ₀)	▲ ▼	\$49.11	49					
7	Standard Dev - Annual (σ)	▲ ▼	74.73%	7					
8	Riskfree Rate- Annual (r)	▲ ▼	0.12%	1					
9	Exercise Price (X)	▲ ▼	\$45.00	45					
10	Time To Maturity - Years (T)	▲ ▼	0.4472	4					
11				1					
12									
13									
14	Outputs								
15	d ₁		0.426						
16	d ₂		-0.074						
17	N(d ₁)		0.665						
18	N(d ₂)		0.471						
19	Call Price (C ₀)		\$11.49						
20									
21	-d ₁		-0.426						
22	-d ₂		0.074						
23	N(-d ₁)		0.335						
24	N(-d ₂)		0.529						
25	Put Price (P ₀)		\$7.36						
26									
27									
28									
29									
30									

(1)
$$\left(\ln(S_0/X) + (r + \sigma^2/2) \cdot T \right) / (\sigma \cdot \sqrt{T})$$

 Enter = (LN(B6/B9)+(B8+B7^2/2)*B10)/(B7*SQRT(B10))

(2) $d_1 - \sigma\sqrt{T}$
 Enter = B15-B7*SQRT(B10)

(3) Standard Cumulative Normal Distribution (d1)
 Enter = NORMSDIST(B15)
 Copy to cell B18 and copy to the range B23:B24

(4) The Black-Scholes call formula is:

$$C_0 = S_0 N(d_1) - X e^{-rT} N(d_2)$$

 Enter = B6*B17-B9*EXP(-B8*B10)*B18

(5) -d1
 Enter = -B15 and copy to cell B22

(6) The Black-Scholes put formula is:

