GLOBAL EDITION

Excel Modeling in Corporate Finance

FIFTH EDITION

Craig W. Holden

ALWAYS LEARNING

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EXCEL® MODELING IN CORPORATE FINANCE

Fifth Edition

Global Edition

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- Ch 03 NPV Using Constant Discounting - Ready-To-Build.xlsx
- Ch 04 NPV Using General Discounting - Ready-To-Build.xlsx
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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 Corporate Finance 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 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 corporate finance, including nearly all niche areas of corporate finance.

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 corporate finance content:

- Real options, including project valuation with abandonment options, expansion options, contraction options, chooser options, and compound options
- Lease vs. buy decisions, including car and corporate applications
- Taxable vs. traditional vs. Roth savings plans

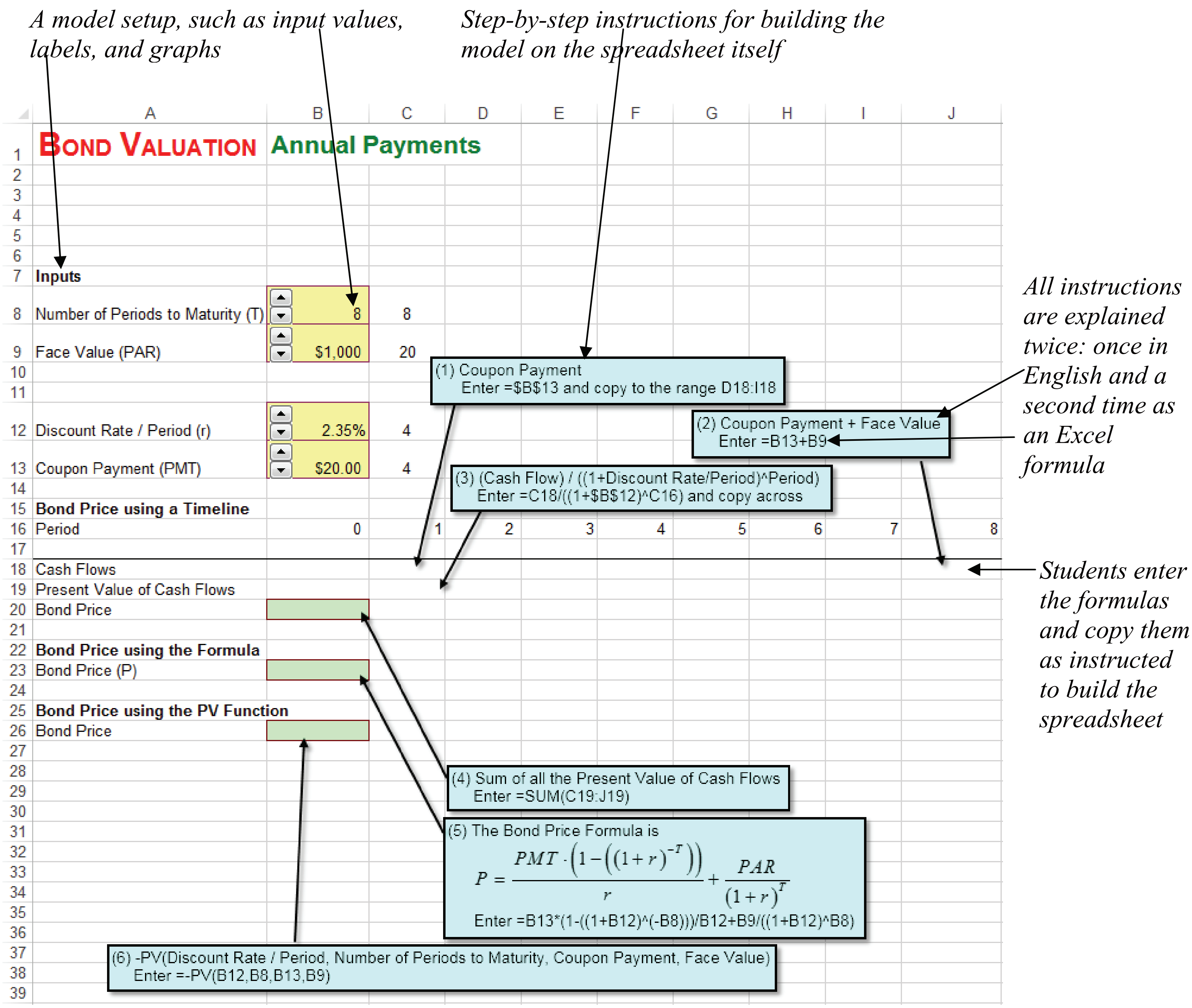
All of the real-world data, including financial statements, bond prices, the yield curve, asset returns, exchange rates, and options prices, have been updated.

Ready-To-Build Spreadsheets

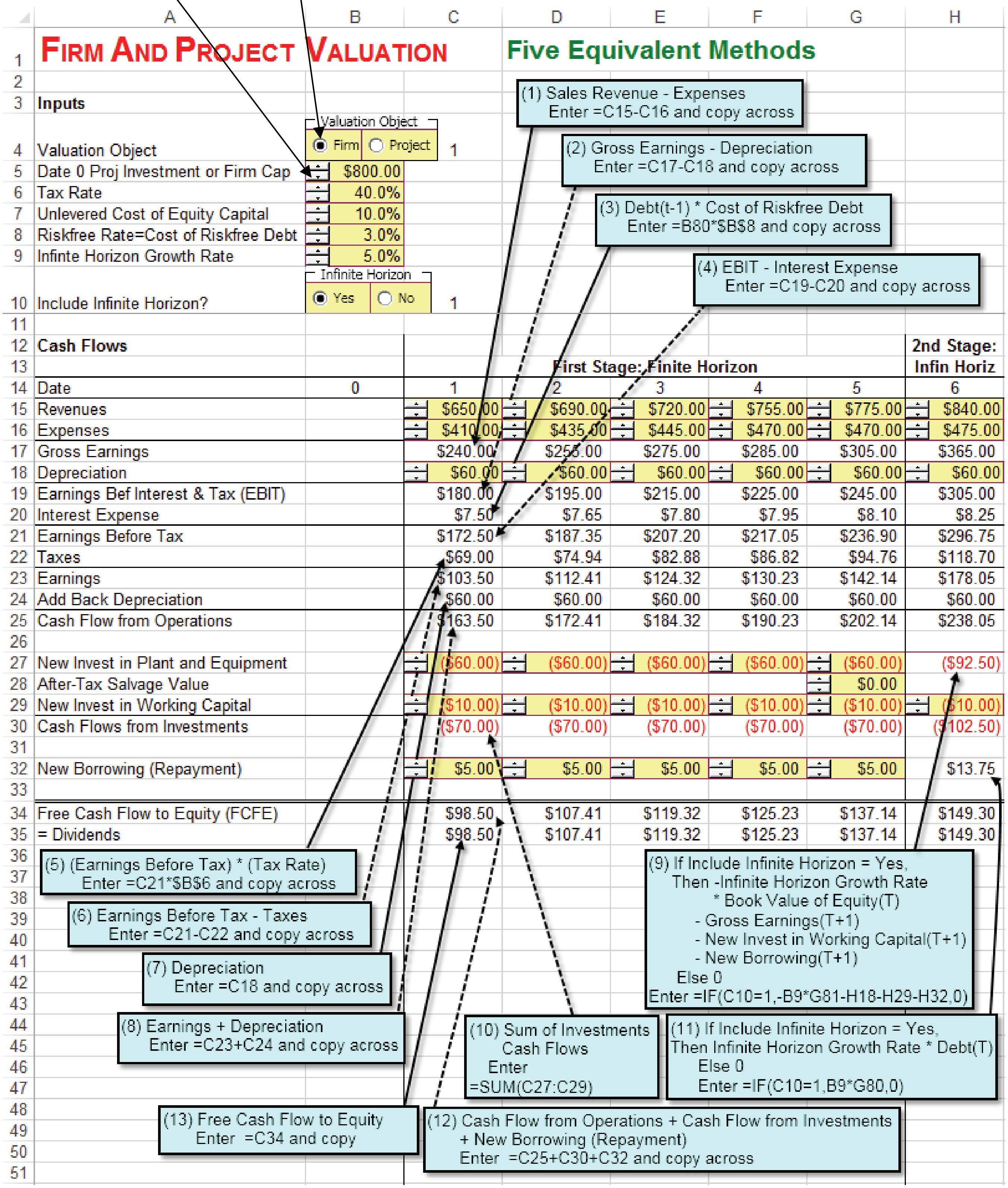
This product includes **Ready-To-Build spreadsheets**, which can be downloaded from www.pearsonglobaleditions.com/Holden. The spreadsheets are available in both "**XLSX**" and "**XLS**" file formats. By default, the screen shots and instructions in the book are based on **Excel 2013**. For the items 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.

