1 *Spreadsheet Basics*

After studying this chapter, you should be able to:

1. *Explain the basic purpose of a spreadsheet program.*
2. *Identify the various components of the Excel screen.*
3. *Navigate the Excel worksheet (entering, correcting, and moving data within the worksheet).*
4. *Explain the purpose and usage of Excel's built-in functions and macro functions.*
5. *Create graphics and know how to print and save files in Excel.*

The term "spreadsheet" covers a wide variety of elements useful for quantitative analysis of all kinds. Essentially, a spreadsheet is a simple tool consisting of a matrix of cells that can store numbers, text, or formulas. The spreadsheet's power comes from its ability to recalculate results as you change the contents of other cells. No longer does the user need to do these calculations by hand or on a calculator. Instead, with a properly constructed spreadsheet, changing a single number (say, a sales forecast) can result in literally thousands of automatic changes in the model. The freedom and productivity enhancement provided by modern spreadsheets presents an unparalleled opportunity for learning financial analysis.

Spreadsheet Uses

Spreadsheets today contain built-in analytical capabilities previously unavailable in a single package. Users often had to learn a variety of specialized software packages to do any relatively complex analysis. With the newest versions of Microsoft Excel, users can perform tasks ranging from the routine maintenance of financial statements to multivariate regression analysis to Monte Carlo simulations of various hedging strategies.

It is literally impossible to enumerate all of the possible applications for spreadsheets. You should keep in mind that spreadsheets are useful not only for financial analysis, but for any type of quantitative analysis whether your specialty is in marketing, management, engineering, statistics, or economics. For that matter, a spreadsheet can also prove valuable for personal uses. With Excel it is a fairly simple matter to build a spreadsheet to monitor your investment portfolio, do retirement planning, experiment with various mortgage options when buying a house, keep a mailing list, etc. The possibilities are quite literally endless. The more comfortable you become with the spreadsheet, the more valuable uses you will find. Above all, feel free to experiment! Try new things. Using a spreadsheet can help you find solutions that you never would have imagined on your own.

Starting Microsoft Excel

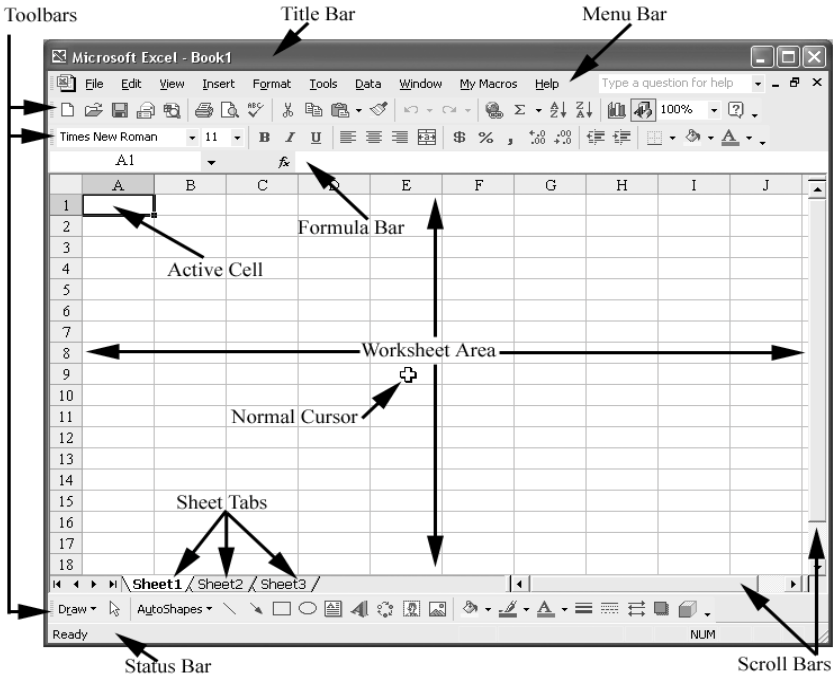
Excel 2002 Icon

Before you can do any work in Excel, you have to run the program. In Windows, programs are generally started by double-clicking on the program's icon. The location of the Excel icon will depend on the organization of your system. You may have the Excel icon (left) on the desktop. Otherwise, you can start Excel by clicking the Start button and then choosing Microsoft Excel from the All Programs menu.

For easier access, you may wish to create a Desktop or Taskbar shortcut. To do this right-click on the Excel icon in the All Programs menu and either choose Create Shortcut or drag the icon to the Desktop or Taskbar. Remember that a shortcut is not the program itself, so you can safely delete the shortcut if you later decide that you don't need it.

Parts of the Excel Screen

FIGURE 1-1
MICROSOFT EXCEL 2002



The Title Bar

The title bar is the area at the very top of the Excel screen. It serves a number of functions:

- Identifies the program as Microsoft Excel and displays the name of the currently active workbook.
- Appears brightly colored when Excel is the active program.
- Can be "grabbed" with the mouse to move the window around within the Windows environment, if the window is not maximized.

- Contains the system menu (left corner) and the minimize, maximize, and close buttons (right corner). The system menu provides choices for moving the window or changing its size as well as the ability to switch to or run other programs. The minimize button will collapse the window down to an icon at the bottom of the Windows screen where it is still active, but out of the way. The maximize button causes the program to occupy the entire screen. The close button will exit the program.
- When double-clicked, the title bar duplicates the functioning of the maximize button.

The Menu Bar

FIGURE 1-2
THE EXCEL 2002 MAIN MENUS

The main menu bar in Excel provides access to nine menus, each of which leads to further choices. There are two ways to select a menu: click on the menu of choice with the mouse, or use the Alt key in combination with the underlined letter in the menu name. For example, to choose the **F**ile menu, you could either click on the word "**F**ile" or press Alt+F on the keyboard. Either method will lead to the **F**ile menu dropping down, allowing you to make another choice.

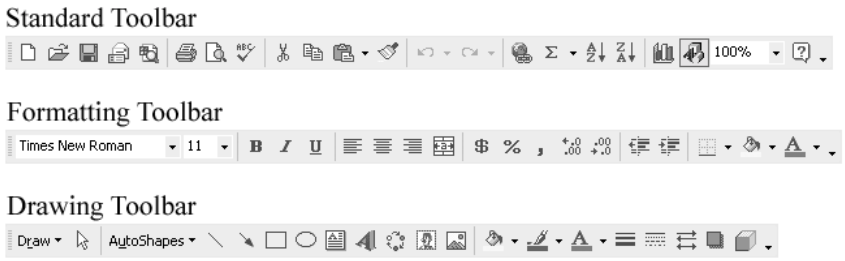
In Windows, menus are persistent, meaning that they stay visible on the screen until you either make a selection or cancel the menu by pressing the Esc key. While the menu is visible, you may use either the arrow keys or the mouse to select a function.

At times, some menu selections are displayed in a light gray color (grayed). These options are not available for selection at the time that the menu is selected. For example, if you have not cut or copied a cell, the **P**aste option from the **E**dit menu has nothing to paste, so it is grayed. Only the menu options displayed in black may be selected.

Refer to Appendix A for a short description of each menu selection.

The Toolbars

FIGURE 1-3
MOST COMMON EXCEL 2002 TOOLBARS



Immediately below the menu bar, Excel displays a series of shortcut buttons on Toolbars. The exact buttons, and their order, may be different on different machines. The buttons provide a quick way to carry out certain commands without wading through menus and dialog boxes. To add, delete, or rearrange buttons choose **V**iew **T**oolbars **C**ustomize from the menus. You can learn what function each button performs by simply moving the mouse pointer over a button on a Toolbar. After a few seconds, a message will appear that informs you of the button's function. This message is known as a ToolTip. ToolTips are used frequently by Excel to help you to identify the function of various items on the screen.

Note that you can move a Toolbar, or make it float over the worksheet, by clicking on a blank area of the Toolbar and dragging it to the new location. Dropping it over the worksheet area will leave it floating. The Toolbar will stay wherever you drop it, even after exiting and restarting Excel.

The Formula Bar

FIGURE 1-4
THE EXCEL 2002 FORMULA BAR

The formula bar displays information about the currently selected cell. The left part of the formula bar indicates the name of the selected cell. The right part of the formula bar displays the contents of the selected cell. If the cell contains a formula, the formula bar displays the formula, and the cell displays the result of the formula.

The *fx* button on the formula bar is used to show the Insert Function dialog box. This dialog box helps you to enter functions without having to memorize them. See page 23 for more information.

The Worksheet Area

The worksheet area is where the real work of the spreadsheet is done. The worksheet is a matrix (256 columns and 65,536 rows) of cells, each of which can contain text, numbers, formulas, or graphics. Each cell is referred to by a column letter and a row number. Column letters (A,B,C,. . . ,IV) are listed at the top of each column, and row numbers (1,2,3,. . . ,65536) are listed to the left of each row. The cell in the upper left corner of the worksheet is therefore referred to as cell A1, the cell immediately below A1 is referred to as cell A2, the cell to the right of A1 is cell B1, and so on. This naming convention is common to all spreadsheets and will become comfortable once you have practiced a bit.

The active cell (the one into which any input will be placed) can be identified by a solid black border around the cell. Note that the active cell is not always visible on the screen, but it is always named in the leftmost portion of formula bar.

Sheet Tabs

FIGURE 1-5
THE SHEET TABS

Excel worksheets are stored in a format which combines multiple worksheets into one file known as a workbook. This allows several related worksheets to be contained in one file. The sheet tabs, near the bottom of the screen, allow you to switch between sheets in a workbook. You may rename, copy, or delete any existing sheet or insert a new sheet by clicking a tab with your right mouse button and making a choice from the resulting menu. You can easily change the order of the sheet tabs by left-clicking a tab and dragging it to a new position.

It is easy to do any of these operations on multiple worksheets at once, except renaming. Simply click the first sheet and then Ctrl+click each of the others. (You can select a contiguous group of sheets by selecting the first, and then Shift+click the last.) Now, right-click one of the selected sheets and select the appropriate option from the pop-up menu. When sheets are grouped, anything you do to one

sheet gets done to all. This is useful if, for example, you need to enter identical data into multiple sheets or need to perform identical formatting on several sheets. To ungroup the sheets, either click on any non-grouped sheet or right-click a sheet tab and choose **U**ngroup Sheets from the pop-up menu. A new feature in Excel 2002 allows you to choose a color for each tab. To do this just right-click the tab and choose **T**ab Color from the pop-up menu.

The VCR-style buttons to the left of the sheet tabs are the sheet tab control buttons; they allow you to scroll through the list of sheet tabs. Right-clicking on any of the VCR-style buttons will display a pop-up menu that allows you to quickly jump to any sheet tab in the workbook. This is especially helpful when you have too many tabs for them all to be shown.

Status Bar

FIGURE 1-6
THE STATUS BAR

The status bar contains information regarding the current state of Excel, as well as certain messages. For example, most of the time the only message is "Ready" indicating that Excel is waiting for input. At other times, Excel may add "Calculate" to the status bar to indicate that it needs to recalculate the worksheet because of changes. You can also direct Excel to do certain calculations on the status bar. For example, in Figure 1-6 Excel is calculating the average of the cells that are highlighted in the worksheet. By right-clicking on the status bar you can also get Excel to calculate the sum, count, minimum, or maximum of any highlighted cells. This is useful when you need a quick calculation, but it doesn't need to be in the worksheet. The right side of the status bar shows if the Num Lock or Scroll Lock keys are on.

Navigating the Worksheet

There are two principle methods for moving around within the worksheet area: the arrow keys and the mouse. Generally speaking, for small distances the arrow keys provide an easy method of changing the active cell, but moving to more distant cells is usually easier with the mouse.

Most keyboards have a separate keypad containing arrows pointing up, down, left, and right. If your keyboard does not, then the numeric keypad can be used if the Num Lock function is off (you will see the word NUM in the status bar if Num Lock is on). To use the arrow keys, simply press the appropriate key once for each cell that you wish to move across. For example, assuming that the current cell is A1 and you wish to move to cell D1, simply press the Right arrow key three times. To move from D1 to D5 press the Down arrow key four times. You can also use the Tab key to move one cell to the right.

The mouse is even easier to use. While the mouse pointer is over the worksheet area it will be in the shape of a fat cross (see Figure 1-1). To change the active cell move the mouse pointer over the destination cell and click the left button. To move to a cell that is not currently displayed on the screen, click on the scroll bars until the cell is visible and then click on it. For example, if the active cell is A1 and you wish to make A100 the active cell, merely click on the arrow at the bottom of the scroll bar on the right-hand part of the screen until A100 is visible. Move the mouse pointer over cell A100 and click with the left button. Each click on the scroll bar moves the worksheet up or down one page. If you wish to move up, click above the thumb. If down, click beneath the thumb. The thumb is the small button that moves up and down the scroll bar to indicate your position in the worksheet. To move more quickly, you can drag the thumb to the desired position.