$$P_0 = -S_0 N(-d_1) + X e^{-rT} N(-d_2)$$

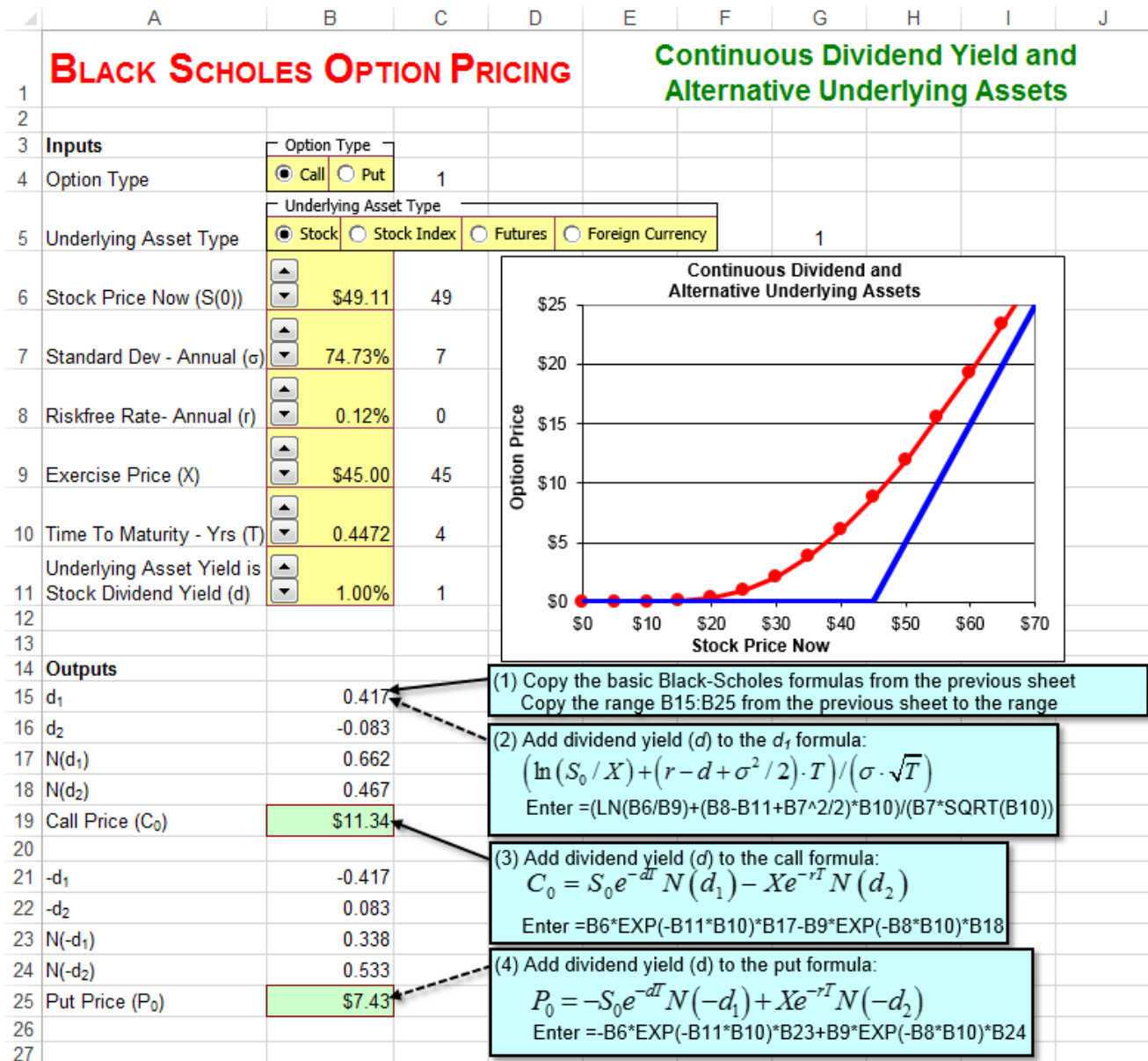
 Enter = -B6*B23+B9*EXP(-B8*B10)*B24

The Black-Scholes model predicts a call price of \$11.49. This is four cents different than what the Binominal Option Pricing - Full-Scale Estimation model predicts for a *European* call with identical inputs (including no dividends). The Black-Scholes model predicts a put price of \$7.36. This is four cents different than what the Binominal Option Pricing - Full-Scale Estimation model predicts for a *European* put with identical inputs (including no dividends). The advantage of the Black-Scholes model and its natural analytic extensions is that they are quick and easy to calculate. The disadvantage is that they are limited to a narrow range of derivatives (such as *European* options only, etc.).

19.2 Continuous Dividend

Problem. Suppose that Facebook paid dividends in tiny amounts on a continuous basis throughout the year at a 1.0% / year rate. What would be the new price of the call and put?

FIGURE 19.2 Black-Scholes – Cont Div Yield and Alt Under Assets – Call



Solution Strategy. Modify the basic Black-Scholes formulas from the previous sheet to include the continuous dividend.

Results. We see that the continuous dividend model predicts a call price of **\$11.34**. This is a drop of 15 cents from the no dividend version. The continuous dividend model predicts a put price of **\$7.43**. This is a rise of 7 cents from the no dividend version. To create a dynamic chart, we have a few more steps.