Ready-To-Build Spreadsheets for every chapter provide:



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



	A	B	C	D	E	F	G	H
1	FIRM AND PROJECT VALUATION			Five Equivalent Methods				
2								
3	Inputs							
4	Valuation Object	Valuation Object: Firm / Project	1					
5	Date 0 Proj Investment or Firm Cap	$800.00						
6	Tax Rate	40.0%						
7	Unlevered Cost of Equity Capital	10.0%						
8	Riskfree Rate=Cost of Riskfree Debt	3.0%						
9	Infinte Horizon Growth Rate	5.0%						
10	Include Infinite Horizon?	Infinite Horizon: Yes / No	1					
11								
12	Cash Flows							2nd Stage:
13				First Stage: Finite Horizon				Infin Horiz
14	Date	0	1	2	3	4	5	6
15	Revenues		$650.00	$690.00	$720.00	$755.00	$775.00	$840.00
16	Expenses		$410.00	$435.00	$445.00	$470.00	$470.00	$475.00
17	Gross Earnings		$240.00	$255.00	$275.00	$285.00	$305.00	$365.00
18	Depreciation		$60.00	$60.00	$60.00	$60.00	$60.00	$60.00
19	Earnings Bef Interest & Tax (EBIT)		$180.00	$195.00	$215.00	$225.00	$245.00	$305.00
20	Interest Expense		$7.50	$7.65	$7.80	$7.95	$8.10	$8.25
21	Earnings Before Tax		$172.50	$187.35	$207.20	$217.05	$236.90	$296.75
22	Taxes		$69.00	$74.94	$82.88	$86.82	$94.76	$118.70
23	Earnings		$103.50	$112.41	$124.32	$130.23	$142.14	$178.05
24	Add Back Depreciation		$60.00	$60.00	$60.00	$60.00	$60.00	$60.00
25	Cash Flow from Operations		$163.50	$172.41	$184.32	$190.23	$202.14	$238.05
26								
27	New Invest in Plant and Equipment		($60.00)	($60.00)	($60.00)	($60.00)	($60.00)	($92.50)
28	After-Tax Salvage Value						$0.00	
29	New Invest in Working Capital		($10.00)	($10.00)	($10.00)	($10.00)	($10.00)	($10.00)
30	Cash Flows from Investments		($70.00)	($70.00)	($70.00)	($70.00)	($70.00)	($102.50)
31								
32	New Borrowing (Repayment)		$5.00	$5.00	$5.00	$5.00	$5.00	$13.75
33								
34	Free Cash Flow to Equity (FCFE)		$98.50	$107.41	$119.32	$125.23	$137.14	$149.30
35	= Dividends		$98.50	$107.41	$119.32	$125.23	$137.14	$149.30

Many spreadsheets use real-world data

	A	B	C	D	E	F	G	H	I
1	**CORPORATE FINANCIAL PLANNING**				**Full-Scale Estimation**				
2	**Nike, Inc.**	5/31/2010	5/31/2011	5/31/2012	5/31/2013	5/31/2014	5/31/2015	5/31/2016	Ave. %
3	**Financial Plan**	Actual	Actual	Actual	Actual	Forecast	Forecast	Forecast	of Sales
4	**Key Assumptions**								
5	Sales Growth Rate		5.8%	16.0%	8.5%	9.0%	10.0%	11.0%	
6	Tax Rate	24.2%	24.1%	25.0%	24.7%	24.0%	24.0%	24.0%	
7	Int Rate on Short-Term Debt	0.12%	0.04%	0.09%	0.05%	0.10%	0.15%	0.20%	
8	Int Rate on Long-Term Debt	1.17%	0.71%	0.39%	0.58%	0.70%	0.80%	0.90%	
9	Dividend Payout Rate	26.9%	26.3%	28.8%	29.1%	28.0%	29.0%	30.0%	
10	Price / Earnings	18.4	18.6	21.6	22.2	21.0	21.0	21.0	
11									
12									
13	**Income Statement (Mil.$)**								
14	Sales	$19,014.0	$20,117.0	$23,331.0	$25,313.0	$27,591.2	$30,350.3	$33,688.8	
15	Cost of Goods Sold	$10,213.6	$10,915.0	$13,183.0	$14,279.0	$15,236.4	$16,760.0	$18,603.6	
16	Gross Margin	$8,800.4	$9,202.0	$10,148.0	$11,034.0	$12,354.8	$13,590.3	$15,085.2	
17									
18	Selling, Gen & Adm Expenses	$6,326.4	$6,361.0	$7,051.0	$7,766.0	$8,677.0	$9,544.7	$10,594.6	
19	Non-Operating Income	$42.9	$21.0	($58.0)	$18.0	$10.5	$11.6	$12.8	
20	Depreciation	$0.0	$0.0	$14.0	$14.0	$8.0	$8.7	$9.7	
21	EBIT	$2,516.9	$2,862.0	$3,025.0	$3,272.0	$3,680.4	$4,048.4	$4,493.7	
22									
23	Interest Expense	$0.0	$0.0	$0.0	$0.0	$8.53	$2.93	$3.51	
24	Taxes	$610.2	$690.0	$756.0	$808.0	$881.2	$970.9	$1,077.7	
25	Extraordinary Items	$0.0	$39.0	$46.0	($21.0)	$21.2	$23.4	$25.9	
26	Net Income	$1,906.7	$2,133.0	$2,223.0	$2,485.0	$2,769.3	$3,051.2	$3,386.6	
27	Shares Outstanding (Millions)	968.0	936.0	916.0	894.0	894.0	894.0	894.0	
28	Earnings Per Share	$1.97	$2.28	$2.43	$2.78	$3.10	$3.41	$3.79	