If you know the name or address of the cell to which you wish to move (for large worksheets remembering the cell address isn't easy, but you can use named ranges) use the Go To command. The Go To command will change the active cell to whatever cell you indicate. The Go To dialog box can be used by choosing the **E**dit menu and then the **G**o To command, by pressing the F5 function key, or by pressing the Ctrl+G key combination. To move to cell A50, simply press F5, type: `A50` in the Reference box, and then press Enter. You will notice that cell A50 is now highlighted and visible on the screen. You can also use Go To to find certain special cells (e.g., the last cell that has data in it) by pressing the **S**pecial . . . button in the Go To dialog box.

Selecting a Range of Cells

Many times you will need to select more than one cell at a time. For example, you may wish to apply a particular number format to a whole range of cells, or you might wish to clear a whole range. Since it would be cumbersome to do this one cell at a time, especially for a large range, Excel allows you to simultaneously select a whole range and perform various functions on all of the cells at once. The easiest way to select a contiguous range of cells is to use the mouse. Simply point

to the cell in the upper left corner of the range, click and hold down the left button, and drag the mouse until the entire range is highlighted. As you drag the mouse, watch the left side of the formula bar. Excel will inform you of the number of selected rows and columns.

You can also use the keyboard to select a range. First change the active cell to the upper left corner of the range to be selected, press and hold down the Shift key, and use the arrow keys to highlight the entire range. Note that if you release the Shift key while pressing an arrow key you will lose the highlight. A very useful keyboard shortcut is the Shift+Ctrl+Arrow (any arrow key will work) combination. This is used to select all of the cells from the active cell up to, but not including, the first blank cell. For example, if you have 100 numbers in a column and need to apply a format, just select the first cell and then press Shift+Ctrl+Down Arrow to select them all. This is faster and more accurate than using the mouse.

Many times it is also useful to select a discontiguous range (i.e., two or more unconnected ranges) of cells. To do this, simply select the first range as usual, and then hold down the Ctrl key as you select the other ranges.

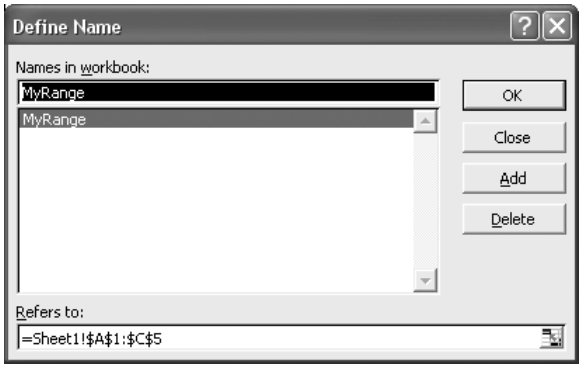
The ability to select cells in Excel is crucial because Excel, like most other Windows applications, works in the "select, then act" mode. (In the old days, users of DOS programs were familiar with the "act, then select" method of operation.) In Excel, you first select the cells that you wish to act on, then choose the operation (e.g., **E**dit **C**opy) that you want to perform. This would seem to be a minor point, but it is actually a big productivity improvement. In the "select, then act" method, the cells stay selected after the operation has been performed, thereby allowing another operation on those cells without reselecting them.

Using Named Ranges

A named range is a cell, or group of cells, for which you have supplied a name. Range names can be useful in a number of different ways, but locating a range on a big worksheet is probably the most common use. To name a range of cells, start by selecting the range. For example, select A1:C5 and then choose **I**nsert **N**ame **D**efine from the menus. In the edit box at the top of the Define Name dialog box, enter a name, say MyRange (note that a range name cannot contain spaces or most special characters). Now, click the Add button and the range is named. Figure 1-7

shows how the dialog box should look. Note that at the bottom the **R**efers To edit box shows the address to which the name refers.[1]

FIGURE 1-7
THE DEFINE NAME DIALOG BOX



Once the range is named, you can select it using the Go To command. The name will appear in the list on the Go To dialog box. An even faster method is to use the Name Box on the left side of the formula bar. Simply drop the list and choose the named range that you wish to select.

Named ranges can also be used in formulas in place of cell addresses, and can be used in the ChartSeries function for charts. As useful as they can be at times, there is no requirement to use them.

Entering Text and Numbers

Each cell in an Excel worksheet can be thought of as a miniature word processor. Text can be entered directly into the cell and then formatted in a variety of ways. To enter a text string, first select the cell where you want the text to appear and then begin typing. It is that simple.

1. Note that the name is actually defined as a formula. This subtle point is important for some of the more advanced uses of named ranges. For example, the range of cells referred to by the name can be made to change automatically depending on circumstances.

Excel is smart enough to know the difference between numbers and text, so there are no extra steps for entering numbers. Let's try the following example of entering numbers and text into the worksheet.

Move the cell pointer to cell A1 (using the arrow keys, mouse, or the Go To command) and type: `Microsoft Corporation Sales`. In cell A2 enter: `(Millions of Dollars)`. Select cell A3 and type: `1997 to 2002`. Note that the entry in cell A3 will be treated as text by Excel because of the spaces and letters included. In cells A4 to F4 we now want to enter the years. In A4 type: `2002`, in B4 type: `2001`, now select A4:B4 and move the mouse pointer over the lower right corner of the selection. The mouse pointer will now change to a skinny cross indicating that you can use the AutoFill feature.[2] Click and drag the mouse to the right to fill in the remaining years. Notice that the most recent data is typically entered at the left, and the most distant data at the right. This convention allows us to easily recognize and concentrate on what is usually the most important data.

We have now set up the headings for our first worksheet. Now let's add Microsoft's sales (in millions of dollars) for the years 1997 to 2002 into cells A5 to F5 as shown in Exhibit 1-1.[3]

Formatting and Alignment Options

The worksheet in Exhibit 1-1 on page 12 isn't very attractive. Notice that the text is displayed at the left side of the cells, while the numbers are at the right. By default this is the way that Excel aligns text and numbers. However, we can easily change the way that these entries are displayed through the use of the formatting and alignment options.

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2. The AutoFill feature can be used to fill in any series that Excel can recognize. For example, type `January` in one cell and `February` in an adjacent cell. Select both cells and drag the AutoFill handle to automatically complete fill in a series of month names. You can also define your own series by using the Custom Lists tab in the Options dialog box (**T**ools **O**ptions).
3. All of the data for Microsoft in this chapter was obtained from the Microsoft Corp. Web site at http://www.microsoft.com/msft/download/financialhistoryFY.xls.

EXHIBIT 1-1
THE FIRST WORKSHEET

	A	B	C	D	E	F
1	Microsoft Corporation Sales					
2	(Millions of Dollars)					
3	1997 to 2002					
4	2002	2001	2000	1999	1998	1997
5	28365	25296	22956	19747	15262	11936

Before continuing, we should define a few typographical terms. A "typeface" is a particular style of drawing letters and numbers. For example, the main text of this book is set in the Times New Roman typeface. However, the text that you are expected to enter into a worksheet is displayed in the `Courier New` typeface. Typeface also refers to whether the text is drawn in **bold**, *italics*, or perhaps ***bold italics***.

The term "type size" refers to the size of the typeface. When typewriters were commonly used, type size was defined in characters per inch (CPI). This convention was somewhat confusing because the larger the CPI number, the smaller was the text. Today, with computers we normally refer to the type size in "points." Each point represents an increment of 1/72nd of an inch, so there are 72 points to the inch. A typeface printed at a 12 point size is larger than the same typeface printed at a size of 10 points.

Generally, we refer to the typeface and type size combination as a font. So when we say "change the font to 12-point bold Times New Roman," it is understood that we are referring to a particular typeface (Times New Roman, bolded) and type size (12 point).

For text entries, the term "format" refers to the typeface and type size and cell alignment used to display the text. Let's change the font of the text that was entered to Times New Roman, 12-point, bold. First, select the range from A1 to A3 by clicking on A1 and dragging to A3. Now select the F**o**rmat menu and choose C**e**lls. A dialog box allows you to change the various attributes of the cells. Click on the tab labeled "Font" so that the font choices are displayed. We want to select Times New Roman from the font list, bold from the style list, and 12 from the size list. Notice that there is a sample of this font displayed in the lower right corner of the dialog box, so you can see how the chosen font will look on the worksheet. Since none of these changes actually take effect until you validate them by clicking the

OK button, you can experiment until the text in the sample window looks right. Click on the OK button or press the Enter key to make the change take effect. You can also make all of these changes with the Formatting Toolbar.

We can just as easily change the font for numbers. Suppose that we want to change the years in cells A4:F4 to 12-point italic Times New Roman. First select the range A4:F4 by clicking on A4 and dragging the mouse until the highlight extends to F4. Choose F**o**rmat C**e**lls (the font dialog box should be displayed since that was the last change that was made) and select the attributes. Click on the OK button and the change will be made. Note that this change could also have been made at the same time as the text was changed, or you could now choose **E**dit **R**epeat Font from the menus. In many cases the **E**dit menu will contain a choice that allows you to repeat or undo the last action. In addition, the F4 key, or Ctrl+Y, will repeat the last action.

Our worksheet is now beginning to take on a better look, but it still isn't quite right. We are used to seeing the titles of tables nicely centered over the table, but our title is way over at the left. We can remedy this by using Excel's alignment options. Excel provides for seven different horizontal alignments within a cell. We can have the text (or numbers) aligned with the left or right sides of the cell or centered within the cell boundaries. Excel also allows centering text across a range of cells.

Let's change the alignment of our year numbers first. Highlight cells A4:F4 and select F**o**rmat C**e**lls from the menu. Click on the Alignment tab to display the alignment choices. Horizontal alignment refers to the left and right alignment, vertical refers to the up and down alignment, and orientation refers to the way that the font is rotated. For now, we simply want to change the horizontal alignment to centered. Choose "Center" from the horizontal choices and click on the OK button. Notice that the numbers are all centered within their respective cells.

Next, we want to center our table title across the whole range of numbers that we have entered. To do this, we must select the entire range across which we want to center our titles. Highlight cells A1:F3 and select F**o**rmat C**e**lls from the menu. You will again be presented with the alignment dialog box from which you should select "Center across selection." Click on the OK button and notice that the titles are indeed centered across the columns A to F. Note that there is also a button on the Formatting Toolbar that will "Merge and Center" the selected cells. This button will have the appearance of doing the same thing as "Center across selection," but it doesn't. In addition to centering the text, it also merges all of the selected cells into one big cell. Using this button may create alignment problems if you later decide to

insert additional columns into the worksheet. Generally speaking, it is better not to use the Merge and Center button.

Number Formats

Aside from changing the typeface and type size, when dealing with numbers we can also change their appearance by adding commas and dollar signs, and by altering the number of decimal places displayed. Furthermore, we can make the numbers appear different depending on whether they are positive or negative. For example, we might want negative numbers to be red in color and displayed in parentheses rather than using the negative sign. You can experiment with designing your own number formats, but for now we will stick to the more common pre-defined formats.

Microsoft is a large company, and their sales have ranged from nearly $12 billion to over $28 billion over the 1997 to 2002 time period. Numbers this large, even when expressed in millions of dollars, become difficult to read unless they are written with commas separating every third digit. Let's format our sales numbers so that they are easier to read.

Select the range of sales numbers (A5:F5) and choose F**o**rmat C**e**lls from the menus and then click on the Number tab. You are presented with the Number Format dialog box which contains a list of formatting categories. For now, select Number from the category list. This will give you the option to choose the number of decimal places displayed, choose whether or not to use a 1000 separator, and select the format of negative numbers. We want to display the sales numbers with commas separating every third digit and two decimal places, so change the decimal places to 2 and check the box to add a 1000 separator.[4] Click on the OK button and notice that the numbers are now displayed in this more readable format.

At this point, we have made several formatting changes to the Microsoft Sales worksheet. Your worksheet should look like the one in Exhibit 1-2. All of this formatting may seem tedious at the moment, but it will quickly become easy as you become more familiar with the menus. Furthermore, the payoff in readability will be worth far more than the few seconds spent in formatting the worksheet.

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4. Note that in the United States we use a comma as a 1000 separator. In many other countries a decimal point is used instead. Excel determines which to use based on the settings in the Control Panel's regional and language settings utility.

EXHIBIT 1-2
ORIGINAL WORKSHEET REFORMATTED

	A	B	C	D	E	F
1	**Microsoft Corporation Sales**					
2	**(Millions of Dollars)**					
3	**1997 to 2002**					
4	*2002*	*2001*	*2000*	*1999*	*1998*	*1997*
5	28,365.00	25,296.00	22,956.00	19,747.00	15,262.00	11,936.00

Borders and Shading

Text formatting is not the only design element that is available in Excel. We can also enliven worksheets by placing borders around cells and shading them. In your worksheet select A4:F4 (the years). From the menus choose F**o**rmat C**e**lls and then select the Border tab from the dialog box. There are 13 different line styles that can be applied, and you can change the color of the lines. Click on the thick solid line (fifth down on the right side) and then click on both of the top and bottom lines in the sample view. Click the OK button to see the change.

