CHAPTER 3

Smart Excel Appendix

Use the Smart Excel spreadsheets and animated tutorials at the Smart Finance section of http://www.cengage.co.uk/megginson.

Appendix Contents

EXCEL PREREQUISITES

You need to be familiar with the following *Excel* features to use this appendix:

- Creating formulas in *Excel*
- Mathematical operators
- Order of mathematical operations
- Financial functions

If this is new to you, be sure to complete the ***Excel Prereqs*** tab of the Chapter 3 *Excel* file before proceeding.

SOLVING TIME VALUE OF MONEY PROBLEMS IN *EXCEL*

Solving even complex future value, present value, and other time value of money problems is straightforward using *Excel*.

In this appendix, we review three different approaches to solving time value of money problems using *Excel*.

Approach 1. Use the mathematical formula.
Approach 2. Use the financial functions in *Excel*.
Approach 3. Create a basic model and solve using either of the above two approaches.

But first, let's review the *Excel* basics you'll need to solve time value of money problems in *Excel*. If you are new to *Excel*, be sure to review the *Excel* prerequisites for the chapter on the first tab of the Chapter 3 *Excel* file.

4 *EXCEL* BASICS

1. Learn the notation.

As you've seen in the chapter, there are five key variables listed in the table below. The variables are called function arguments in *Excel*. The notation in the text is slightly different than the notation in *Excel*.

5 Key Variables	**Text notation**	***Excel* notation**
Present value	*PV*	P_V
Future value	*FV*	F_V
Payment	*PMT*	Pmt
Rate	*R*	Rate
Time or # periods	*N*	nper

If you know four of these variables, you can solve for the fifth.

In the chapter, we normally assume any cash flows occur at the end of the year (ordinary annuity). *Excel* allows for the option of any payment to be at the beginning of the year or at the end of the year. This option is provided for in *Excel* with a sixth variable called type (more on this later).

2. Know the mathematical operator signs in *Excel*.

Remember, all formulas must start with "=".

Mathematical operation	**In *Excel* use**
Addition	+
Subtraction	-
Multiplication	*
Division	/
Exponent	^

3. Note that cash flow signs matter in *Excel*.

Excel's financial functions have been designed so that the ***cash flow sign matters***. Cash inflows and outflows MUST have different signs in *Excel*. Cash inflows should have a positive sign and cash outflows a negative sign. This means that if you are looking for a future value of a sum invested, the original funds invested are a cash outflow and have a negative cash flow sign—because the investment is money flowing away. The future value is a cash inflow and has a positive sign. Keep this in mind as you work through the example below.

4. Use *Excel* Smartly!

You can always use *Excel* like a calculator. But *Excel*'s real value in financial analysis is the model you build to change key inputs or assumptions that examine the effect on output. Approach 3 shows you how to build smart financial models in *Excel* to solve time value of money problems, using either the mathematical or the *Excel* function approach.

FUTURE VALUE IN *EXCEL*

Future Value of a Lump Sum

Open the Chapter 3 *Excel* file at the Smart Finance Web site. If you are new to *Excel*, be sure to review the *Excel* prerequisites for the chapter on the first tab of the Chapter 3 *Excel* file. Otherwise,

proceed to the worksheet tab labeled ***FV lump sum***. We will solve the following problem, using the three approaches outlined above.

Problem: Find the future value of €1,000 invested for five years at 8%.

Consider the five key variables here:

Present value	€1,000
Future value	You are solving for future value.
Payment	There is no annual payment.
Rate	The rate is 8%.
Number of periods	five years

Approach 1: Use the mathematical formula.

Equation 3.1 on page 91 shows the formula for a future value as

$FV = PV\,3\,(1+r)^n$

In a cell in *Excel* type in the formula as

=1000*(1.08)^5

Formula result: €1,469.33

Note: All solutions are provided in the* Excel *file, so if you have any trouble, check your result against the solution.

Approach 2: Use the future-value function in *Excel.*

A future-value function is built into *Excel*'s financial functions.

As with all *Excel* functions, begin with an equals sign followed by the function symbol, here fv, and the function arguments.

You can use the future-value function directly in a cell by using the following format:

=fv(rate,nper,pmt,pv,type)

Note: You must start with an "=".

Enter pv as a negative number because the funds are invested—cash outflow.

Type can be left blank (inserting a 1 here changes the payment to the beginning of the year).

Leave no spaces between variables.

Commas are required between variables.

In this example, type in a cell

=fv(8%,5,0,-1000)

Formula result: €1,469.33

You should get the same result as in the first approach.