(1) Forecast key assumptions Enter forecast values in the range F5:H10 (done for you)

(2) Gross Margin - SG&AE + Non-Op Inc - Depreciation
Enter =B16-B18+B19-B20 and copy across

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. 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 Corporate Finance 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 full-scale estimation Excel model in Corporate Financial Planning uses three years of historical 10K data on Nike, Inc. (including every line of their income statement, balance sheet, and cash flow statement), constructs a complete financial system (including linked financial ratios), and projects these financial statements three years into the future. The chapter on Estimating the Cost of Capital uses 10 years of monthly returns for individual stocks, U.S. Fama-French portfolios, and country ETFs to estimate the cost of capital using the Static CAPM based on the Fama-MacBeth method and to estimate the cost of capital using the APT or Intertemporal CAPM based on the Fama-MacBeth method. The Excel model to estimate firm valuation or project valuation demonstrates the equivalence of the Free Cash Flow To Equity, Free Cash Flow to the Firm, Residual Income, Dividend Discount Model, and the Adjusted Present Value technique, not just in the perpetuity case covered by some textbooks, but for a fully general two-stage project with an arbitrary set of cash flows over an explicit forecast horizon, followed by an infinite horizon growing perpetuity. As a practical matter, all of these sophisticated applications require Excel.

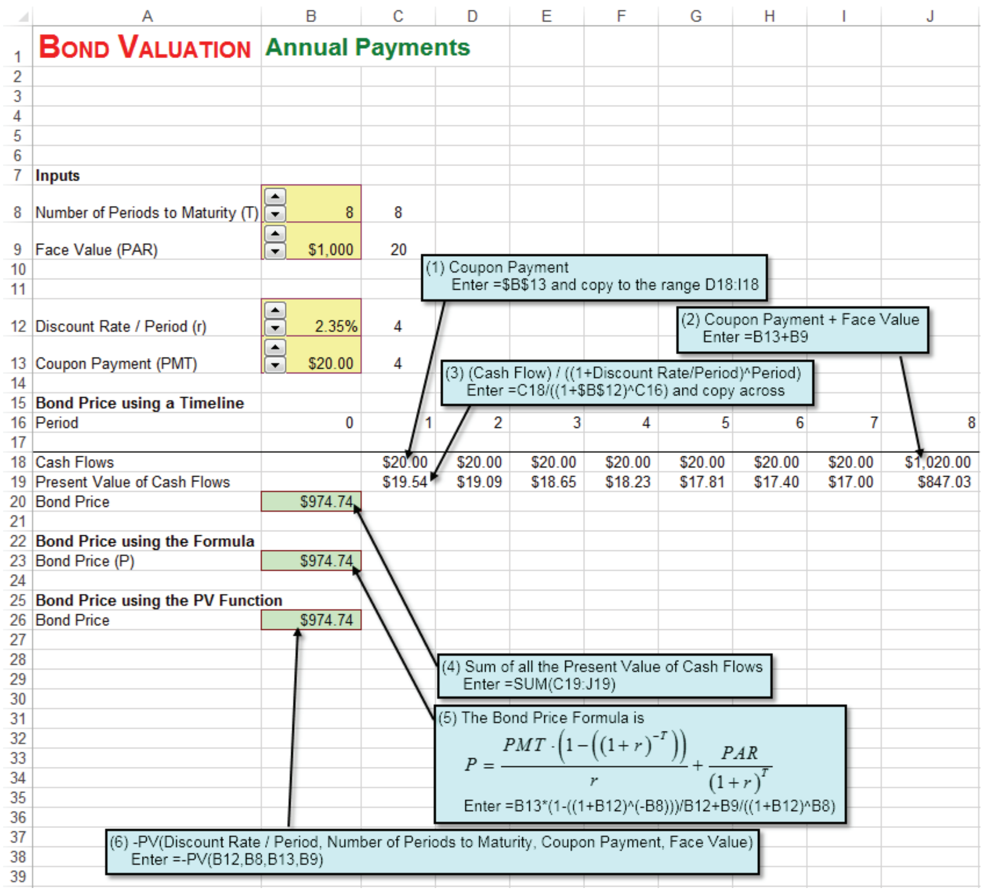
Conventions Used in This Book

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 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 Corporate Finance
- 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 Investments*. 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 Corporate Finance*. 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.pearsonglobaleditions.com/Holden**. 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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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**.