Next, with A4:F4 still selected, we will add shading. As before, choose F**o**rmat C**e**lls from the menus but this time select the Patterns tab. This tab allows you to set the background color and pattern of the cells. Click on the lightest gray color and then press the OK button. Now, to make the text more readable make it bold. Your worksheet should now look like the one in Exhibit 1-3.

EXHIBIT 1-3
THE WORKSHEET WITH BORDERS AND SHADING

	A	B	C	D	E	F
1	**Microsoft Corporation Sales**					
2	**(Millions of Dollars)**					
3	**1997 to 2002**					
4	***2002***	***2001***	***2000***	***1999***	***1998***	***1997***
5	28,365.00	25,296.00	22,956.00	19,747.00	15,262.00	11,936.00

Entering Formulas

So far, we haven't done anything that couldn't just as easily be done in any word-processing application. The real power of spreadsheets becomes obvious when formulas are used. Formulas will enable us to convert the data that we have entered into useful information.

At the moment, our sample worksheet contains only sales data for Microsoft. Suppose, however, that we are interested in performing a simple analysis of the profitability of Microsoft over the 1997 to 2002 time period. In this case we would also need to see the net income for each of the years under study. Let's make some modifications to the worksheet to make it more useful.

Add the data from Table 1-1 to the sample worksheet in cells A6:F6, immediately below the sales data, and apply the same format. Now, we have a couple of problems. The title of our worksheet, in cell A1, is no longer accurate. We are now putting together a profitability analysis, so we should change the title to reflect this change of focus. Select cell A1 (even though the title is centered across A1:F1, Excel still keeps the data in A1) by clicking on it. Notice that the text appears in the right-hand side of the formula bar. To edit the title, click on the formula bar just to the right of the word "Sales." Backspace over the word "Sales" and then type: `Profitability Analysis`, and press Enter to accept the change.

TABLE 1-1
MICROSOFT NET INCOME

Year	Net Income
2002	7,829.00
2001	7,346.40
2000	9,421.00
1999	7,785.00
1998	4,490.00
1997	3,454.00

Our only remaining problem is that the data in the table are not clearly identified. Ideally, we would like to have the data labeled in the column just to the left of the first data point. But, there is no column to the left of the data! There are several ways to overcome this problem. The easiest is to simply tell Excel to insert a

column to the left of column A. To accomplish this feat, select column A entirely by clicking on the column header where it has an "A." Notice that the whole column is highlighted (we can do this with rows as well). Now, from the menus, choose **I**nsert **C**olumns. The new column is magically inserted, and all of our data have been moved one column to the right. In cell A5 type: `Sales`, and in A6 type: `Net Income`.

If you are following the examples exactly, the words Net Income probably do not fit exactly into A6. Instead, part of the text is cut off so as not to overflow onto the data in B6. We can easily remedy this by changing the width of column A. Again select column A, and then choose F**o**rmat **C**olumn **W**idth . . . which will cause a dialog box to be displayed. In the edit box type: `20` and press the Enter key. Column A should now be wide enough to hold the text that we have added and will add later.

We can now proceed with our profitability analysis. Because of the dramatic growth in sales over the years, it isn't immediately clear from the data whether Microsoft's profitability has improved or not, even though net income has increased over this time. In this type of situation, it is generally preferable to look at net income as a percentage of sales (net profit margin) instead of dollar net income. Thankfully, we do not have to type in more data to do this. Instead, we can let Excel calculate these percentages for us. All we need to do is to enter the formulas.

Formulas in Excel are based upon cell addresses. To add two cells together, we simply tell Excel to take the contents of the first cell and add it to the contents of the second. The result of the formula will be placed in the cell in which the formula is entered. In our problem, we need to find net income as a percentage of sales. We will do this first for 2002.

Before entering our first formula, we should insert a label identifying the data. In cell A7 type: `Net Profit Margin`. Change the active cell to B7 where we want to place the result of the calculation. The problem that we want to solve is to take the number in cell B6 and divide it by the number in B5. In Excel, division is represented by the forward slash (/), so in B7 type: `=B6/B5`. *The equals sign must precede all formulas in Excel*, otherwise it will treat the formula as text and will not calculate the result. Press the Enter key to make Excel calculate the formula (you should get 0.2760 as the result).

In this example, we typed the formula directly into the cell because the small size of our worksheet made it easy to know what cells we wanted to use in the formula. In

many instances, this is not the case. In more complicated worksheets it is usually easier to use the "pointer mode" to enter formulas. In pointer mode, we use the mouse to point to the cells that we want included, and Excel inserts them into the formula. Move to C7 and we will enter the formula using the pointer mode. First, type = which places Excel in edit mode. Now, instead of typing C6, click on C6 with the mouse. Notice that C6 appears in the formula bar to the right of the equals sign. Press the forward slash key to indicate division and then click on C5. In the formula bar you should see the formula "=C6/C5." Press the Enter key to calculate the result of the formula (you should get 0.2904 as the result).

Let's change the format of these cells so that they are easier to read. In this case, it would be nice to see them in percentage format with two decimal places. First, highlight cells B7:C7. Choose F**o**rmat C**e**lls and click on the Number tab. From the Category list click on Percentage and then set the **D**ecimal places to 2. Press the Enter key or click the OK button. You could also apply this format by using the Percent Style button on the Formatting Toolbar. To get two decimal places, you need to click the Increase Decimal button on the same Toolbar. Figure 1-8 shows these and other formatting icons.

FIGURE 1-8
FORMATTING ICONS

Copying and Moving Formulas

We have now calculated the net profit margin for 2002 and 2001, but that still leaves four years for which we need to enter formulas. Repeatedly typing essentially the same formula can get tedious. Fortunately, we can simply copy the formula, and Excel will update the cell addresses to maintain the same relative relationships. For example, we know that for 2000 the formula should read "=D6/D5." If we copy the formula from C7 to D7, Excel will change the formula from "=C6/C5" to "=D6/D5," automatically.

This works because Excel treats all cell references as relative. When you typed the formula in cell B7 (=B6/B5) Excel read that as "take the contents of the cell that is one row above the current cell and divide that by the contents of the cell that is two

rows above the current cell." When copying formulas, Excel maintains the same relative cell relationships so that the formulas are updated. When we copy to the left or right, Excel updates the columns in the formulas. When we copy up or down, Excel changes the rows.

Rather than retyping the formula for our other cells, let's simply copy from C7. First, select C7 and then choose **E**dit **C**opy from the menus. Now highlight cells D7:G7 and choose **E**dit **P**aste from the menus. At this point, your worksheet should closely resemble the one in Exhibit 1-4.

EXHIBIT 1-4
A PROFITABILITY ANALYSIS FOR MICROSOFT

	A	B	C	D	E	F	G
1		**Microsoft Corporation Profitability Analysis**					
2		**(Millions of Dollars)**					
3		**1997 to 2002**					
4		***2002***	***2001***	***2000***	***1999***	***1998***	***1997***
5	Sales	28,365.00	25,296.00	22,956.00	19,747.00	15,262.00	11,936.00
6	Net Income	7,829.00	7,346.40	9,421.00	7,785.00	4,490.00	3,454.00
7	Net Profit Margin	27.60%	29.04%	41.04%	39.42%	29.42%	28.94%

We can see from Exhibit 1-4 that Microsoft's net profit margin increased from 1997 to 2000, but has been declining since. The declining profit margins in the past two years are roughly aligned with the economic recession and the beginning of the bear market in 2000, but they are still quite high compared to many other company's margins.

In addition to copying formulas (which maintains the relative cell references) they can also be moved. Moving a formula to a different cell has no effect on the cell references. For example, we could move the formula in B7 (=B6/B5) to B8. To do this, select B7 and then choose **E**dit **C**ut from the menus. Next, select B8 and choose **E**dit **P**aste from the menus. Notice that the result in B8 is exactly the same as before. Furthermore, the formula is unchanged.

Formulas (or anything else) may also be moved with the mouse. Simply select the cells containing the data that you want to move, position the mouse pointer at the edge of the cell so that it changes to an arrow, and then click the left mouse button and drag the cell to its new location. Now move the formula back to B7. Highlight

B8 and drag it back to B7. Or, select B8 and choose **E**dit **C**ut, select B7 and choose **E**dit **P**aste. The worksheet should again resemble the one pictured in Exhibit 1-4.

Mathematical Operators

Aside from division, which we have already seen, there are four additional primary mathematical operations: addition, subtraction, multiplication, and exponentiation. All of these operations are available in Excel and can be used as easily as division. Table 1-2 summarizes the five basic operations and the result that you should get from entering the example formula into cell B8.

TABLE 1-2
MATHEMATICAL OPERATIONS

Operation	Key	Example	Result in B8
Addition	+	=B5+B6	36,194
Subtraction	–	=B5–B6	20,536
Multiplication	*	=B5*B7	7,829
Division	/	=B6/B7	28,365
Exponentiation	^	=15^2	225

Parentheses and the Order of Operations

Using the mathematical operators provided by Excel is straightforward in most instances. However, there are times when it gets a bit complicated. For example, let's calculate the rates of growth of Microsoft's sales and net income. To calculate the growth rates we will usually want the compound annual growth rate (geometric mean growth rate) rather than the arithmetic average growth rate. The general equation for the geometric mean growth rate is:

$$\overline{G} = \sqrt[(N-1)]{\frac{X_N}{X_1}} - 1 = \left(\frac{X_N}{X_1}\right)^{\frac{1}{(N-1)}} - 1 \qquad \textbf{(1-1)}$$

where $\overline{G}$ is the geometric mean, N is the count of the numbers in the series, X_1 is the first number in the series (1997 sales in our example), and X_N is the last number in the series (2002 sales).

Translating this equation into Excel is not as simple as it may at first appear. To do this correctly requires knowledge of operator precedence. In other words, Excel doesn't necessarily evaluate equations from left to right. Instead, some operations are performed before others. Exponentiation is usually performed first. Multiplication and division are usually performed next, but they are considered equal in precedence so any multiplication and division are evaluated from left to right. Finally addition and subtraction are evaluated, and they are also considered equal in precedence to each other.

We can modify the order of precedence by using parentheses. Operations enclosed in parentheses are always evaluated first. As a simple example, how would you evaluate the following expression?

$$X = 2 + 4 / 3$$

Is X equal to 2 or 3.33? Algebraically, X is equal to 3.33 because the division should be performed before the addition (as Excel would do). If the answer we were seeking was 2, we could rewrite the expression using parentheses to clarify:

$$X = (2 + 4) / 3$$

The parentheses clearly indicate that the addition should be performed first, so the answer is 2.

To calculate the compound annual growth rate of sales, move to cell A8 and type: `Sales Growth`. Now, enter the following into B8: `=(B5/G5)^(1/5)-1`. Pressing the Enter key will reveal that the growth rate of sales for the five-year period was 18.90% per year (you may have to reformat the cell to display as a percentage with two decimal places). To determine the average growth rate of net income, type: `Net Income Growth` into A9, and then copy the formula from B8 to B9. You should find that the compound annual rate of growth of net income has been 17.78% per year and that the formula in B9 is: `=(B6/G6)^(1/5)-1`.

Using Excel's Built-In Functions

We could build some pretty impressive worksheets with the techniques that we have examined so far. But why should we have to build all of our formulas from scratch, especially when some of them can be quite complex and therefore error-prone? Excel comes with hundreds of built-in functions, more than 50 of them are

financial functions. These functions are ready to go; all they need is for you to supply cell references as inputs. We will be demonstrating the use of many of these functions throughout the book, but for now let's redo our growth rate calculations using the built-in functions.

Since we want to know the compound annual rate of growth, we can use Excel's built-in **GEOMEAN** function.[5] To use this function the syntax is:

=GEOMEAN(*NUMBER1*, *NUMBER2*, . . .)

The **GEOMEAN** function takes up to 30 cell addresses separated by commas. As is usual in Excel, we can also supply a range of cells rather than specifying the cells individually. Remember, we want to find the geometric mean *rate of growth* of sales, not the geometric mean of the dollar amount of sales. Since the **GEOMEAN** function simply finds the N*th* root of the product of the inputs, we need to redefine our inputs (we used sales in our custom-built formula). Let's add a row of percentage changes in sales to our worksheet.

Move to A10 and enter the label: `% Change in Sales`, then move to B10 and enter the formula: `=B5/C5-1`. The result in B10 should be 0.1213, indicating that sales grew by 12.13% from 2001 to 2002. Now copy the formula from B10 to each cell in the C10:F10 range. Note that we don't copy the formula into G10 because that would cause an error since H10 doesn't contain any data (try it, and you will see #DIV/0! in G10, meaning that your formula tried to divide by zero).