Approach 3: Create a basic model and solve using either of the above approaches.

The first two approaches help you get a solution quickly and easily, but what if you want to change your initial assumptions? You can redo your calculation or go back in and edit your formula, but another option is to create a basic model.

Financial models built in *Excel* provide the same output but allow you to change your initial assumptions easily. Models are handy for examining the results under different input assumptions. In this example, suppose you want to determine the future value if the rate was changed to 5% or 11%, and to also look at the effect of longer or shorter time horizons.

Our financial models will have three key components:

1. **inputs**
2. **calculation**
3. **output**

The output is the "answer" you want to find. The inputs are the variables used in calculating the output.

In this model, the **output** desired is future value. The **input** assumptions are rate, time, payment, and present value. The **calculation** is straightforward and can be performed using either of the approaches above.

The key to creating a good model is building a formula that makes it easy to change inputs. Why? Because then you won't have to redo your calculations every time you want to change an input assumption. We demonstrate below, using the future-value function in Approach 2.

4 steps in a basic financial model

Step 1: Determine the desired output and select an approach to calculate it (mathematical formula or *Excel* function).
Step 2: Set up an area for input assumptions (done for you in this *Excel* file).
Step 3: Build a formula to calculate output by **USING CELL REFERENCES**, not by typing in the actual numbers (in our solution we use Approach 2).
Step 4: Change the input assumptions, as desired, and analyze the effect on output.

Look at the file provided. Note the section for inputs. Type your input assumptions in here.

Your worksheet should look like this:

Rate	8%
# periods	5
Pmt	0
Present value	(1,000)
Type	

Note that present value is entered as a negative number because the €1,000 is invested (cash outflow). Type can be left blank if payments are zero or occur at the end of the year.

Create a formula for future value by using cell references to the inputs. We use the built-in FV function rather than the mathematical formula, but either approach will work.

Your formula should read

=fv(C31,C32,C33,C34,C35)

Again, the result is €1,469.33.

Apply it

Change the input assumptions and analyze the effect. If you change the rate input to 5%, the future value is €1,338.23. At 11%, it is €1,685.06.

Return to a rate of 8% but invest for ten years, and the future value is €2,158.92.

Models make financial analysis in *Excel* valuable. Throughout most of this book, we create financial models to solve problems so that it is straightforward to change inputs and analyze the effect on output.

Future Value of an Annuity

In the Chapter 3 *Excel* file, go to the ***FV annuity*** tab and solve the following problem, using the three approaches outlined above.

Problem: Assume that after landing your first job at age twenty-one, you begin saving for retirement. You invest €1,200 at the end of each year for the next forty years and earn 9%. What is the value of your investment at the end of forty years?

Careful: In this problem, there is ***no*** present value because there is no money invested immediately. But there ***is*** an annual payment.

Did you get €405,458.93?
Solutions for each approach are provided to the right of the file.

Apply it

Change the input assumptions and analyze the effect.

- *Suppose you earn 11% instead of 9%?*
  The future value is €698,191.28.
- *Suppose you earn 9%, but you begin saving late and invest for only twenty years?*
  The future value is only €61,392.14.
- *Go back to the original problem but assume the payment is made at the beginning of the year instead of at the end of the year.*
  The type argument allows for any payment to be made at the beginning or at end of the year. Leaving type blank or setting it to zero represents payment at the end of the year (ordinary annuity). Setting at 1 represents payment at the beginning of the year (annuity due).

  The future value is €441,950.24.

  Analysis is much easier with the financial model designed in Approach 3.

Future Value Challenge:

Problem: Assume that after landing your first job at age twenty-one, you begin saving for retirement. You invest €1,500 immediately. You then invest €1,200 at the end of each year, and your employer matches 100% of your investment. If this occurs for forty years and earns 9% each year, what is the value of your investment at the end of forty years?

Solve using the approach of your choice. The solutions are provided on the ***FV Challenge*** *tab of the* Excel *file.*

PRESENT VALUE IN *EXCEL*

Present Value of a Lump Sum

Open the Chapter 3 *Excel* file at the Smart Finance Web site. Go to the worksheet tab labeled ***PV lump sum***. We will solve the following problem, using the three approaches outlined above.

Problem: Find the present value of €1,000 to be received at the end of five years if the opportunity cost of funds is 8%.

Consider the five key variables here:

Present Value	You are solving for present value.
Future Value	€1,000
Payment	There is no annual payment.
Rate	The rate is 8%.
Number of periods	five years

Approach 1: Use the mathematical formula.