PART 1 TIME VALUE OF MONEY

Chapter 1 Single Cash Flow

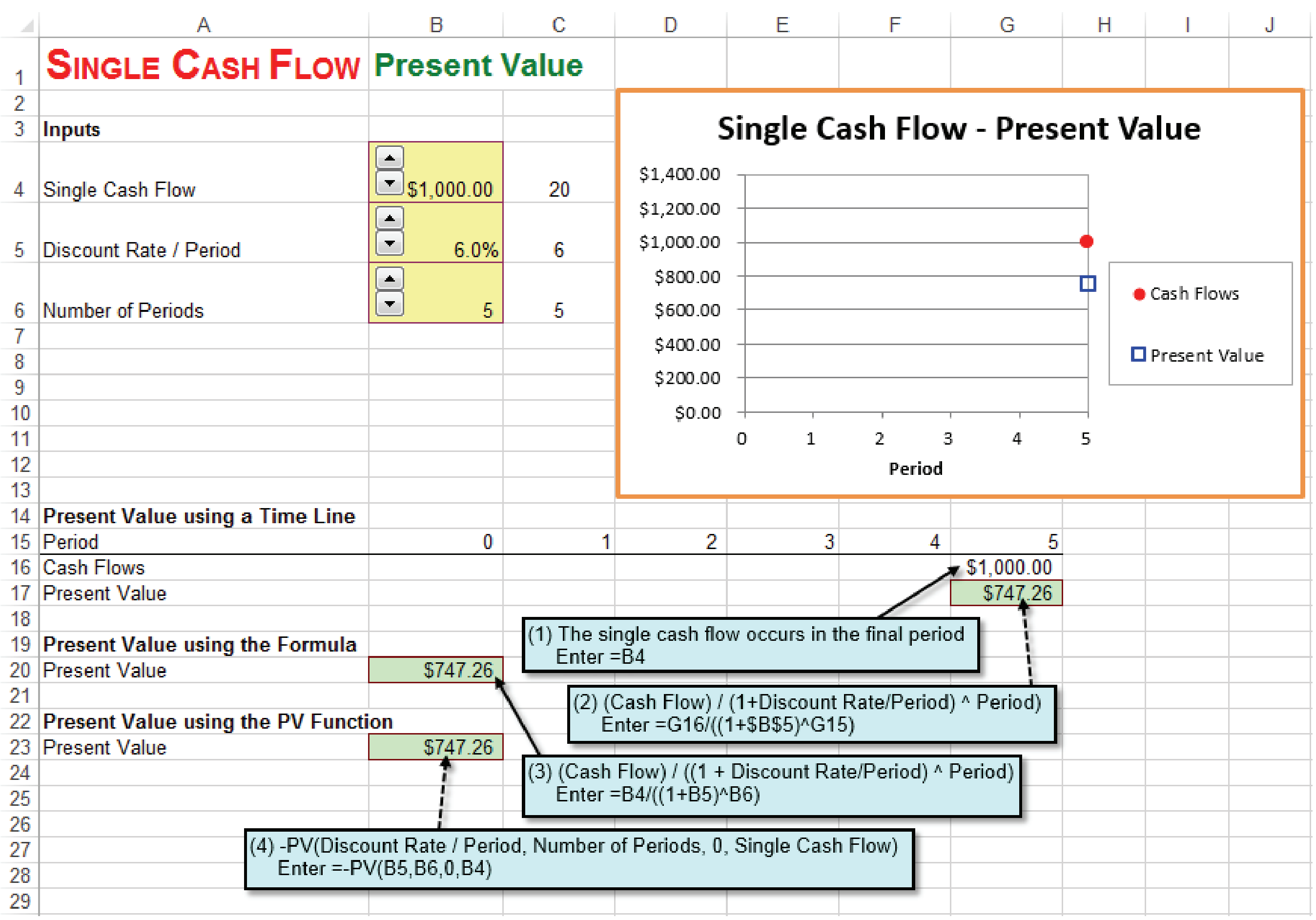
1.1 Present Value

Problem. A single cash flow of $1,000.00 will be received in 5 periods. For this cash flow, the appropriate discount rate / period is 6.0%. What is the present value of this single cash flow?

Solution Strategy. We will calculate the present value of this single cash flow in three equivalent ways. First, we will calculate the present value using a time line, where each column corresponds to a period of calendar time. Second, we use a formula for the present value. Third, we use Excel's **PV** function for the present value.

Excel 2013

FIGURE 1.1 Excel Model for Single Cash Flow - Present Value.



The Present Value of this Single Cash Flow is $747.26. Notice you get the same answer all three ways: using the time line, using the formula, or using the PV function!

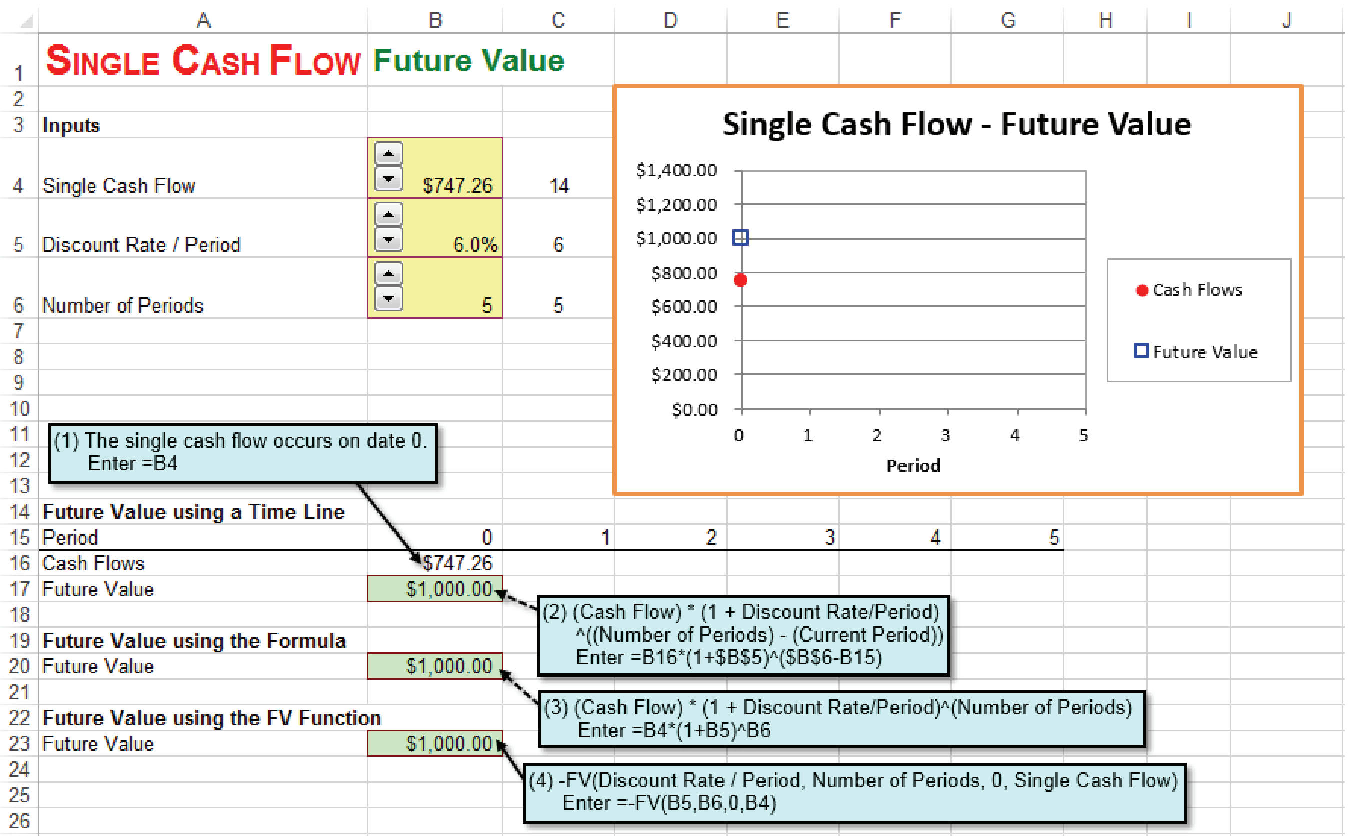
1.2 Future Value

Problem. A single cash flow of $747.26 is available now (in period 0). For this cash flow, the appropriate discount rate / period is 6.0%. What is the period 5 future value of this single cash flow?

Solution Strategy. We will calculate the future value of the single cash flow in three equivalent ways. First, we will calculate the future value using a time line, where each column corresponds to a period of calendar time. Second, we use a formula for the future value. Third, we use Excel's **FV** function for the future value.

Excel 2013

FIGURE 1.2 Excel Model for Single Cash Flow - Future Value.



The Future Value of this Single Cash Flow is $1,000.00. Notice you get the same answer all three ways: using the time line, using the formula, or using the FV function!

Comparing Present Value and Future Value, we see that they are opposite operations. That is, one operation "undoes" the other. The Present Value of $1,000.00 in period 5 is $747.26 in period 0. The Future Value of $747.26 in period 0 is $1,000.00 in period 5.

Problems

1. A single cash flow of $1,723.48 will be received in 6 periods. For this cash flow, the appropriate discount rate / period is 6.8%. What is the present value of this single cash flow?

2. A single cash flow of $1,032.47 is available now (in period 0). For this cash flow, the appropriate discount rate / period is 2.9%. What is the period 5 future value of this single cash flow?