Now, to calculate the compound annual rate of sales growth we need to enter the **GEOMEAN** function into B11: `=geomean(B10:F10)`. Since our data points are in one contiguous range, we chose to specify the range rather than each individual cell. Let's also supply a label so that when we come back later we can recall what this cell represents. Move to A11 and enter: `Sales Growth`.

Have you noticed any problems with the result of the **GEOMEAN** function? The result was 17.51%, rather than the 18.90% which we got when using our custom formula. Either our custom formula is incorrect, or we have misused the **GEOMEAN** function. Actually, this type of error is common, and easily overlooked. What has happened is that when using the **GEOMEAN** function, we didn't fully understand what goes on behind the scenes. Remember that **GEOMEAN** simply

5. We could calculate the arithmetic mean using the **AVERAGE** function, but this would ignore the compounding and overstate the true average growth rate. This function is defined as =**AVERAGE**(***NUMBER1***, *NUMBER2*, . . .)

takes the N*th* root of the product of the numbers. When multiplying numbers that are less than one, the result is even smaller, not larger as is the case with numbers greater than one. What we should have done is taken the geometric mean of the relative changes (i.e., one plus the percentage change).

To correct the error, replace the formula in B10 with: `=B5/C5` and copy it to the other cells. Now replace the formula in B11 with: `=geomean(B10:F10)-1`. The result is 18.90%, exactly the same as our previous result. To avoid errors like this one, you absolutely must understand what the built-in formula is doing. *Never blindly accept results just because Excel has calculated them for you*. There is an old saying in computer science: "garbage in, garbage out."

At this point, your worksheet should closely resemble the one pictured in Exhibit 1-5.

EXHIBIT 1-5
ANALYSIS OF MICROSOFT'S GROWTH RATES

	A	B	C	D	E	F	G
1		Microsoft Corporation Profitability Analysis					
2		(Millions of Dollars)					
3		1997 to 2002					
4		*2002*	*2001*	*2000*	*1999*	*1998*	*1997*
5	Sales	28,365.00	25,296.00	22,956.00	19,747.00	15,262.00	11,936.00
6	Net Income	7,829.00	7,346.40	9,421.00	7,785.00	4,490.00	3,454.00
7	Net Profit Margin	27.60%	29.04%	41.04%	39.42%	29.42%	28.94%
8	Sales Growth	18.90%					
9	Net Income Growth	17.78%					
10	% Change in Sales	1.1213	1.1019	1.1625	1.2939	1.2787	
11	Sales Growth	18.90%					

Using the Insert Function Dialog Box

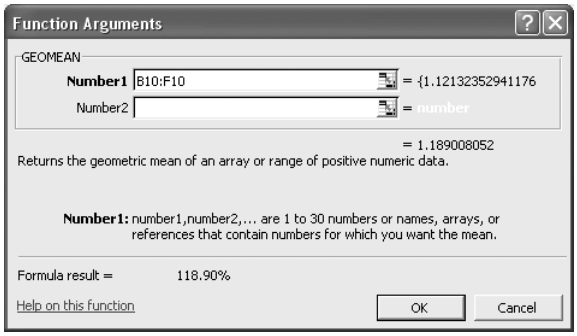
With the hundreds of built-in functions that are available in Excel, it can be difficult to remember the name of the one you want to use, or the order of the parameters, etc. To help you with this problem, Excel provides the Insert Function dialog box, a series of dialog boxes that guide you through the process of selecting and entering a built-in formula.

Let's use Insert Function to insert the **GEOMEAN** function into B11. First, Select cell B11 and then clear the current formula by choosing **E**dit Cle**a**r All from the

menus (or, press the Delete key on the keyboard). Find the Insert Function button (pictured at left) on the Formula Bar. Click this button to bring up the first Insert Function dialog box.

In the first dialog box click on Statistical in the "select a **c**ategory" list. The "Select a functio**n**" list will now contain all of the built-in statistical functions. Scroll down this list and click on **GEOMEAN**. Notice that there is a definition of the function at the bottom of the dialog box. Click on the OK button to change to the next dialog box, which is pictured in Exhibit 1-6.[6]

EXHIBIT 1-6
THE EXCEL 2002 INSERT FUNCTION DIALOG BOX



In the second dialog box you will see prompts and definitions for each of the inputs to the selected function. In this case, we want to click and drag the mouse over the B10:F10 range. This range will appear in the "Number 1" edit box. Click on the OK button to have the function entered. Notice that the result is 1.1890, not the 0.1890 that we expected. We need to subtract 1 from the result of the function, so click in the Formula Bar and type `-1` after the **GEOMEAN** function and then press Enter. The formula in B11 should be: `=Geomean(B10:F10)-1`.

Insert Function is an easy way to discover new functions and to use familiar ones. Using it will make Excel much easier for you to learn.

6. Note that this dialog box is frequently in the way of your work. You may click and drag any portion of the dialog box to move it out of the way.

Using Macro Functions

There are times when you need to calculate a complex function and Excel doesn't have a built-in function that will do the job. In this case you can either type the formula into a cell (which can be very tedious) or use a macro function. A *macro function* is similar to a built-in function, except that it was created by somebody other than the Excel development team at Microsoft. Macro functions can be purchased, downloaded from online services or the Internet, or you can create your own. Writing macro functions in Excel's macro language (Visual Basic for Applications) is beyond the scope of this chapter, but we have included several functions in the Famefnc.xls file which is on the disk that was supplied with this book. These functions will be used occasionally throughout the book.

Using a macro function is almost exactly the same as using a built-in function. The only difference is that the file containing the functions must be opened in order for the functions to be known to Excel. You can even use the Insert Function dialog box with macro functions (select the User Defined function category).

As an example of the use of macro functions, we have created a macro to calculate the geometric mean rate of growth of sales. The macro is defined as:[7]

FAME_GEOMEAN(*SALES*)

FAME_GEOMEAN is the name of the function, and ***SALES*** is the required range of cells that contain the sales figures. Before using the function you must open the file Famefncs.xls. (Note that this file only needs to be opened; you will not need to do anything with it.) Once the file is opened, switch back to your original worksheet by choosing **W**indow from the menus and then selecting the workbook from the bottom of the menu.

Now, in your original worksheet, select cell B12 and then bring up the Insert Function dialog box. From the "select a **c**ategory" list choose User Defined to display a list of the functions that were supplied with this book. In the "Select a functio**n**" list select the macro named **FAME_GEOMEAN** and then click the OK button. In the edit box for Dollar Values enter `B5:G5` which is the range that contains Microsoft's sales. Click on the OK button and see that the answer is exactly the same as before. The function in B12 is: `=famefnc.xls!FAME_Geomean(B5:G5)`. The part of the function that reads

7. This function was written specifically for this data. Do not attempt to use it in any other applications as it may return erroneous results.

"famefnc.xls!" simply tells Excel that the function is located in a workbook named famefnc.xls.

Creating Graphics

In our simple profitability analysis it is obvious that Microsoft's profit margins have been growing at a slower rate in the last two years. Many times, you will build much more complicated worksheets where the key trends are not so easy to spot; especially for others who didn't build the worksheet. You may also find that you need to give a presentation, perhaps to a group of investors to convince them to invest in your firm. In cases such as these, tables full of numbers may actually obscure your point. People (and students too!) tend to get a glazed look in their eyes when examining tables of numbers. The solution to this problem is to present a chart of the numbers to illustrate your point. Fortunately, high-quality graphics are a snap with Excel.

There are two ways that charts can be created in Excel: in separate chart sheets, or embedded in the worksheet. We will cover each of these methods in turn.

Creating Charts in a Chart Sheet

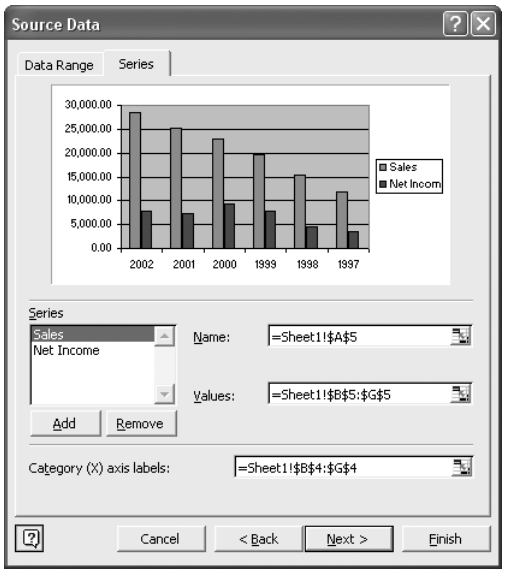
Before the advent of graphical user interfaces (GUIs), worksheets and graphics were separate entities. The original Lotus 1-2-3 actually used a separate program to create charts of worksheet data. Today, charts are usually created within the main program. In Excel, we can create a chart separate from the worksheet by selecting the data and inserting a new chart sheet. Excel will then help you to create the chart with the Chart Wizard. Let's try creating a graph of Sales versus Net Income for Microsoft.

First select the data in the A5:G6 range and then right-click the tab for the current worksheet (which is probably labeled "Sheet 1"). From the menu that appears, choose **I**nsert. You will now be presented with a list of different file types from which to select. Since we want to create a chart, select Chart from the list and press Enter or click OK.

The Chart Wizard will guide you through the process of creating the chart. The first dialog box asks you to choose the type of chart. In this case, a column chart probably best suits the data, so choose the Column type by double-clicking on it. The second dialog box asks for your data range; if you have selected A5:G6 the

range will already be in the edit box. Note that the example of the chart shows that the X-axis is labeled with the numbers 1 through 6. Since it would be better to have the years on the X-axis, we need to specify the location of the X-axis labels. Click the Series tab and enter the range into the edit box labeled "Category (X) axis labels." Note that you have to be very specific if you choose to type in the date range. You must type the range in the form: `=Sheet1!B4:G4`.[8] Alternatively, you can simply click in the edit box and then select the range. You'll see that the axis is now correctly labeled.

FIGURE 1-9
THE SOURCE DATA DIALOG BOX OF THE CHART WIZARD

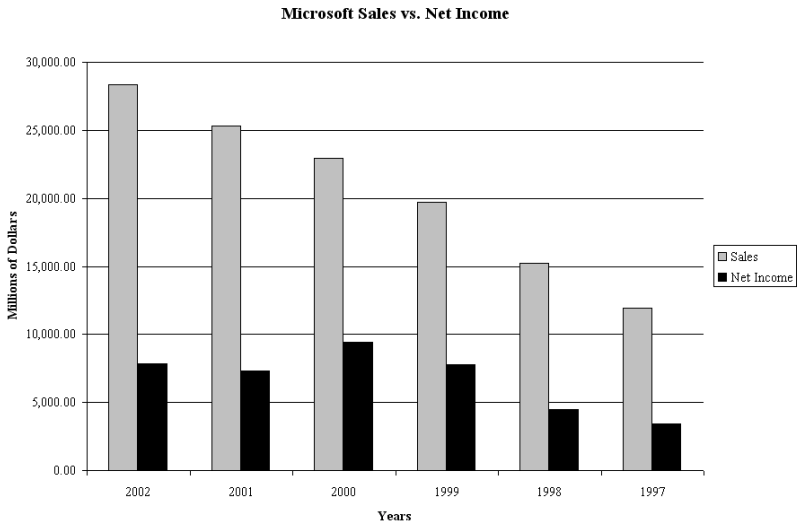


Click the Next button and you are asked to enter a chart title and titles for the axes. For the chart title enter: `Microsoft Sales vs. Net Income`. For the X-axis enter: `Years`. For the Y-axis enter: `Millions of Dollars`.

Press the Finish button, and Excel will open a new chart sheet with a chart resembling that in Exhibit 1-7.

8. Simply typing B4:G4 will not work. Excel will interpret this as the label for the first data point. Therefore, you must include the name of the worksheet in the range.

EXHIBIT 1-7
A STAND-ALONE CHART



Creating Embedded Charts

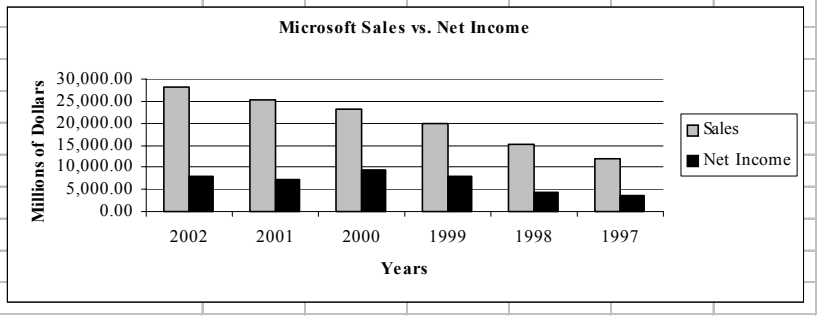
You may want to create a chart that will be saved and displayed within the worksheet itself. Such a chart is referred to as an "embedded chart" because it appears within the worksheet. Unlike a separate chart sheet, embedded charts can be displayed and printed on the same page as the worksheet data. Furthermore, embedded charts don't require any extra steps to display them. Once created, embedded charts are always opened and closed along with the worksheet automatically. If necessary, embedded charts can be saved and printed separately from the worksheet.