Equation 3.2 on page 97 shows the formula for a present value as

$PV = FV / (1+r)^n$

In a cell in *Excel*, type in the formula as

=1000/(1.08)^5

Formula result: €680.58

Note: All solutions are provided in the* Excel *file, so if you have any trouble, check your result against the solution.

Approach 2: Use the PV function in *Excel.*

A present-value function is built into *Excel*'s financial functions.

As with all *Excel* functions, begin with an equals sign followed by the function symbol, here pv.

You can use the present-value function directly in a cell by using the following format:

=pv(rate,nper,pmt,fv,type)

Note: You must start with an "=".

Type is an optional argument and can be left blank (inserting a 1 here changes the payment to the beginning of the year).

Leave no spaces between variables.

Commas are required between variables.

In this example, type in a cell

=pv(8%,5,0,1000)

Formula result: –€680.58

The present value should appear as a NEGATIVE number, because* Excel *solves for the amount INVESTED today that leads to a future value of €1,000. The intuition is that investing €680.58 today at a rate of 8% is equivalent to €1,000 in five years.

Approach 3: Create a basic model and solve using either of the above approaches.

Try it. *The model is set up for you in the* Excel *file. Enter the inputs and use either the mathematical approach or the built-in present-value function. If you use Approach 2, the present value will appear as a negative number.*

Your worksheet should look like this:

Rate	8%
# periods	5
Pmt	0
Present value	1,000
Type	

If you use the built-in *Excel* present-value function, your formula should read

=pv(C32,C33,C34,C35,C36)

Again, the result is **–€680.58.**

Present Value of an Annuity

In the Chapter 3 *Excel* file, go to the ***PV annuity*** tab and solve the following problem, using the three approaches outline above.

Problem: Find the present value of five annual end-of-year payments of €1,000 if the appropriate rate is 8%.

Your result should be €3,992.71.

OTHER TIME VALUE OF MONEY APPLICATIONS IN *EXCEL*

Excel also includes built-in financial functions to solve for payment, rate, and time. An example of each is provided below and in the *Excel* file.

Payment

Open the Chapter 3 *Excel* file at the Smart Finance Web site. Go to the worksheet tab labeled ***Payment***.

Problem: You want to accumulate €1 million by retirement in thirty-five years. Unfortunately, you have not saved anything yet. If you can earn 9% each year, how much do you need to invest annually at the end of the year to reach your goal?

The format for the payment function in *Excel* is

=pmt(rate,nper,pv,fv,type)

here,

=pmt(9%,35,0,1000000)

Type is optional and not included here. DO NOT type in commas in the numbers.

The result is €4,635.84. This appears as a negative number if the *Excel* functions are used because the funds are invested (cash outflows).

Apply it
Change the input assumptions and analyze the effect.

- *Suppose you earn 8% instead of 9%?*
  Your annual payment would increase to €5,803.26.
- *Suppose you earn 9%, but you begin saving late and invest for only twenty-five years?*
  Your annual payment would increase to €11,806.25.

Rate

Open the Chapter 3 *Excel* file at the Smart Finance Web site. Go to the worksheet tab labeled ***Rate***.

Problem: You want to accumulate €1 million by retirement in thirty-five years. You have €5,000 to invest immediately. If you invest €1,000 at the end of each year, what rate do you need to earn to reach your goal?

The format for the rate function in *Excel* is

=rate(pmt,nper,pv,fv,type)

here,

=rate(–1000,35,–5000,1000000)

The result is 13.37%.

Apply it
Change the input assumptions and analyze the effect.

- *Suppose you invest for forty years instead of 35?*
  The rate you need to earn drops from 13.37% to 11.32%.
- *Suppose you invest €1,500 in each of the thirty-five years?*
  The rate you need to earn drops from 13.37% to 12.36%.
- *Suppose you did not invest €5,000 initially?*
  You need to earn 15.53% to reach €1 million.

Hint: If you try this in a blank worksheet, you may get a result of 0. If this occurs, make sure you have formatted the cell as a %.

Time
Open the Chapter 3 Excel file at the Smart Finance Web site. Go to the worksheet tab labeled ***Time***.

Problem: You want to accumulate €1 million by retirement. You have €10,000 to investimmediately. If you invest €1,800 at the end of each year and earn 9.5%, how many years do youneed to save to reach your goal?

The format for the time function in *Excel* is nper, or number of periods.

=nper(rate,pmt,pv,fv,type)

here,

=nper(9.5%,–1800,35,–10000,1000000)

The result is 39.24 years.

Apply it
Change the input assumptions and analyze the effect.