Chapter 2 Annuity

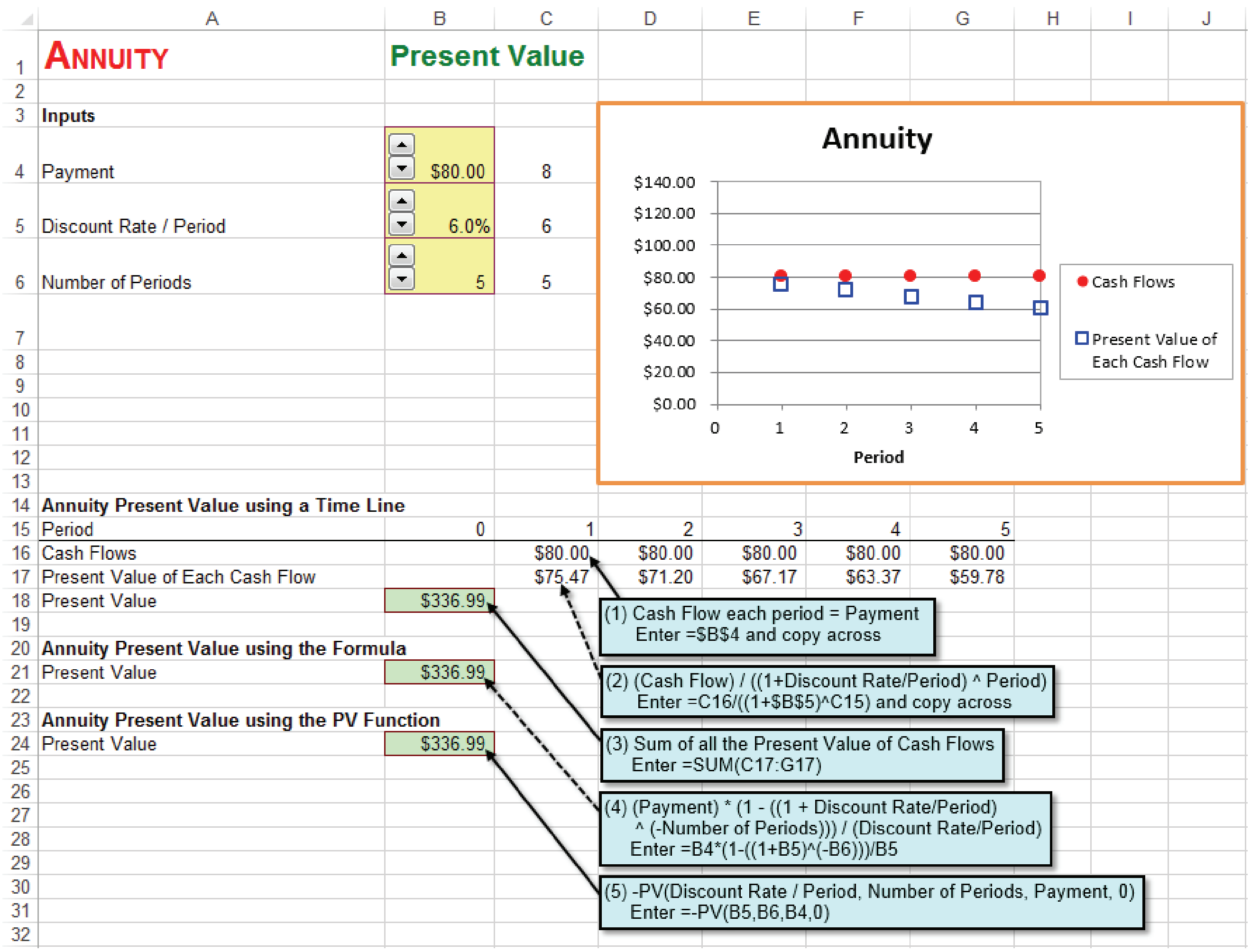
2.1 Present Value

Problem. An annuity pays $80.00 each period for 5 periods. For these cash flows, the appropriate discount rate / period is 6.0%. What is the present value of this annuity?

Solution Strategy. We will calculate the present value of this annuity in three equivalent ways. First, we will calculate the present value using a time line, where each column corresponds to a period of calendar time. Second, we use a formula for the present value. Third, we use Excel's **PV** function for the present value.

Excel 2013

FIGURE 2.1 Excel Model for Annuity - Present Value.



The Present Value of this Annuity is $336.99. Notice you get the same answer all three ways: using the time line, using the formula, or using the PV function.