To create an embedded chart, first switch to Sheet 1. Now select the data as before, click on the Chart Wizard button (on the Toolbar; see icon in margin), and follow the prompts exactly as you did to create the stand-alone chart. The chart will appear in the middle of your worksheet. To resize the chart, click and drag any of the selection boxes on its perimeter. To move the chart, click on a blank area inside the chart and drag it to wherever you want it to be. Your worksheet should now resemble the one in Exhibit 1-8, except for some minor formatting changes.

Note that you can change your embedded chart into a separate chart sheet and vice versa. There is no need to invoke the Chart Wizard. Just right-click in the chart and choose **L**ocation from the shortcut menu. You can even move your chart to a different worksheet in this way.

EXHIBIT 1-8
A WORKSHEET WITH AN EMBEDDED CHART

	A	B	C	D	E	F	G
1		**Microsoft Corporation Profitability Analysis**					
2		**(Millions of Dollars)**					
3		**1997 to 2002**					
4		***2002***	***2001***	***2000***	***1999***	***1998***	***1997***
5	Sales	28,365.00	25,296.00	22,956.00	19,747.00	15,262.00	11,936.00
6	Net Income	7,829.00	7,346.40	9,421.00	7,785.00	4,490.00	3,454.00
7	Net Profit Margin	27.60%	29.04%	41.04%	39.42%	29.42%	28.94%
8	Sales Growth	18.90%					
9	Net Income Growth	17.78%					
10	% Change in Sales	1.1213	1.1019	1.1625	1.2939	1.2787	
11	Sales Growth	18.90%					
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							



Formatting Charts

We have now created a basic chart of Sales versus Net Income, but it probably isn't quite what you expected. First of all, we normally expect that the most recent data in a chart is at the right side and the oldest at the left. Because we have created our worksheet data in the opposite direction, our chart is backward and a quick glance might suggest that sales and profits have been declining.

In Excel, every element of a chart is treated as a separate "object." This means that each element can be selected and edited separately from the other elements. In addition, these chart objects are somewhat intelligent. They "know" what actions can be performed on them, and will present a menu of these actions if you click on them with the right mouse button. The major objects in any chart include each data series, the plot area, the gridlines, the axes, the axis titles, the chart title, and any other text strings entered into the chart. To select an object, all you need to do is to click on it with the left mouse button. Once the object is selected, it will be redisplayed with small squares (selection boxes) surrounding it. With this knowledge, let's edit our chart.

First, we want to turn the x-axis around so that the data are presented in the order that we normally expect. Click on the x-axis (or axis labels) with the right mouse button to cause the shortcut menu to appear. You will know that the x-axis is selected when you see a small square at both ends of the axis. The shortcut menu will be different depending on which graphic object you click on, so it is important to click directly on the x-axis.

Once the menu appears, choose F**o**rmat Axis and then click on the Scale tab. From the resulting dialog box select "Categories in **r**everse order" and press Enter. Notice that the x-axis has reversed, but the y-axis is now on the right side of the chart. That doesn't look right, so go back to the scale tab and click on "Value (Y) axis crosses at **m**aximum category." We could have checked both of these boxes at the same time.

If you did not add the titles in the Chart Wizard, adding a title and axis labels to our chart simply requires a menu choice and a little typing. To add a chart title, select **C**hart Chart Opt**i**ons from the menus and then enter the titles in the appropriate edit boxes. You can also access the Chart Options dialog box by right-clicking in a blank area of the chart and choosing Chart Opt**i**ons from the shortcut menu. You can now edit the titles directly in the chart by selecting them, or you can return to the Chart Options dialog box.

Suppose, for example, that we wanted to change the title so that it mentions the years that are covered by the data. Simply click on the title to select it, then click at the end of the title. You could begin typing immediately, but we want to put the new text on a second line. Press enter to begin a new line, then type: `1997 to 2002` and press the Esc key or click anywhere else on the chart.

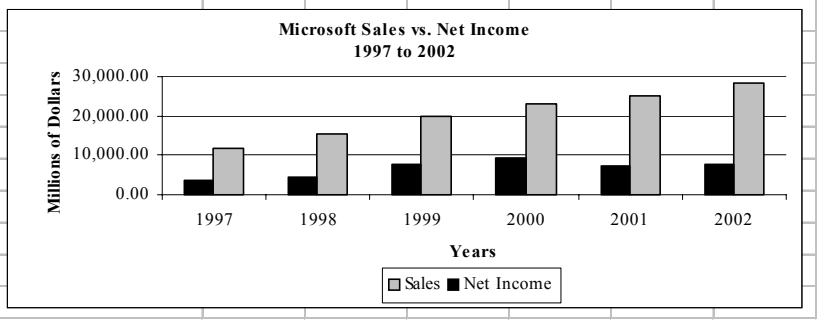
Next, let's move the legend to the bottom of the chart to see if it looks better there. Click on the legend with the right mouse button and choose F**o**rmat Legend from

the shortcut menu. Now, select the Placement tab and select **B**ottom from the choices. Press the Enter key to return to the chart. Now the plot area of the chart looks squashed. To fix this, click in the plot area to select it and drag the selection boxes until the plot area is the proper size.

To return to editing the worksheet, click anywhere in the worksheet. Your worksheet should now resemble the one in Exhibit 1-9.

EXHIBIT 1-9
WORKSHEET WITH REFORMATTED CHART

	A	B	C	D	E	F	G
1		**Microsoft Corporation Profitability Analysis**					
2		**(Millions of Dollars)**					
3		**1997 to 2002**					
4		***2002***	***2001***	***2000***	***1999***	***1998***	***1997***
5	Sales	28,365.00	25,296.00	22,956.00	19,747.00	15,262.00	11,936.00
6	Net Income	7,829.00	7,346.40	9,421.00	7,785.00	4,490.00	3,454.00
7	Net Profit Margin	27.60%	29.04%	41.04%	39.42%	29.42%	28.94%
8	Sales Growth	18.90%					
9	Net Income Growth	17.78%					
10	% Change in Sales	1.1213	1.1019	1.1625	1.2939	1.2787	
11	Sales Growth	18.90%					
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							



Changing the Chart Type

Excel offers many different types of charts, everything from the bar chart that we have created to 3-dimensional bar charts and radar plots. Some of these chart types are very sophisticated, even allowing you to rotate them to see a different view of the data.[9] Despite these potential complexities, changing the chart type is very straightforward.

Let's assume that we would prefer to see the data in our chart presented as two lines, rather than as columns. To make this change right-click on a blank area around the outside edge of the chart and choose Chart **T**ype from the menu. Select a type of line chart and click on the OK button. The chart is now displayed as a line chart. You can even change the individual data series chart type. For example, you might want to see Sales as a column chart and Net Income as a line on the same chart. Give it a try. Simply right-click on the Net Income data series and change the chart type to a line. To try other types of charts be sure to select the Custom tab of the Chart Wizard.

You can also change other formatting in the chart very easily. For example, to change the color of the bars for Sales, simply right-click on one of the data points and choose F**o**rmat Data Series. On the Patterns tab you can choose a different color and it will be applied to each of the bars for that data series. You can also change the border around the bars and add a shadow for a three dimensional effect.

Printing

There are many times when a worksheet displayed on screen accomplishes all that you need. Other times there is no escaping the need for a hard copy. Excel makes printing a worksheet both easy and flexible. For small worksheets, all that need be done is to choose **F**ile **P**rint from the menus and let Excel worry about the details. Larger printing tasks are only slightly more complex.

Suppose that our profitability analysis of Microsoft needs to be printed so that it can be distributed at a meeting. As a first step, we need to decide if we want to print the entire worksheet, or only a portion of it. In this case, let's assume that we wish to

9. You can learn about the types of charts that Excel can create, complete with examples, at http://office.microsoft.com/assistance/2002/articles/ExamplesofChartTypes.aspx.

print the whole worksheet, except that we want to print the graph on a separate page so that it can more easily be converted to an overhead transparency.

Because we wish to print the numbers and chart separately, we need to tell Excel the range of cells that we want printed. Select the range A1:G11 and then choose **F**ile Prin**t** Area **S**et Print Area from the menus. Notice that a light gray dashed line now surrounds the range that we have selected for printing. Before actually printing a worksheet, it is good practice to preview the output to make sure that it looks exactly as we want. This practice will save both time and paper. From the **F**ile menu select Print Pre**v**iew. Excel will now display, on the screen, a likeness of the actual printed page.

If you have followed the examples to this point, you might, depending on the type of printer you are using and the font size, notice that our worksheet is too wide to fit on one page. Since we would ideally like to fit the whole worksheet on one page, we have some adjustments to make. Essentially we have two options: either change the page orientation to print sideways (i.e., landscape mode) or have Excel reduce the printout to fit on one page. Each of these methods is equally viable, but let's go for the reduction to one page.

From the Print Preview mode, we can press the **S**etup button to change various options for printing. Clicking on Setup brings up the Page Setup dialog box. This dialog box may also be reached from outside of Print Preview by choosing Page Se**t**up from the **F**ile menu. There are many options available in this dialog box, but the Scaling options are what we want now. Click on the Page tab and then select **F**it to: __ pages wide by __ tall, and enter a `1` in both boxes. We also don't want the gridlines to print. Click on the Sheet tab and make sure that the Cell **G**ridlines option is deselected (no x in the box.) Press the Enter key to return to Print Preview. Before actually printing the worksheet, it is a good idea to zoom in and check more closely that it looks as we want. To zoom in, simply click on the page. Your view will now be enlarged for closer inspection.

At this point, everything should be ready for printing, so click on the "Print…" button. Excel now returns to the normal view and presents you with the print dialog box. Because we want to print the whole range that we have selected, make sure your printer is ready (turned on, has paper, etc.) and click on the OK button. Your page should look nearly identical to the on-screen version.

To print the chart on a separate page, we first need to click on it so that it is selected. Now, to print the chart simply select **F**ile **P**rint then from the print dialog box click

on the OK button. Presto! The chart prints out on its own page. Of course, you can use Print Preview and Page Setup for charts just as we did for the worksheet.

What if you wanted to print the chart on the same page as the worksheet? Simple, just select the entire range that you want to print, including the chart. Now repeat the steps from above, and the worksheet and chart will print on the same page. An easier alternative is to select the range to print, choose File Print, and make sure that Selection is selected in the Print What section of the print dialog box. Now, click on the OK button.

Saving and Opening Files

Now that we have created a worksheet, you should save it so that it will be available at a later time. To save this file, choose File Save As… from the menus. This will cause a dialog box to be displayed which allows you to supply a name for the file and the location where you would like it stored. For example, to save the file as MSOFT.XLS on a floppy disk in the A: drive, you would change the Save in directory to "3½ Floppy (A:)" drive and type: `msoft.xls` in the File Name edit box.

After saving a file, you can open it at any time by choosing File Open… from the menus. This will cause a dialog box to be displayed from which you may select the file. Once a file has been named and saved the first time, you may save further changes by choosing File Save.

Saving Worksheets for the Internet

In addition to saving worksheets in Excel's native file format, you can also save files as a Web page for the Internet in HTML format. Even better, the HTML file can be reopened and edited in Excel 2002 without losing any formatting. To save a file in HTML format, choose File Save as Web Page. In the dialog box you simply give the page a name and select the location. Click the OK button and you've created a Web version of your worksheet. Note that the dialog box also allows you to enter a title for the page by clicking the Change Title button. This title will be displayed in your browser's title bar when the page is displayed.

Finally, you can also post the worksheet directly to your Web site by clicking the Publish button. On the Publish as Web Page dialog box, enter the address of your Web server (or FTP site) in the File name edit box. You can also add nearly

complete functionality to your page by checking the box labeled "**A**dd interactivity with:".

Using Excel with Other Applications

Suppose that you are writing a report on the profitability of Microsoft for the past six years. Chances are good that you are writing the report in one of the major word processing programs. Your word processor probably allows for the creation of tables that can display all of the information that you have created in Excel, but it lacks the computational sophistication and graphics power of Excel. Similarly, Excel lacks the text processing power that you need to write the report. Fortunately, it is very easy to harness the strengths of both programs and combine the results.

While some word processors will read Excel files directly from your disk, this is not usually the easiest way to incorporate spreadsheets into your wordprocessing files. Instead, it is usually easiest to use some variant of copy and paste, just like we've used within Excel itself. Every time you copy data from Excel, it goes to the clipboard. The contents of the clipboard are available to any other application that cares to access them. All you need to do is copy the data from within Excel, switch to the other application, and then choose **E**dit **P**aste from its menus.

Simply pasting the Excel data into a word processor usually results in the word processor reading the data and creating a table. While this may be all that you need, many times it would be more convenient if you could still edit the data in its native environment. In other words, it would be nice if you could still take advantage of Excel's built-in functions and recalculation ability. You can. Instead of using **E**dit **P**aste, use **E**dit Paste **S**pecial.