FIGURE 19.3 Black-Scholes – Cont Div Yield and Alt Under Assets – Call

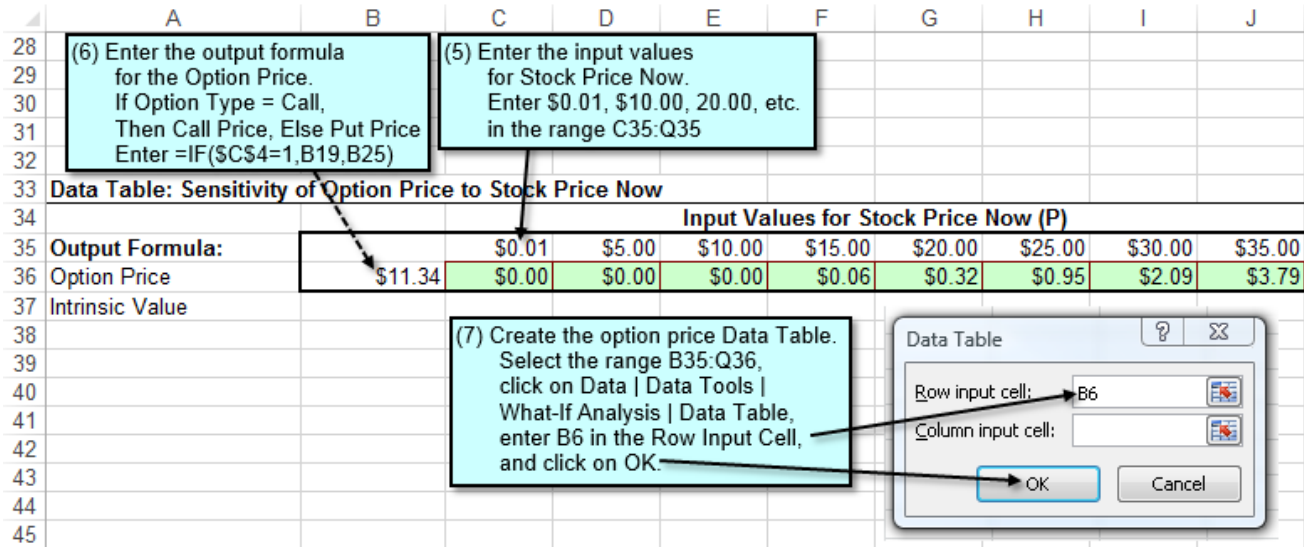
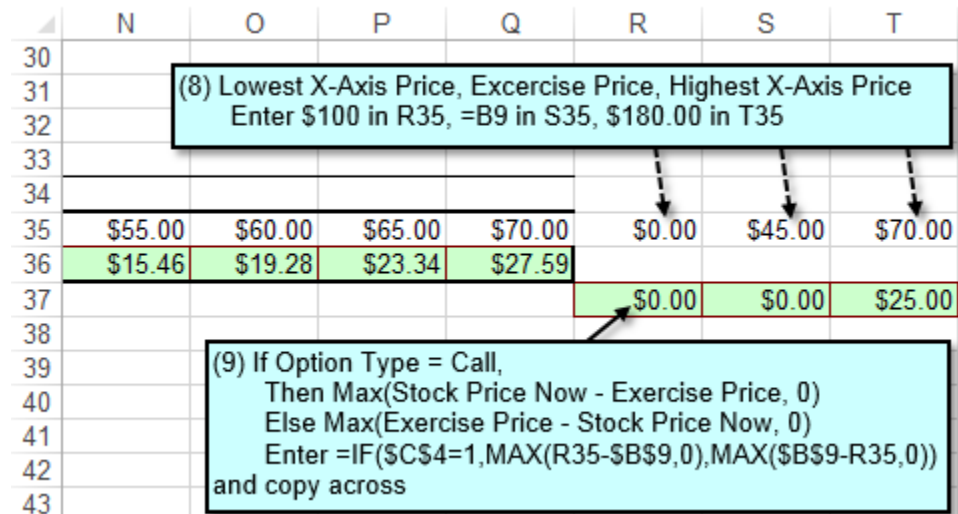