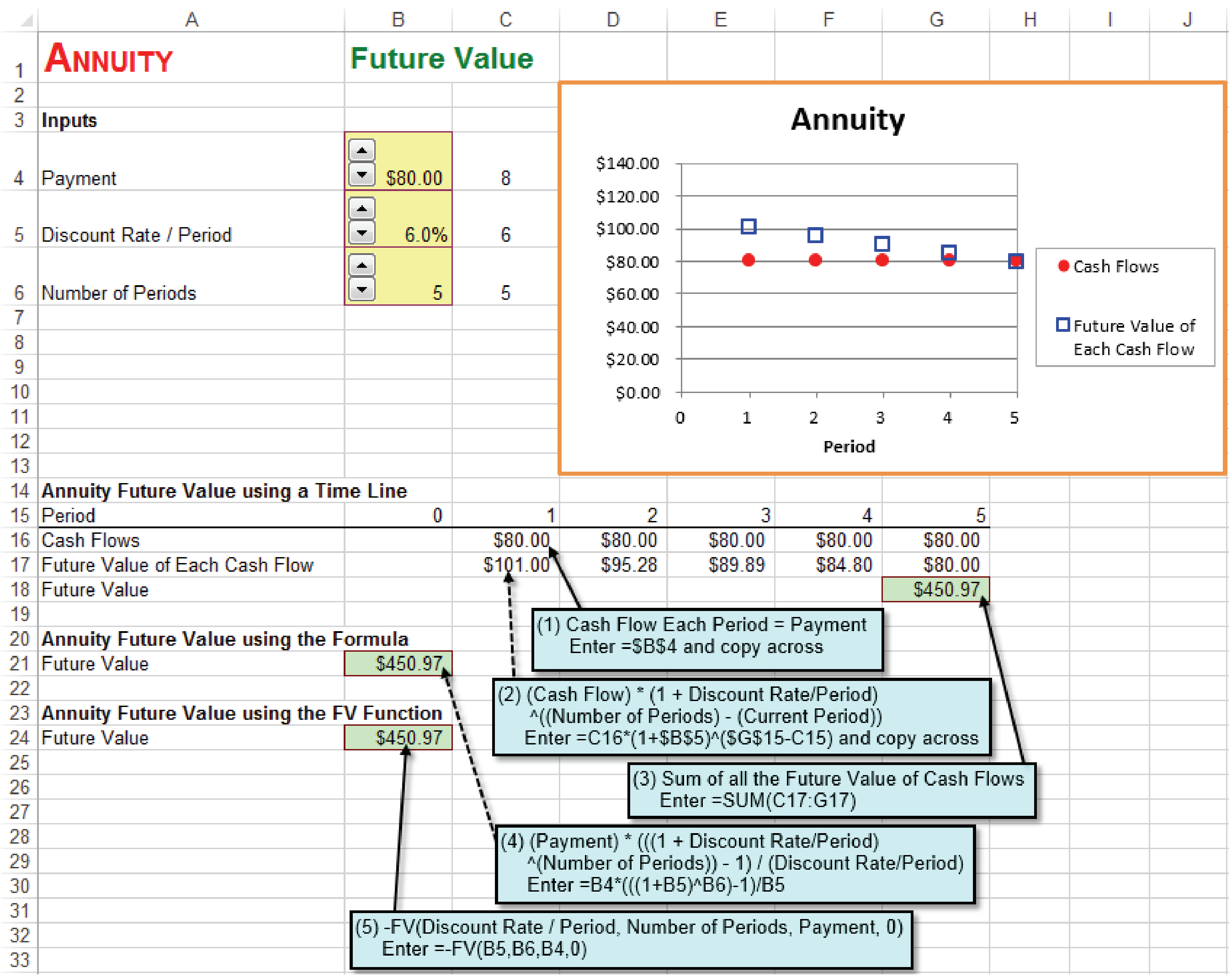
2.2 Future Value

Problem. An annuity pays $80.00 each period for 5 periods. For these cash flows, the appropriate discount rate / period is 6.0%. What is the period 5 future value of this annuity?

Solution Strategy. We will calculate the future value of this annuity in three equivalent ways. First, we will calculate the future value using a time line, where each column corresponds to a period of calendar time. Second, we use a formula for the future value. Third, we use Excel's **FV** function for the future value.

Excel 2013

FIGURE 2.2 Excel Model for Annuity - Future Value.



The Future Value of this Annuity is $450.97. Notice you get the same answer all three ways: using the time line, using the formula, or using the FV function.

2.3 System of Four Annuity Variables

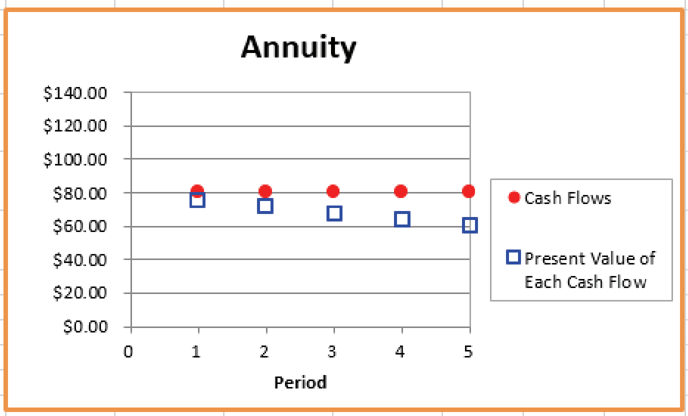
Problem. There is a tight connection between all of the inputs and output to annuity valuation. Indeed, they form a system of four annuity variables: (1) Payment, (2) Discount Rate / Period, (3) Number of Periods, and (4) Present Value. Given any three of these variables, find the fourth variable.

Solution Strategy. Given any three of these variable, we will use as many equivalent ways of solving for the fourth variable as possible. The Annuity – Present Value spreadsheet solves for the present value using a Timeline, a formula, and the **PV** function. Building on that spreadsheet, add the Payment using the formula and **PMT** function. Then add the Discount Rate / Period using the **RATE** function. Then add the Number of Periods, using the **NPER** function.

Excel 2013

FIGURE 2.3 Excel Model for Annuity - System of Four Annuity Variables.

	A	B	C	D	E	F	G
1	**ANNUITY**	**System of Four Annuity Variables**					
2							
3	**Inputs**						
4	Payment	$80.00	8				
5	Discount Rate / Period	6.0%	6				
6	Number of Periods	5	5				
7	Present Value	$336.99	6				
8							
9							
10							
11							
12							
13							
14	**Annuity Present Value using a Time Line**						
15	Period	0	1	2	3	4	5
16	Cash Flows		$80.00	$80.00	$80.00	$80.00	$80.00
17	Present Value of Each Cash Flow		$75.47	$71.20	$67.17	$63.37	$59.78
18	Present Value	$336.99					
19							
20	**Annuity Present Value using the Formula**						
21	Present Value	$336.99					
22							
23	**Annuity Present Value using the PV Function**						
24	Present Value	$336.99					
25							
26							
27	**Payment**						
28	Payment using the Formula	$80.00					
29	Payment using the PMT Function	$80.00					
30							
31	**Discount Rate / Period**						
32	Discount Rate / Per using the RATE Func	6.0%					
33							
34	**Number of Periods**						
35	Num of Periods using the NPER Function	5					
36							
37							



(1) Copy the Annuity formulas from Sheet 2.1
Copy the range B16:G24 from Sheet 2.1 to the range B16:G24

(2) Payment formula is:
= (Present Value) / ((1 - ((1 + Discount Rate/Period) ^ (-Number of Periods))) / (Discount Rate/Period)).
Enter =B7/((1-((1+B5)^(-B6)))/B5)

(3) Payment function is:
=PMT(Discount Rate / Period, Number of Periods, -Present Value, 0).
Enter =PMT(B5,B6,-B7,0)

(4) Rate function is:
=RATE(Number of Periods, Payment, -Present Value, 0).
Enter =RATE(B6,B4,-B7,0)

(5) Number of Periods function is:
=NPER(Discount Rate / Period, Payment, -Present Value, 0).
Enter =NPER(B5,B4,-B7,0)

We see that the system of four annuity variables is internally consistent. The four outputs in rows **13** through **32** (Present Value = $336.99, Payment = $80.00, Discount Rate / Period = 6.0%, and Number of Periods = 5) are identical to the four inputs in rows **4** through **7**. Thus, any of the four annuity variables can be calculated from the other three in a fully consistent manner.

Problems

1) An annuity pays $132.38 each period for 5 periods. For these cash flows, the appropriate discount rate / period is 3.5%. What is the present value of this annuity?

2) An annuity pays $63.92 each period for 4 periods. For these cash flows, the appropriate discount rate / period is 9.1%. What is the period 5 future value of this annuity?

3) Consider a system of four annuity variables.
   (a) An annuity pays $63.00 each period for 3 periods. For these cash flows, the appropriate discount rate / period is 8.0%. What is the present value of this annuity?
   (b) An annuity pays each period for 11 periods, the appropriate discount rate / period is 6.0%, and the present value is $192.38. What is the payment each period?
   (c) An annuity pays $183.00 each period for 14 periods, and the present value is $463.94. What is the discount rate / period of this annuity?
   (d) An annuity pays $30.00 each period, the appropriate discount rate / period is 7.6%, and the present value is $218.49. What is the number of periods?