The Paste Special command allows much more freedom in how the data is stored inside the word processor. For example, if you choose to paste the data as an "Microsoft Excel Worksheet Object" you will be able to edit the data from within the word processor by simply double-clicking on it. The menus and toolbars of your word processor will change to those of Excel, and you can edit the data exactly as if you were in Excel. This process is known as Object Linking and Embedding (OLE).

Alternatively, you can link the data to your worksheet so that when you make changes in Excel, they are automatically reflected in your word processor. Finally,

you can paste a non-editable picture of your data into your document. Either of these last two methods will consume less memory than embedding the worksheet with the OLE technique.

Quitting Excel

To exit from Excel you can select **F**ile E**x**it from the menus, or double-click on the system menu box in the upper left corner of the Excel window. Note that if you attempt to exit Excel without saving your work, Excel will warn you and ask if you would like to save the file.

Summary

In this chapter we have discussed the basics of Microsoft Excel. You should have gained a basic understanding of such topics as entering text and numbers, entering formulas, formatting, graphics, and printing. In the chapters ahead, we will cover many of these topics in more depth. We will, at the same time, introduce you to financial analysis and how Excel can make this analysis easier and more productive. Along the way, we hope to help you develop the reasoning, critical thinking, and quantitative skills that are so necessary in the field of finance today.

TABLE 1-3
FUNCTIONS INTRODUCED IN THIS CHAPTER

Purpose	Function	Page
Calculate the geometric mean	**GEOMEAN(*NUMBER1*, *NUMBER2*,...)**	22
Calculate the arithmetic mean	**AVERAGE(*NUMBER1*, *NUMBER2*,...)**	22
An alternate way to calculate the geometric mean	**FAME_GEOMEAN(*SALES*)**	25

Problems

1. Suppose that in August 1997 you purchased shares in Staples, Inc. (NASDAQ: SPLS). It is now five years later and you decide to evaluate your holdings to see if you have done well with this investment. The table below shows the market prices of SPLS.

Staples, Inc. Stock Prices*	
Date	**Price**
August 1997	12.3125
1998	29.1250
1999	20.7500
2000	11.8125
2001	18.6875
2002	14.0625

* Prices rounded to nearest sixteenth.

   a. Enter the data, as shown, into a worksheet and format the prices to display as fractions in sixteenths.

   b. Create a formula to calculate your rate of return for each year.

   c. Create a line chart showing the stock price from August 1997 to August 2002. Make sure to title the chart and label the axes.

   d. Experiment with the formatting possibilities of the chart. For example, you might try changing the line to a three dimensional line and fill the plot area with a marble background.

2. In your position as research assistant to a portfolio manager, you need to analyze the profitability of the companies in the portfolio. Using the data for Bed Bath & Beyond, Inc., below:

Fiscal Year	2002	2001	2000	1999	1998
Sales	2,928.0	2,396.7	1,878.0	1,397.2	1,066.6
Net Income	219.6	171.9	131.2	97.3	73.1

   a. Calculate the net profit margin for each year.

   b. Calculate the average annual growth rates for sales and net income using the **GEOMEAN** function. Is net income growing more slowly or faster than sales? Is this a positive for your investment in the company?

   c. Calculate the average annual growth rate of sales using the **AVERAGE** function. Is this result more or less accurate than your result in the previous question? Why?

   d. Create a column chart of sales and net income. Be sure to change the chart so that the x-axis labels contain the year numbers, and format the axis so that 2002 is on the far right side of the axis.

3. Repeat Problem 2 using the data below for Lowe's Companies, Inc. However, this time you should create a copy of your worksheet to use as a template. Replace the data for Bed Bath & Beyond with that of Lowe's.

Fiscal Year	2002	2001	2000	1999	1998
Sales	22,111.1	18,778.6	15,905.6	12,244.9	10,136.9
Net Income	1,023.3	809.9	672.8	482.4	357.5

   a. Do you think that Lowe's can maintain the current growth rates of sales and net income over the long run? Why or why not?

   b. Which company was more profitable in 2002? Which was more profitable if you take a longer view? Would this affect your desire to invest in one company over the other?

Internet Exercise

1. Choose your own company and the repeat the analysis from Problem 3. You can get the data from MoneyCentral Investor at http://moneycentral.msn.com/investor/home.asp. To retrieve the data for your company, go to the Stocks area and enter the ticker symbol. Now choose Financial Results and then Statements from the menu on the left side of the screen. Display the annual income statement and copy the sales and net income data. Now enter the data into your template.

2 *The Basic Financial Statements*

After studying this chapter, you should be able to:

1. *Explain the purpose and understand the format of the firm's three basic financial statements: the income statement, the balance sheet, and the statement of cash flows.*
2. *Construct each of these statements in Excel with data for any company.*
3. *Link worksheets together so that formulas in one worksheet can reference data in another.*
4. *Use Excel's "Outline" tool to selectively display or hide parts of a financial statement.*

Much of financial analysis takes as its starting point the basic financial statements of the firm. It is therefore crucial that the analyst have a strong fundamental understanding of these statements. There are three basic financial statements:

1. The *income statement* summarizes the results of the firm's operations over a period of time. The income statement tells us the total revenues and expenses for the time period, and also contains several different measures of the accounting profits earned by the firm. Typically, income statements are prepared for different time periods, usually monthly, quarterly, and annually.

2. The *balance sheet* describes the assets, liabilities, and equity of the firm at a specific point in time. Assets are the (tangible or intangible) things that a firm owns. Liabilities are the firm's debts. Equity is the difference between what the firm owns and what it owes to others. Because the balance sheet is specific to a point in time, it is much like a photograph. What it shows was true when the snapshot was taken, but is not necessarily true when it is viewed.
3. The *statement of cash flows* outlines the sources of the firm's cash inflows and shows where the cash outflows went. Activities that bring cash into the firm are referred to as *sources* of cash, while those that take cash out of the firm are referred to as *uses* of cash.

In this chapter we will build each of these three statements for Elvis Products International, a small producer of Elvis paraphernalia. Each financial statement will be created in its own worksheet in the workbook, and we will create links between the sheets as necessary. Before beginning, open a new workbook.

The Income Statement

The income statement is a fairly simple document that begins by listing a firm's revenues (perhaps by sources or in total) followed by all of the firm's expenses. The result of the income statement is the net income for the period. Net income represents the accounting profit left over after all expenses have been paid from the revenue for the period.

Building an Income Statement in Excel

Exhibit 2-1 presents the income statement for Elvis Products International (EPI) for the year ending December 31, 2004. We will build this income statement first, and then use it as a base for creating the 2003 income statement.

EXHIBIT 2-1
EPI'S INCOME STATEMENT FOR 2004 AND 2003

	A	B	C
1	**Elvis Products International**		
2	**Income Statement**		
3	**For the Year Ended Dec. 31, 2004 ($ 000's)**		
4		***2004***	***2003***
5	Sales	3,850,000	3,432,000
6	Cost of Goods Sold	3,250,000	2,864,000
7	***Gross Profit***	***600,000***	***568,000***
8	Selling and G&A Expenses	330,300	240,000
9	Fixed Expenses	100,000	100,000
10	Depreciation Expense	20,000	18,900
11	***EBIT***	***149,700***	***209,100***
12	Interest Expense	76,000	62,500
13	***Earnings Before Taxes***	***73,700***	***146,600***
14	Taxes	29,480	58,640
15	***Net Income***	***44,220***	***87,960***
16			
17	Notes:		
18	Tax Rate	40%	

Principle 1:
Make Excel do as much of the work as possible. Whenever possible, a formula should be used rather than entering numbers. In the long run this will minimize errors.

Principle 2:
Format the worksheet so that it is easy to understand. Borders, shading, and font choices are more than just decorations. Properly chosen, they can make important numbers stand out and get the attention they deserve.

While we are building the income statement, we want to keep a couple of general principles in mind. Principle 1 says that we want to make Excel do as much of the work as possible. Any time a value can be calculated, we should use Excel to do so. The reasoning behind this principle is that we want to avoid mistakes and increase productivity. A little thought before beginning the design of a worksheet can help to minimize data entry errors, and increase productivity by reducing the amount of data that needs to be entered. Principle 2 says that we should format the worksheet in such a way as to make it easy to comprehend. There are many times that you will be creating a worksheet for others to use, or for your own use at a later date. Properly organizing the cells and judicious use of color and fonts can make the worksheet easier to use and modify.[1] Worksheets that are disorganized and sloppily formatted do not engender faith in their results.

It is usually helpful when working with multiple worksheets in a workbook for each sheet to be given a name other than the default. With the right mouse button, click

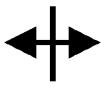
1. We would like to emphasize the word "judicious." Many people to whom fonts are a new idea end up producing documents with a definite ransom note appearance. Do yourself, and others, a favor by limiting your use of fonts to one or two per document.

on the sheet tab labeled "Sheet 1." From the menu choose Rename and then enter `Income Statement` when prompted for the new name of the sheet. This step is important because when we later begin referencing data on this sheet, the references require the name of the sheet.

We will begin building the income statement with the titles in A1:A3. Remember, if the need arises, we can always insert new rows or columns into the worksheet at a later time. In A1 type: `Elvis Products International`; in A2: `Income Statement`; in A3: `For the Year Ended Dec. 31, 2004`. The first line of the title identifies the company, the second identifies the type of statement, and the third identifies the time period that the statement covers. Now center the titles by selecting A1:C3, choose F**o**rmat C**e**lls, select the Alignment tab, and then select "Center Across Selection" under Horizontal. Note that Excel provides an icon on the formatting toolbar that is titled "Merge and Center" and accomplishes a similar alignment. However, in addition to centering the titles over the selected columns it also merges the cells into one. This creates a problem if we later decide to insert a new column. In general, you should never use the Merge and Center icon.

How to proceed from this point is largely a matter of preference. We could move line by line through the income statement, entering a label followed by the value. An alternative is to enter all of the labels and then all of the numbers. The second method is preferable at this point so that we may concentrate on the numbers. The labels are going to be stored in column A, and the numbers will be in column B. It is good practice to enter a label indicating the end of the period above the data, so move to B4 and type: `2004`.

Beginning in A5, enter the labels exactly as they appear in Exhibit 2-1. Once you have entered the labels, it is likely that you will find that some of these labels are too long to fit in only one cell. To remedy this problem, we need to change the width of column A. There are several ways to accomplish this in Excel. The slowest method is to select the whole column (click on the column header) choose F**o**rmat **C**olumn **W**idth and enter: `33.5` in the column width edit box. If you are using some font other than 12 point Times New Roman, you will have to experiment with different numbers to find the appropriate width for the column. Instead of entering a specific number for the column width, we can also let Excel determine the appropriate width. Select column A, and choose F**o**rmat **C**olumn **A**utofit Selection and Excel will automatically make the column wide enough to accommodate the longest text in the column.



As usual, there is an alternative for mouse users. If you slowly move the mouse pointer over the column headers, you will notice that the pointer changes its shape (to that pictured at left) as it passes over the boundary between columns. Press the

left mouse button while the pointer is over this boundary, and drag until the column is wide enough to accommodate the text. You can also double-click on the column boundary and Excel will set the column width to the best fit for the data. Each of these techniques can also be used to change the height of a row.

When entering data for large companies, it is often preferable to display the numbers in thousands or millions of dollars, rather than the full amount. For EPI, we will enter the numbers in full precision, and later display the numbers in millions to simplify the display. Move to B5 and enter: `3,850,000`.[2] Keeping principle 2 in mind, we would like the numbers to display with commas and two decimal places. Since each cell can maintain a number format, regardless of whether it contains any numbers, we will preformat the cells that we are going to use. Select cells B5:C15, choose F**o**rmat C**e**lls from the menus, click on the Number tab, and click the Number category. Now set the number of decimal places to `0` and make sure to click on **U**se 1000 Separator. When we enter numbers into these cells, they will automatically take on the format that we want.

Move to B6 and type: `3,250,000` for Cost of Goods Sold. This is the total cost of the products sold to customers, including inventory shrinkage and write downs for damaged or outdated products. Notice that, as promised, the number in B6 appears with commas.

Gross profit is the amount that is left over after paying for the goods that were sold. To calculate gross profit, we subtract cost of goods sold from sales. Again, we want Excel to make all of the calculations, so in B7 type: `=B5-B6`. Selling, General and Administrative (S,G&A) Expense is an input, so enter: `330,300` in B8. Fixed expenses (rent, salaries, etc.) for the period are an input so enter: `100,000` in B9. Depreciation is also an input in this case, so in B10 enter: `20,000`.