FIGURE 19.4 Black-Scholes – Cont Div Yield and Alt Under Assets – Call

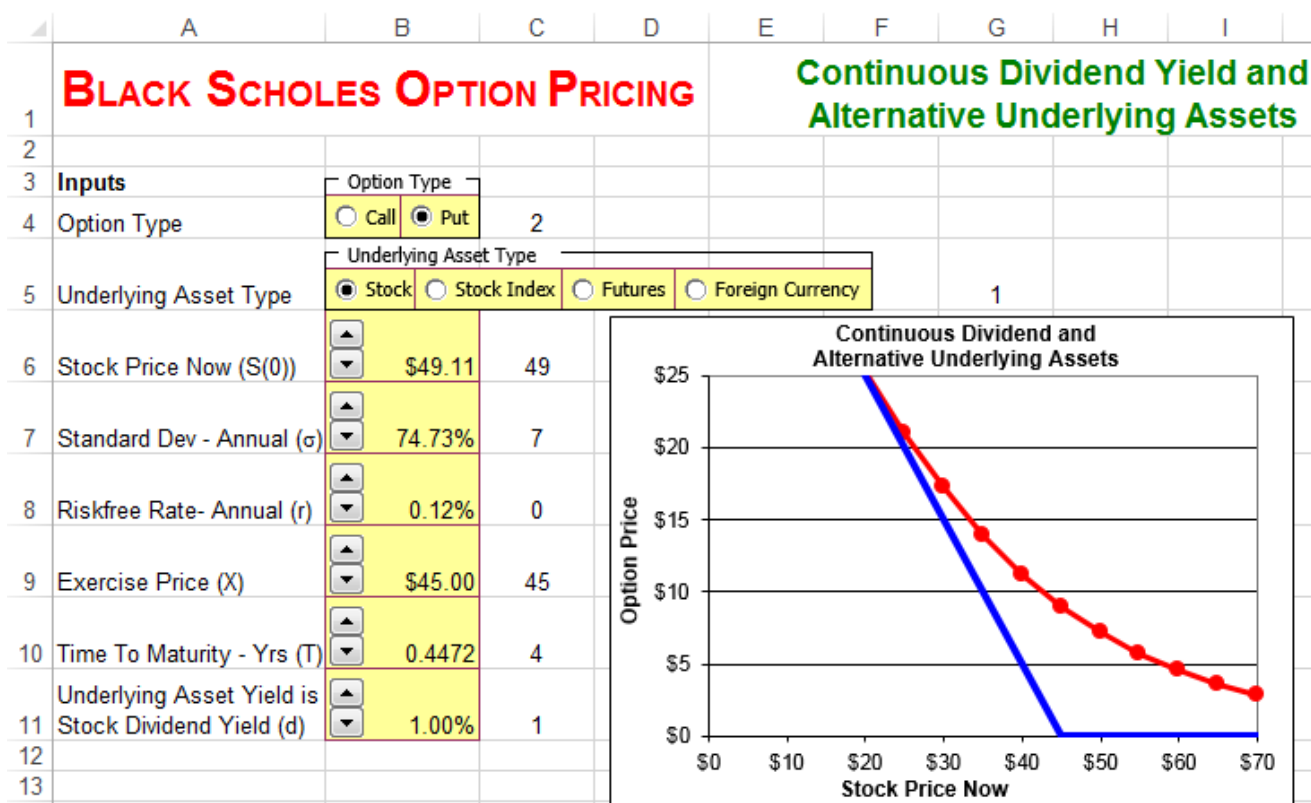


The spin buttons allow you to change Black-Scholes inputs and instantly see the impact on a graph of the option price and intrinsic value. This allows you to perform instant experiments on the Black-Scholes option pricing model. Here is a list of experiments that you might want to perform:

- What happens when the standard deviation is increased?
- What happens when the time to maturity is increased?
- What happens when the exercise price is increased?
- What happens when the riskfree rate is increased?
- What happens when the dividend yield is increased?
- What happens when the standard deviation is really close to zero?
- What happens when the time to maturity is really close to zero?

Notice that the Black-Scholes option price is usually greater than the payoff you would obtain if the option was maturing today (the “intrinsic value”). This extra value is called the “Time Value” of the option. Given your result in the last experiment above, can you explain *why* the extra value is called the “Time Value?” Now let’s look at the put option.

FIGURE 19.5 Black-Scholes – Cont Div Yield and Alt Under Assets - Put



The put option value sometime drops below the intrinsic value. To understand why, try increasing the riskfree rate and see what happens. Then decrease the riskfree rate to zero and see what happens. You can perform many similar experiments on the put option.

The model can handle three additional types of underlying assets (see row 5): (1) stock index, (2) futures, and (3) foreign currency. Then the underlying asset yield (see row 11) becomes: (1) the stock index dividend yield, (2) the riskfree rate, and (3) the foreign riskfree rate, respectively.

FIGURE 19.6 Black-Scholes – Cont Div Yield and Alt Under Assets – Call

BLACK SCHOLLES OPTION PRICING			Continuous Dividend Yield and Alternative Underlying Assets										
1	BLACK SCHOLLES OPTION PRICING					Continuous Dividend Yield and Alternative Underlying Assets							
2													
3	Inputs					Inputs							
4	Option Type	<input checked="" type="radio"/> Call <input type="radio"/> Put	1										
5	Underlying Asset Type	<input type="radio"/> Stock <input checked="" type="radio"/> Stock Index	1	BLACK SCHOLLES OPTION PRICING					Continuous Dividend Yield and Alternative Underlying Assets				
6	Stock Index Now (S(0))	\$49.11	49										
7	Standard Dev - Annual (σ)	74.73%	7										
8	Riskfree Rate- Annual (r)	0.12%	0										
9	Exercise Price (X)	\$45.00	45										
10	Time To Maturity - Yrs (T)	0.4472	4										
11	Underlying Asset Yield is Stock Index Div. Yield (d)	1.00%	1										
12													
13													
14	Outputs												
15	d ₁	0.417											
16	d ₂	-0.083											
17	N(d ₁)	0.662											
18	N(d ₂)	0.467											
19	Call Price (C ₀)	\$11.34											
20													
21	-d ₁	-0.417											
22	-d ₂	0.083											
23	N(-d ₁)	0.338											
24	N(-d ₂)	0.533											
25	Put Price (P ₀)	\$7.43											
26													
27													