Chapter 3 NPV Using Constant Discounting

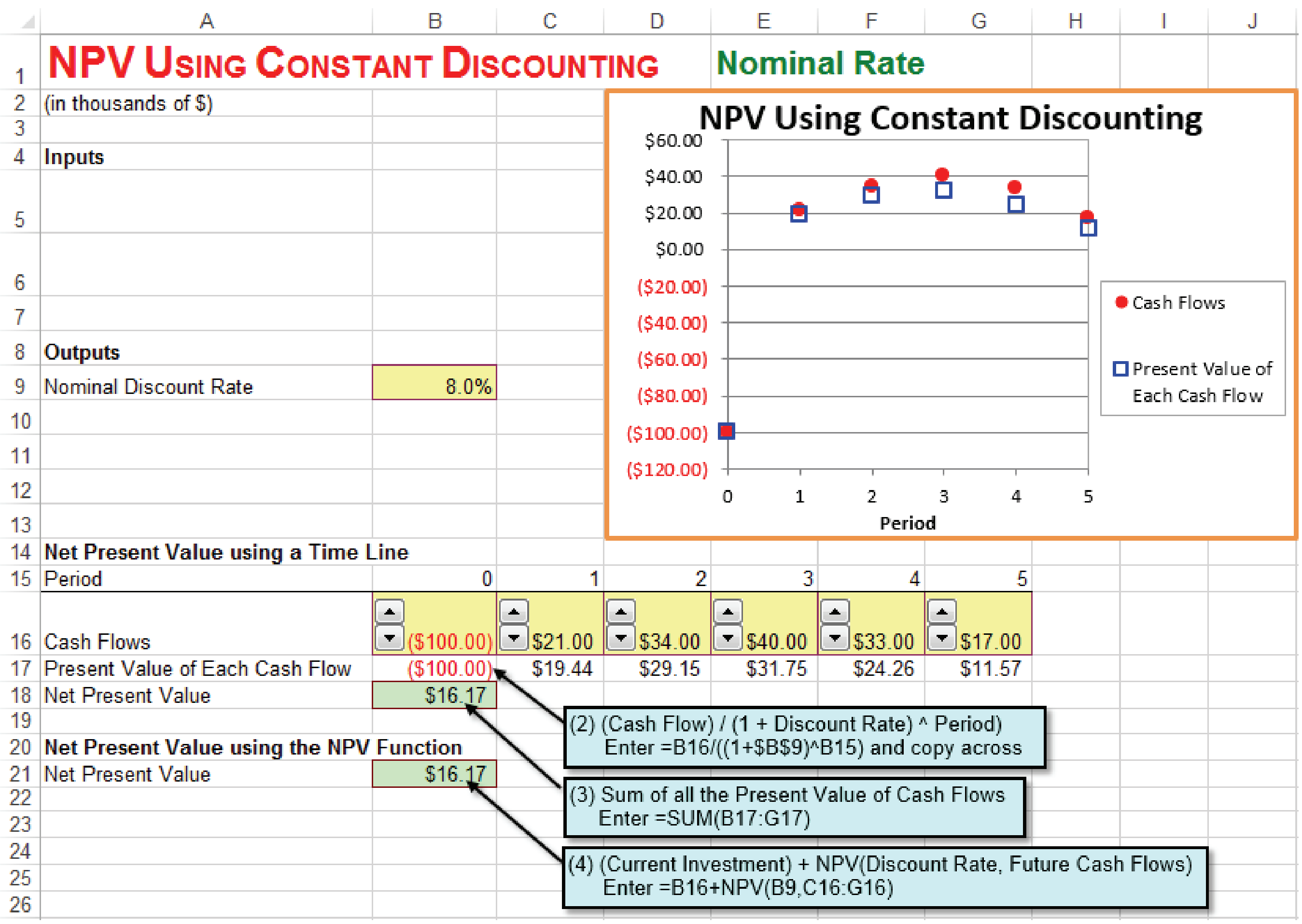
3.1 Nominal Rate

Problem. A project requires a current investment of $100.00 and yields future expected cash flows of $21.00, $34.00, $40.00, $33.00, and $17.00 in periods 1 through 5, respectively. All figures are in thousands of dollars. For these expected cash flows, the appropriate nominal discount rate is 8.0%. What is the net present value of this project?

Solution Strategy. We will calculate the net present value of this project in two equivalent ways. First, we will calculate the net present value using a time line, where each column corresponds to a period of calendar time. Second, we use Excel's **NPV** function for the net present value.

Excel 2013

FIGURE 3.1 NPV Using Constant Discounting – Nominal Rate.



The Net Present Value of this project is $16.17. Notice you get the same answer both ways: using the time line or using the NPV function.

3.2 Real Rate

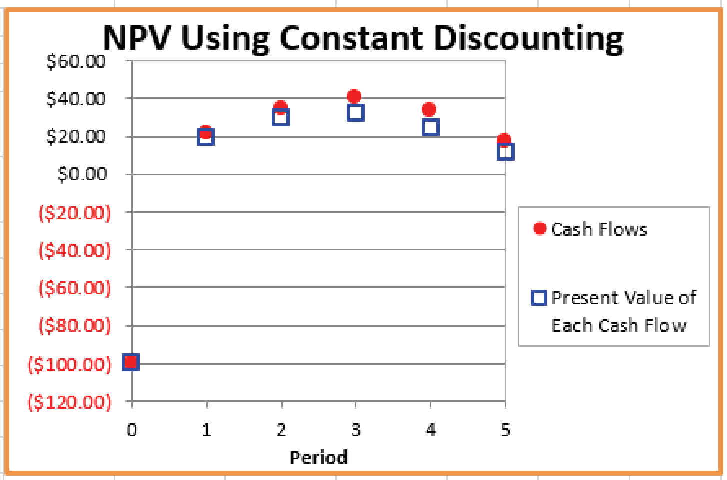
Problem. A project requires a current investment of $100.00 and yields future expected cash flows of $21.00, $34.00, $40.00, $33.00, and $17.00 in periods 1 through 5, respectively. All figures are in thousands of dollars. The inflation rate is 3.0%. For these expected cash flows, the appropriate Real Discount Rate is 4.854%. What is the net present value of this project?

Solution Strategy. We begin by calculating the (nominal) discount rate from the inflation rate and the real discount rate. The rest of the net present value calculation is the same as the Net Present Value - Constant Discount Rate Excel model.

Excel 2013

FIGURE 3.2 NPV Using Constant Discounting – Real Rate.

	A	B	C	D	E	F	G
1	NPV USING CONSTANT DISCOUNTING				Real Rate		
2	(in thousands of $)						
3							
4	**Inputs**						
5	Inflation Rate	3.0%	3				
6	Real Discount Rate	4.854%	4				
7							
8	**Outputs**						
9	Nominal Discount Rate	8.0%					
10							
11	(1) (1 + Inflation Rate) * (1+ Real Discount Rate) - 1 Enter =(1+B5)*(1+B6)-1						
12							
13							
14	**Net Present Value using a Time Line**						
15	Period	0	1	2	3	4	5
16	Cash Flows	($100.00)	$21.00	$34.00	$40.00	$33.00	$17.00
17	Present Value of Each Cash Flow	($100.00)	$19.44	$29.15	$31.75	$24.26	$11.57
18	Net Present Value	$16.17					
19							
20	**Net Present Value using the NPV Function**						
21	Net Present Value	$16.17					



The inflation rate of 3.0% and the real discount rate of 4.854%, combine to yield a nominal discount rate of 8.0%, which is the same as before. Therefore, the Net Present Value of this project is $16.17, which is the same as before.