Earnings Before Interest and Taxes (EBIT) is gross profit less all remaining expenses other than interest and taxes. Any of several formulas could be used for this calculation, for example the obvious formula for EBIT in B11 is: `=B7-B8-B9-B10`. However, obvious formulas aren't always the best. We could simplify this equation somewhat by making use of the **SUM** function. The new function would be: `=B7-Sum(B8:10)`. **SUM** is a built-in Excel function which returns the summation of the arguments. **SUM** is defined as:

SUM(*NUMBER1*, *NUMBER2*, . . .)

2. There is no need for you to type the commas. We are showing them here for clarity. However, Excel will accept the numbers with commas if you wish to type them in.

where ***NUMBER1*** is the first number (or cell address), *NUMBER2* is the second, and so on. Excel will also accept ranges of numbers in place of any individual number. There are two advantages of using the **SUM** function in this case: (1) It is faster and more compact; and (2) The range will automatically expand if we insert a new row. The second advantage is the most important. If we add another category of expense by adding another row above row 9, for example, our formula would automatically incorporate the new row by changing to: B7 - Sum (B8:B11). If we used the original formula, we would have to remember to change it after adding the new row.

SUM is one of the more commonly used built-in functions, so common that Microsoft has included the AutoSum button (pictured at left) on the toolbar to automate the summation of rows or columns of numbers. To use the AutoSum button, simply select the cell where you want the formula to be placed and then click the button. Excel will make an intelligent guess about which cells you want included, and it is usually correct. If it guesses wrong, merely select the range that you wish to include and Excel will make the change. Note that the AutoSum button does not work when you are already in edit mode.

The AutoSum button has proved so popular that its functionality has been improved. If you click the little arrow to the right of the AutoSum button, it will drop down a list of alternative functions. Now you can more quickly use the **AVERAGE**, **COUNT**, **MAX**, or **MIN** functions just by choosing a function from the menu.

In B12 enter `76,000` for the interest expense. Next, we will calculate Earnings Before Taxes with the formula: `=B11-B12` in cell B13. EPI pays taxes at the rate of 40% on taxable income, so in B18 type `40%`. We will calculate the dollar amount of taxes in B14 with: `=B13*$B18`. Note that this lets us easily change the tax rate without having to edit formulas. Finally, *Net Income* is the profit earned by the firm after all revenues and expenses have been taken into account. To calculate net income, enter `=B13-B14` in cell B15.

As you can see, EPI's net income for the fiscal year 2004 was $44,220. However, for analysis purposes, we normally are not overly concerned with net income. Net income does not accurately represent the funds that a firm has available to spend. In the calculation of net income, we include depreciation expense (and/or other non-cash expenses such as depletion or amortization) which ostensibly accounts for the decline in the value of the long-term assets of the firm. Since nobody actually wrote a check for the depreciation expense, it should be added back to the net income number to give a better picture of the cash flow for the period. Cash flow is the number one concern for financial analysts.

To create EPI's income statement for 2003 doesn't take nearly as much work. First, select B5:B15 and copy the cells using **E**dit **C**opy or the Copy button on the Toolbar. Select C5 and choose **E**dit **P**aste. Now you have an exact copy of the 2004 income statement. Enter the numbers from Table 2-1 into the appropriate cells.

TABLE 2-1
EPI'S 2003 INCOME AND EXPENSES

Category	Value
Sales	3,432,000
Cost of Goods Sold	2,864,000
SG&A Expenses	240,000
Depreciation Expense	18,900
Interest Expense	62,500

Notice that you only had to enter the new numbers. The formulas are updated and recalculated automatically. So instead of entering 11 cells of formulas or numbers, you only had to enter five numbers. Your worksheet should now resemble the one in Exhibit 2-1.

The layout of the income statement that we have seen is the one normally used by analysts outside the firm. Those inside the firm will have more information and may find that Excel's Outline display will make the worksheet easier to understand and maintain. To learn about outlining, see page 61.

Custom Number Formatting

When the dollar amounts on a financial statement are in the millions or billions they can be a little confusing and hard to read. To make the numbers easier to read, we can display them in thousands of dollars using a custom number format. This is commonly done in annual reports, or any other report which lists large dollar amounts.

Select B5:C15 and choose F**o**rmat C**e**lls from the menus. On the Number tab, choose the Custom category. This will allow us to define our own number format. First we choose a predefined number format, here we will choose the "#,##0.00" format from the list. If we add a comma after the format, Excel will display the numbers as if they have been divided by 1,000. Two commas would display the number as if they had been divided by 1,000,000, and so on. In the **T**ype edit box add a single comma after the chosen format so that it looks like "#,##0.00,". Note

that Excel will show a sample of what your formatted numbers will look like. The numbers that you have entered will appear to have been divided by 1,000, but this affects only the appearance of the numbers. It is usually better to enter the full number and let Excel format it to look like you wish. The manner in which Excel displays numbers will not affect any calculations. Regardless of the format, Excel always stores numbers with full precision. The format merely changes what we see on the screen, not what is kept in memory. To see the full number, select the cell and look in the formula bar.[3]

Before continuing, edit cell A3 so that it says: `For the Year Ended Dec. 31, 2004 ($ 000's)`. This will allow anyone looking at your worksheet to instantly understand that the numbers are displayed in thousands. Your income statement should now look like the one in Exhibit 2-2.

EXHIBIT 2-2
THE INCOME STATEMENT WITH A CUSTOM NUMBER FORMAT

	A	B	C
1	**Elvis Products International**		
2	**Income Statement**		
3	**For the Year Ended Dec. 31, 2004 ($ 000's)**		
4		***2004***	***2003***
5	Sales	3,850.00	3,432.00
6	Cost of Goods Sold	3,250.00	2,864.00
7	***Gross Profit***	***600.00***	***568.00***
8	Selling and G&A Expenses	330.30	240.00
9	Fixed Expenses	100.00	100.00
10	Depreciation Expense	20.00	18.90
11	***EBIT***	***149.70***	***209.10***
12	Interest Expense	76.00	62.50
13	***Earnings Before Taxes***	***73.70***	***146.60***
14	Taxes	29.48	58.64
15	***Net Income***	***44.22***	***87.96***
16			
17	Notes:		
18	Tax Rate	40%	

3. Excel has pre-defined number formats to meet most needs. However, there are many situations that call for a custom format. To learn more about creating custom formats look for "Number format codes" in the online help.

Common-Size Income Statements

A common technique among financial analysts is to examine *common-size financial statements*. Common-size financial statements display the data not as dollar amounts, but as percentages. These statements provide the analyst with two key benefits:

1. They allow for easy comparisons between firms of different sizes.
2. They can aid in spotting important trends which otherwise might be not be obvious when looking at dollar amounts.

A common-size income statement is one which shows all of the data as a percentage of the firm's total revenues. Excel makes the building of common-size financial statements easy, as we'll see with the EPI data.

To begin, we need to make room for the common-size income statements. Select any cell in column B, or all of column B, by clicking on the column header. From the menus choose **I**nsert **C**olumns which will insert a new column to the left of the selected column. This new column will need to be resized so that it is approximately the same size as column C, which was formerly column B. Now, repeat this process with column D (the 2003 data). In B4 and D4 enter the labels: `2004%` and `2003%`, respectively.

We will start building our common-size income statements with the 2004 data. In B5 enter the formula: `=C5/C$5`.[4] The resulting display is likely to be nonsensical because the formatting will be the same as the cells in column C. So change the number format (F**o**rmat C**e**lls) to a Percentage format with `2` decimal places. You should now see that the result is 100.00%. Copy B5, select cells B6:B15, and then choose **E**dit **P**aste. You have now created a common-size income statement for 2004.

To create the common-size income statement for 2003, simply copy B5:B15 and then paste into D5. The resulting worksheet should appear like the one in Exhibit 2-3. You can easily see why this is a useful tool for analysts. By looking at row 8, you can

4. The $ in the formula will freeze the reference to a specific address. In this instance, C$5 will always refer to row 5, but the column reference will change if you copy the formula to the right or left. We could freeze only the column address with $C5. However, that would be counter-productive in this case. Here, we always want the divisor to be sales, but it should be the appropriate sales figure. Note that you can use the F4 key to cycle through all possible combinations (C5, $C5, C$5, $C$5).

instantly see that Selling and G&A expenses have risen quite sharply in 2004 relative to sales. Also, looking at row 15 instantly shows that the firm's net profit margin (see page 118) has decreased by half.

EXHIBIT 2-3
EPI'S COMMON-SIZE INCOME STATEMENTS

	A	B	C	D	E
1	**Elvis Products International**				
2	**Income Statement**				
3	**For the Year Ended Dec. 31, 2004 ($ 000's)**				
4		***2004%***	***2004***	***2003%***	***2003***
5	Sales	100.00%	3,850.00	100.00%	3,432.00
6	Cost of Goods Sold	84.42%	3,250.00	83.45%	2,864.00
7	***Gross Profit***	***15.58%***	***600.00***	***16.55%***	***568.00***
8	Selling and G&A Expenses	8.58%	330.30	6.99%	240.00
9	Fixed Expenses	2.60%	100.00	2.91%	100.00
10	Depreciation Expense	0.52%	20.00	0.55%	18.90
11	***EBIT***	***3.89%***	***149.70***	***6.09%***	***209.10***
12	Interest Expense	1.97%	76.00	1.82%	62.50
13	***Earnings Before Taxes***	***1.91%***	***73.70***	***4.27%***	***146.60***
14	Taxes	0.77%	29.48	1.71%	58.64
15	***Net Income***	***1.15%***	***44.22***	***2.56%***	***87.96***
16					
17	Notes:				
18	Tax Rate		40%		

Simplifying the Display with Custom Views

Now that we have created the common-size income statements, the worksheet is a bit cluttered, and potentially confusing. One way that we can clean things up is by using the *Custom Views* tool.

Excel's Custom Views tool allows us to have several different views of the worksheet without making multiple copies. In this case, we would like to have three views. The first will be the equivalent of the worksheet as it appears now. The other two will show just the common-size income statements and just the dollar income statements.

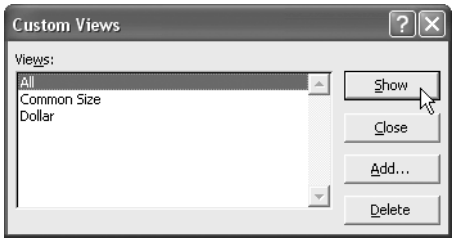
First select **V**iew Custom **V**iews from the menus. This will bring up the Custom Views dialog box which allows us to create or delete views and to switch between the views that we have defined. To create a new view click on the **A**dd . . . button.

In the resulting dialog box type: `ALL` as the name. This view will show the entire worksheet just like Exhibit 2-3.

To create a view of just the dollar income statements we must first arrange the worksheet so that it has the appearance that we need for this view. Click on the column headers for column B and D (when selecting column D, remember to hold down the Ctrl key) and then select F**o**rmat **C**olumn **H**ide. This will set the width of the column to 0 so that it doesn't display. Now define a view named `Dollar` using the same steps as were used to create the view ALL.

To create the third view, we first need to switch back to the ALL view. Choose **V**iew Custom **V**iews from the menus and then double-click on ALL. You should now see the whole worksheet again. Hide columns C and E and then create a view called `Common Size`.

FIGURE 2-1
THE CUSTOM VIEWS DIALOG BOX



You can now switch between these three views by simply calling up the Custom Views and selecting the view that you would like to display. As an example, if you display the Common Size view, your worksheet should appear like the one in Exhibit 2-4. If you display the Dollar view, it will look like the one in Exhibit 2-2, except that the data will be in different columns. This feature is also very useful for printing different views of a spreadsheet.

EXHIBIT 2-4
THE "COMMON-SIZE" VIEW OF EPI'S INCOME STATEMENTS

	A	B	D
1	**Elvis Products International**		
2	**Income Statement**		
3	**For the Year Ended Dec. 31, 2004 ($ 000's)**		
4		***2004%***	***2003%***
5	Sales	100.00%	100.00%
6	Cost of Goods Sold	84.42%	83.45%
7	***Gross Profit***	***15.58%***	***16.55%***
8	Selling and G&A Expenses	8.58%	6.99%
9	Fixed Expenses	2.60%	2.91%
10	Depreciation Expense	0.52%	0.55%
11	***EBIT***	***3.89%***	***6.09%***
12	Interest Expense	1.97%	1.82%
13	***Earnings Before Taxes***	***1.91%***	***4.27%***
14	Taxes	0.77%	1.71%
15	***Net Income***	***1.15%***	***2.56%***
16			
17	Notes:		
18	Tax Rate	40%	

The Balance Sheet

The balance sheet is usually depicted in two sections: the assets section at the top or left side, and the liabilities and owner's equity section at the bottom or right side. It is important to realize that the balance sheet must balance (thus the name). That is, total assets must equal the sum of total liabilities and total owner's equity. Each of these sections is usually further divided into subsections.