BLACK SCHOLLES OPTION PRICING			Continuous Dividend Yield and Alternative Underlying Assets										
1	BLACK SCHOLLES OPTION PRICING					Continuous Dividend Yield and Alternative Underlying Assets							
2													
3	Inputs					Inputs							
4	Option Type	<input checked="" type="radio"/> Call <input type="radio"/> Put	1										
5	Underlying Asset Type	<input type="radio"/> Stock <input type="radio"/> Stock Index <input checked="" type="radio"/> Futures <input type="radio"/> Foreign Currency	3										
6	Futures Price Now (F(0))	\$49.11	49										
7	Standard Dev - Annual (σ)	74.73%	7										
8	Riskfree Rate- Annual (r)	0.12%	0										
9	Exercise Price (X)	\$45.00	45										
10	Time To Maturity - Yrs (T)	0.4472	4										
11	Underlying Asset Yield is Riskfree Rate - Annual (r)	0.12%	1										
12													
13													
14	Outputs												
15	d ₁	0.417											
16	d ₂	-0.083											
17	N(d ₁)	0.662											
18	N(d ₂)	0.467											
19	Call Price (C ₀)	\$11.34											
20													
21	-d ₁	-0.417											
22	-d ₂	0.083											
23	N(-d ₁)	0.338											
24	N(-d ₂)	0.533											
25	Put Price (P ₀)	\$7.43											
26													
27													

BLACK SCHOLLES OPTION PRICING			Continuous Dividend Yield and Alternative Underlying Assets										
1	BLACK SCHOLLES OPTION PRICING					Continuous Dividend Yield and Alternative Underlying Assets							
2													
3	Inputs					Inputs							
4	Option Type	<input checked="" type="radio"/> Call <input type="radio"/> Put	1										
5	Underlying Asset Type	<input type="radio"/> Stock <input type="radio"/> Stock Index <input type="radio"/> Futures <input checked="" type="radio"/> Foreign Currency	4										
6	Spot Exch Rate Now	\$49.11	49										
7	Standard Dev - Annual (σ)	74.73%	7										
8	Riskfree Rate- Annual (r)	0.12%	0										
9	Exercise Price (X)	\$45.00	45										
10	Time To Maturity - Yrs (T)	0.4472	4										
11	Underlying Asset Yield is Foreign Riskfree Rate	1.00%	1										
12													
13													
14	Outputs												
15	d ₁	0.417											
16	d ₂	-0.083											
17	N(d ₁)	0.662											
18	N(d ₂)	0.467											
19	Call Price (C ₀)	\$11.34											
20													
21	-d ₁	-0.417											
22	-d ₂	0.083											
23	N(-d ₁)	0.338											
24	N(-d ₂)	0.533											
25	Put Price (P ₀)	\$7.43											
26													
27													

(1) Copy the basic Black-Scholes formulas from the previous sheet
Copy the range B15:B25 from the previous sheet to the range

(2) Add dividend yield (d) to the d₁ formula:

$$d_1 = \frac{\ln(S_0/X) + (r - d + \sigma^2/2) \cdot T}{\sigma \cdot \sqrt{T}}$$
 Enter =LN(B6/B9)+(B8-B11+B7^2/2)*B10)/(B7*SQRT(B10))

(3) Add dividend yield (d) to the call formula:

$$C_0 = S_0 e^{-dt} N(d_1) - X e^{-rT} N(d_2)$$
 Enter =B6*EXP(-B11*B10)*B17-B9*EXP(-B8*B10)*B18

(4) Add dividend yield (d) to the put formula:

$$P_0 = -S_0 e^{-dt} N(-d_1) + X e^{-rT} N(-d_2)$$
 Enter =-B6*EXP(-B11*B10)*B23+B9*EXP(-B8*B10)*B24