Problems

1. A project requires a current investment of $179.32 and yields future expected cash flows of $35.19, $63.11, $88.54, $82.83, and $68.21 in periods 1 through 5, respectively. All figures are in thousands of dollars. For these expected cash flows, the appropriate discount rate is 5.3%. What is the net present value of this project?

2. A project requires a current investment of $107.39 and yields future expected cash flows of $48.31, $58.53, $82.80, $106.31, and $62.18 in periods 1 through 5, respectively. All figures are in thousands of dollars. The inflation rate is 3.7%. For these expected cash flows, the appropriate Real Discount Rate is 7.6%. What is the net present value of this project?

Chapter 4 NPV Using General Discounting

4.1 Nominal Rate

Problem. A project requires a current investment of $100.00 and yields future expected cash flows of $21.00, $34.00, $40.00, $33.00, and $17.00 in periods 1 through 5, respectively. All figures are in thousands of dollars. For these expected cash flows, the appropriate nominal discount rates are 8.0% in period 1, 7.6% in period 2, 7.3% in period 3, 7.0% in period 4, and 7.0% in period 5. What is the net present value of this project?

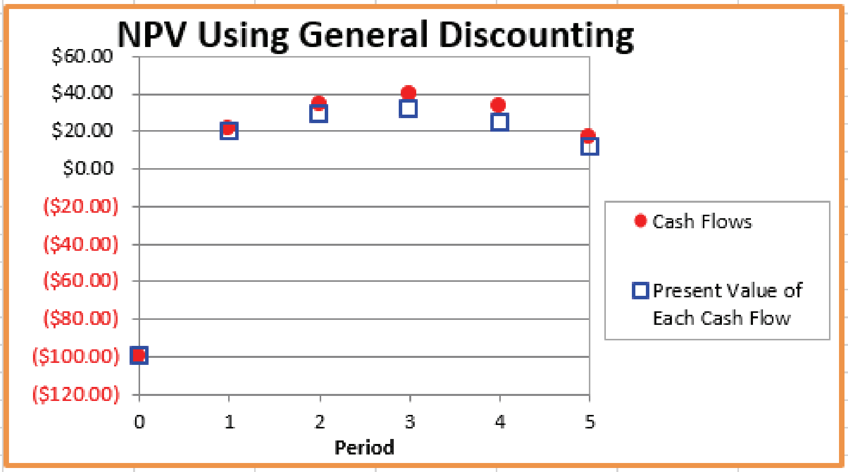
Solution Strategy. We will calculate the Net Present Value of this project using a Time Line. This is the *only* possible way to calculate the project NPV in the general case where the discount rate changes over time. Excel's **NPV** function cannot be used because it is limited to the special case of a constant discount rate. There is no simple formula for NPV, short of typing in a term for each cash flow.

Excel 2013

FIGURE 4.1 NPV Using General Discounting – Nominal Rate.

NPV USING GENERAL DISCOUNTING **Nominal Rate**

(in thousands of $)



	A	B	C	D	E	F	G
20	**Inputs**						
26	Period	0	1	2	3	4	5
27	Nominal Discount Rate		8.0%	7.6%	7.3%	7.0%	7.0%
31	**Net Present Value using a Time Line**						
32	Period	0	1	2	3	4	5
33	Cash Flows	($100.00)	$21.00	$34.00	$40.00	$33.00	$17.00
34	Cumulative Discount Factor	0.0%	8.0%	16.2%	24.7%	33.4%	42.8%
35	Present Value of Each Cash Flow	($100.00)	$19.44	$29.26	$32.08	$24.73	$11.91
36	Net Present Value	$17.42					

(2) (1 + Cumulative Discount Factor on date t-1) * (1 + Discount Rate on date t) - 1
Enter =(1+B34)*(1+C27)-1 and copy across

(3) (Cash Flow on date t) / (1 + Cumulative Discount Factor on date t)
Enter =B33/(1+B34) and copy across

(4) Sum of all the Present Value of Cash Flows
Enter =SUM(B35:G35)

The Net Present Value of this project is $17.42.

4.2 Real Rate

Problem. A project requires a current investment of $100.00 and yields future expected cash flows of $21.00, $34.00, $40.00, $33.00, and $17.00 in periods 1 through 5, respectively. All figures are in thousands of dollars. The forecasted inflation rate is 3.0% in period 1, 2.8% in period 2, 2.5% in period 3, 2.2% in period 4, and 2.0% in period 5. For these expected cash flows, the appropriate REAL discount rate is 4.854% in period 1, 4.669% in period 2, 4.683% in period 3, 4.697% in period 4, and 4.902% in period 5. What is the net present value of this project?

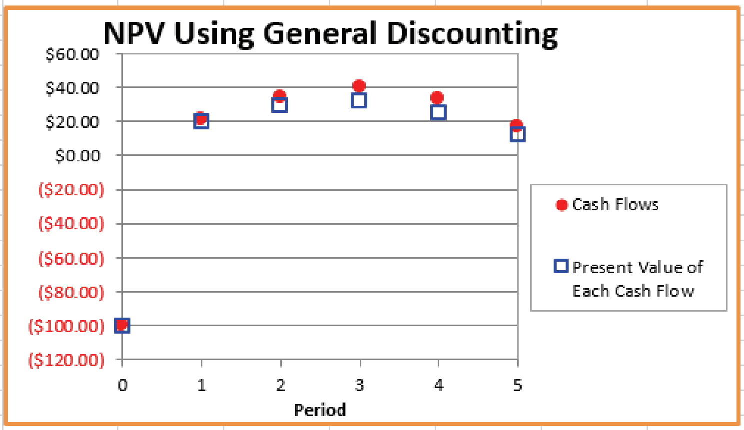
Solution Strategy. We begin by calculating the (nominal) discount rate for each period from the inflation rate in each period and corresponding real discount rate. The rest of the net present value calculation is the same as the Net Present Value - General Discount Rate Excel model.

Excel 2013

FIGURE 4.2 NPV Using General Discounting – Real Rate.

NPV USING GENERAL DISCOUNTING **Real Rate**

(in thousands of $)



	A	B	C	D	E	F	G	H	I	J
20	**Inputs**									
21	Period	0	1	2	3	4	5			Add to All Periods
22	Inflation Rate		3.0%	2.8%	2.5%	2.2%	2.0%			0.0%
23	Real Discount Rate		4.854%	4.669%	4.683%	4.697%	4.902%			0.0%
24										
25	**Outputs**									
26	Period	0	1	2	3	4	5			
27	Nominal Discount Rate		8.0%	7.6%	7.3%	7.0%	7.0%			
28										
29										
30										
31	**Net Present Value using a Time Line**									
32	Period	0	1	2	3	4	5			
33	Cash Flows	($100.00)	$21.00	$34.00	$40.00	$33.00	$17.00			
34	Cumulative Discount Factor	0.0%	8.0%	16.2%	24.7%	33.4%	42.8%			
35	Present Value of Each Cash Flow	($100.00)	$19.44	$29.26	$32.08	$24.73	$11.91			
36	Net Present Value	$17.42								

(1) (1 + Inflation Rate) * (1 + Real Discount Rate) - 1
Enter =(1+C22)*(1+C23)-1 and copy across