Suppose you did not invest the €10,000 initially?
You need to invest for almost forty-four years to reach €1 million.

EXCEL EXTRAS: DATA TABLES AND GRAPHS

Data tables and graphs are tools that enable you to display the effect of changing inputs on output values. We will show how each can be applied to the first problem we examined—the future value of a lump sum.

DATA TABLES
Open the Chapter 3 Excel file at the Smart Finance Web site. Go to the worksheet tab labeled ***Data table***.

Problem: Create a data table to show the future value of €1,000 invested for different time horizons and different interest rates.

A data table allows you to view the results of a single formula as one or more input variables are changed.
Assume you want to look at €1,000 invested for the following number of years and interest rates:

years: 0, 3, 5, 7, 10, 25

rates: 0%, 2%, 4%, 6%, 8%, 10%, 12%, 14%, 16%, 18%, 20%

Steps to create a data table:

Step 1: Begin with a simple model to calculate future value. You can use the results from the *FV* lump-sum problem.

Approach 3: Create a basic model.

Inputs

Rate	8%
# periods	5
Pmt	0
Present value	(1,000)
Type	

Output

Future value	**€1,469.33**

Step 2: Because we are creating a table for various future values, we need to set up the table based on the future-value formula. Select a cell to control the data table. This cell is in the top left corner of the table. Then, use a cell reference to refer to the formula that is the basis of the data table—here Future Value. In the *Excel* file, the cell is color-coded for easy identification.

Step 3: Enter the values for the various inputs—to the right and directly below the control cell. Look at the file; it is set up for you. Note that the rates are entered vertically and the time horizontally. Enter labels.

Step 4: Use the shift and arrow keys to select the entire table areas, INCLUDING the control cell, and row and column variables. DO NOT include the labels.

1,469	**0**	**3**	**5**	**7**	**10**	**25**
0%						
2%						
4%						
6%						
8%						
10%						
12%						
14%						
16%						
18%						
20%						

Step 5: On the toolbar, select **data**, then **table**. The table dialog box will appear.

Step 6: Input the row and column information for the table. You must enter the cell reference from your original model that contains the information needed for the table.

Row input cell: Input the cell reference where the number of periods is entered because the variable in the row is time.

Column input cell: Input the cell reference for rate because the rate is entered in the column.

Step 7: Click OK. The table is completed, and the result is an array formula based on the Table function with two arguments. The result follows:

Years Invested

Rates						
1,469	**0**	**3**	**5**	**7**	**10**	**25**
0%	1,000	1,000	1,000	1,000	1,000	1,000
2%	1,000	1,061	1,104	1,149	1,219	1,641
4%	1,000	1,125	1,217	1,316	1,480	2,666
6%	1,000	1,191	1,338	1,504	1,791	4,292
8%	1,000	1,260	1,469	1,714	2,159	6,848
10%	1,000	1,331	1,611	1,949	2,594	10,835
12%	1,000	1,405	1,762	2,211	3,106	17,000
14%	1,000	1,482	1,925	2,502	3,707	26,462
16%	1,000	1,561	2,100	2,826	4,411	40,874
18%	1,000	1,643	2,288	3,185	5,234	62,669
20%	1,000	1,728	2,488	3,583	6,192	95,396

This table shows the future value of €1,000 invested at various rates and time horizons.

GRAPHS

Open the Chapter 3 *Excel* file at the Smart Finance Web site. Go to the worksheet tab labeled ***Graph***.

Problem: Create a graph to show the future value of €1,000 invested for five years at different interest rates.

Assume you want to look at €1,000 invested five years at the following interest rates:

rates: 0%, 2%, 4%, 6%, 8%, 10%, 12%, 14%, 16%, 18%, 20%

Excel offers a large number of graphing options. In this appendix, we provide a simple illustration of a basic line graph embedded in the file.

Steps to create a graph:

Step 1: Create a table with the information you want to graph. This is done for you here using information from the previous tab on future values and rates.

Step 2: Place your cursor anywhere within the table. On the toolbar, select "insert", then "chart" (or use the chart wizard icon). Choose a line graph.

Step 3: Follow the prompts from the chart wizard. The chart will appear in the worksheet. Drag it to a new location and resize it, as desired.

Notice that the relationship between the future value and the interest rate is not a straight line. The future value increases at an increasing rate as the interest rate rises.

Working with graphs, especially formatting graphs, takes a little practice. Also, there are many options available to reformat axes, add titles and labels, and so on. Experiment and use the *Excel* help function or a basic *Excel* text for more information on graphing.