On the asset side, there are two subsections. The *current assets* section describes the value of the firm's short-term assets. Short-term, in this case, is defined as one year or the time it takes for the asset to go through one cash flow cycle (i.e., from purchase to sale to collection). Typical current assets are cash, accounts receivable, and inventories. *Fixed assets* are those assets with lives longer than one year. Examples of fixed assets include vehicles, property, buildings, etc.

Like assets, liabilities can be subdivided into two sections. *Current liabilities* are those liabilities that are expected to be retired within one year. Examples are items

such as accounts payable, wages payable, etc. *Long-term liabilities* are those that will not be paid off within the current year. Generally, long-term liabilities are made up of various types of bonds, bank loans, etc.

Owner's equity represents the difference between the value of the total assets and liabilities of the firm. This part of the balance sheet is subdivided into contributed capital and retained earnings. *Contributed capital* is the investment made by the common and preferred stockholders of the firm. *Retained earnings* is the accumulation of the undistributed profits of the firm.

Building a Balance Sheet in Excel

The process of building a balance sheet in Excel is very similar to building the income statement. We will build EPI's 2004 and 2003 balance sheets, as shown in Exhibit 2-5, for an example.

We will keep EPI's balance sheets in the same workbook, but on a different worksheet, as the income statement. Keeping related data in the same workbook allows for easy referencing. Using separate worksheets allows us to keep the worksheets uncluttered and makes it easier to design worksheets. Click on the "Sheet 2" tab with the right mouse button and select Rename . . . from the menu. Type `Balance Sheet` as the new name for this worksheet.

Enter the labels from Exhibit 2-5 into the blank worksheet. Notice that many of the labels in the balance sheet are indented. There are two ways to accomplish this effect. The method that we usually use, and are using here, is to first type the text into the cell and then click the "Increase Indent" button on the formatting toolbar (pictured at left).

The alternative is to insert the indented labels into column B instead of column A. This way, by controlling the width of column A, we can control the depth of the indentation. The labels in column A will simply overlap into column B as long as there is no text in the cell to the right.

EXHIBIT 2-5
EPI'S BALANCE SHEET

	A	B	C
1	**Elvis Products International**		
2	**Balance Sheet**		
3	**As of Dec. 31, 2004 (000's)**		
4	***Assets***	***2004***	***2003***
5	Cash and Equivalents	52,000	57,600
6	Accounts Receivable	402,000	351,200
7	Inventory	836,000	715,200
8	*Total Current Assets*	*1,290,000*	*1,124,000*
9	Plant & Equipment	527,000	491,000
10	Accumulated Depreciation	166,200	146,200
11	*Net Fixed Assets*	*360,800*	*344,800*
12	***Total Assets***	***1,650,800***	***1,468,800***
13	***Liabilities and Owner's Equity***		
14	Accounts Payable	175,200	145,600
15	Short-term Notes Payable	225,000	200,000
16	Other Current Liabilities	140,000	136,000
17	*Total Current Liabilities*	*540,200*	*481,600*
18	Long-term Debt	424,612	323,432
19	*Total Liabilities*	*964,812*	*805,032*
20	Common Stock	460,000	460,000
21	Retained Earnings	225,988	203,768
22	*Total Shareholder's Equity*	*685,988*	*663,768*
23	***Total Liabilities and Owner's Equity***	***1,650,800***	***1,468,800***

In EPI's balance sheet, nearly everything is a direct input so we won't discuss every cell. The italicized entries are formulas that we will discuss for 2004. The formulas for the 2003 balance sheet can be copied from the 2004 balance sheet. As with the income statement, you should enter the numbers as shown and then apply the custom format (see page 47) that we used earlier.

In the asset section, the first formula is for total current assets in B8. This is simply the sum of all of the current asset accounts, so the formula is: `=SUM(B5:B7)`. Next, we calculate EPI's net fixed assets. This is equal to plant and equipment less accumulated depreciation, so in B11 enter: `=B9-B10`. Finally, calculate total assets by adding the current assets and net fixed assets with the formula: `=B8+B11`.

The liabilities and owner's equity section is similar. We will calculate several subtotals and then a grand total in B23. Total current liabilities in B17 are calculated with: `=SUM(B14:B16)`. Total liabilities are calculated with the

formula: `=B17+B18` in B19. Total shareholder's equity is calculated in B22 with: `=B20+B21`. And, finally, we calculate the total liabilities and owner's equity in B23 with: `=B19+B22`. Copy these formulas into the appropriate cells in column C to create the 2003 balance sheet.

To achieve the underlining and shading effects pictured in the Exhibits, select the cells and then choose F**o**rmat C**e**lls from the menus and then click on the Border tab. To set the type of border, first click on the line type on the right side of the dialog, and then click on the location of the line in the Border area of the dialog. If you want to shade the selection, click on the Patterns tab and then select the color and pattern for the shading. It is usually best to make the text in a shaded cell bold so that it can be clearly seen. Before continuing, make sure that your worksheet looks like the one in Exhibit 2-5, except that you should have applied the custom format to display the numbers in thousands.

Creating a Common-Size Balance Sheet

You can create a common-size balance sheet just as we did for the income statement. The only difference is that the balance sheet entries are displayed as a percentage of the firm's total assets instead of total revenues.

To create the common-size balance sheets for EPI, proceed in the same manner as for the common-size income statements. To be complete, you should also create the same three views as we did for the income statement. Note that you will need to use different names for the views than were used in the income statement. Your "Common-Size" view should look like that in Exhibit 2-6.

EXHIBIT 2-6
COMMON-SIZE VIEW OF EPI'S BALANCE SHEET

	A	B	D
1	**Elvis Products International**		
2	**Common-size Balance Sheet**		
3	**As of Dec. 31, 2004 (000's)**		
4	***Assets***	***2004%***	***2003%***
5	Cash and Equivalents	3.15%	3.92%
6	Accounts Receivable	24.35%	23.91%
7	Inventory	50.64%	48.69%
8	*Total Current Assets*	*78.14%*	*76.53%*
9	Plant & Equipment	31.92%	33.43%
10	Accumulated Depreciation	10.07%	9.95%
11	*Net Fixed Assets*	*21.86%*	*23.47%*
12	***Total Assets***	**100.00%**	**100.00%**
13	***Liabilities and Owner's Equity***		
14	Accounts Payable	10.61%	9.91%
15	Short-term Notes Payable	13.63%	13.62%
16	Other Current Liabilities	8.48%	9.26%
17	*Total Current Liabilities*	*32.72%*	*32.79%*
18	Long-term Debt	25.72%	22.02%
19	*Total Liabilities*	*58.45%*	*54.81%*
20	Common Stock	27.87%	31.32%
21	Retained Earnings	13.69%	13.87%
22	*Total Shareholder's Equity*	*41.55%*	*45.19%*
23	***Total Liabilities and Owner's Equity***	**100.00%**	**100.00%**

Building a Statement of Cash Flows

Boiled down to its essence, a firm participates in two kinds of financial transactions: those that increase the cash balance (cash inflows, or *sources* of funds) and those that decrease the cash balance (cash outflows, or *uses* of funds).

One way that a financial analyst can determine how well a firm's management is performing is to examine how they are managing the shareholder's money. The accounting profession has developed a tool which is useful for this type of analysis.

The tool is known as the *Statement of Cash Flows*.[5] The statement of cash flows summarizes the causes of changes in the firm's cash balance. Changes in the cash balance can be determined as follows:

TABLE 2-2
DETERMINING THE CHANGE IN THE CASH BALANCE

	Beginning Cash Balance
+	Cash inflows (sources)
–	Cash outflows (uses)
=	Ending Cash Balance

The statement of cash flows is organized into three sections according to how the cash flows were generated. The first section is "Cash Flows from Operations" which describes the cash flows generated by the firm in the ordinary course of conducting its business. The next section, "Cash Flows from Investing," describes cash flows due to the firm altering its mix of fixed assets. The final section, "Cash Flows from Financing," describes the cash flows that are generated in the course of financing the firm.

It is important that you recognize that the statement of cash flows consists primarily of *changes* in balance sheet accounts. In order to calculate those changes, we must have balance sheets from two periods. Other than balance sheet changes, we also need the latest income statement, where the most important operational cash flows (net income and depreciation expense) are located.

Unlike the income statement and balance sheet, which are mostly exercises in data entry, the statement of cash flows is primarily composed of formulas. Since these formulas reference many different cells in the workbook it is generally easiest to use Excel's pointer mode when entering them. To begin, rename "Sheet 3" to `Statement of Cash Flows` and enter the labels as shown in Exhibit 2-7. Next, apply our custom number format to the cells in B5:C20.

5. Prior to the November 1987 release of FASB standard 95, this statement was known as the Statement of Changes in Financial Position. The Sources and Uses of Funds statement, as it was also known, contained the same information but was organized differently.

EXHIBIT 2-7
STATEMENT OF CASH FLOWS FOR EPI

	A	B	C
1	**Elvis Products International**		
2	**Statement of Cash Flows**		
3	**For the Year Ended Dec. 31, 2004 ($ 000's)**		
4	**Cash Flows from Operations**		
5	Net Income	44.22	
6	Depreciation Expense	20.00	
7	Change in Accounts Receivable	-50.80	
8	Change in Inventories	-120.80	
9	Change in Accounts Payable	29.60	
10	Change in Other Current Liabilities	4.00	
11	**Total Cash Flows from Operations**		**-73.78**
12	**Cash Flows from Investing**		
13	Change in Plant & Equipment	-36.00	
14	**Total Cash Flows from Investing**		**-36.00**
15	**Cash Flows from Financing**		
16	Change in Short-term Notes Payable	25.00	
17	Change in Long-term Debt	101.18	
18	Cash Dividends Paid to Shareholders	-22.00	
19	**Total Cash Flows from Financing**		**104.18**
20	**Net Change in Cash Balance**		**-5.60**

The first two items under Cash Flows from Operations are Net Income and Depreciation Expense. These are unique items because they are the only ones on the statement of cash flows that come from the income statement and are also the only items that are not represented as changes from a previous period.[6] Also realize that Net Income summarizes every other item on the income statement. Therefore, if we were to include Sales, for example, we would be double counting. To enter the net income first type an = in B5 and then (before pressing the Enter key) click on the sheet tab for the Income Statement. Excel will change to the worksheet containing the income statement. Now click on C15 and press Enter. At this point, Excel will switch back to the Statement of Cash Flows worksheet and your formula in B5 should read: `='Income Statement'!C15`. This formula directs Excel to put the value from cell C15 on the Income Statement worksheet into B5. If we should change some values in the income statement, any change in net income will automatically be reflected in the statement of cash flows. This type

6. Actually, we could calculate depreciation expense as the change in accumulated depreciation.

of cell linking works across workbooks (different files) as well as within workbooks.

We can actually make referencing other sheets slightly easier if we display two or more sheets on the screen at once. We will use this technique to complete the statement of cash flows.

First, switch to the Income Statement sheet and then choose **W**indow **N**ew Window from the menus. This will open a second copy of the workbook. Now choose **W**indow **A**rrange and then H**o**rizontal. You should now see two identical copies of the workbook. In one of the copies, click on the sheet tab for the Statement of Cash Flows. In B6, type = and then click anywhere on the other workbook. Now scroll down so that cell C10 is visible and click on it and press the Enter key. The formula in B6 of the Statement of Cash Flows should read: `='Income Statement'!C10`, and the value should be 20,000. Notice that the custom format that we applied to the income statement is not carried over. Therefore we need to apply the same format to the cells that we will be using. Select B5:C20 and then F**o**rmat C**e**lls and apply the same custom format. Alternatively, you can click on any cell in the Income Statement worksheet and then click the Format Painter icon on the formatting toolbar (pictured at left) to copy the format. Now, select B5:C20 on the Statement of Cash Flows worksheet to paste the format.

The rest of the statement of cash flows can be completed in a similar manner. Since we are done with the income statement, we now want to display the balance sheet in that workbook. Click on the sheet tab labeled Balance Sheet. You should now have both the Statement of Cash Flows sheet and the Balance Sheet displayed.

At this point, we must be careful with respect to the signs of the numbers entered into the statement of cash flows. In general, when an asset account increases it represents a cash outflow (i.e., a *use* of funds). An asset account which decreases represents a cash inflow (i.e., a *source* of funds). Liability and equity accounts are exactly the opposite. We represent uses of funds as negative numbers and sources of funds as positive numbers on the statement of cash flows.

Table 2-3 summarizes this point. For example, EPI's accounts receivable balance increased from $351,200 in 2003 to $402,000 in 2004. This represents a use of funds and should be indicated with a negative sign on the statement of cash flows. On the other hand, the accounts payable balance increased and, because it is a liability account, represents a source of funds.

TABLE 2-3
SIGNS OF CASH FLOWS FOR THE STATEMENT OF CASH FLOWS

	Direction of Change		Order of Subtraction
Type of Account	**Increase**	**Decrease**	
Asset	–	+	Older – Newer
Liability or Equity	+	–	Newer – Older

The formula for the change in accounts receivable in B7 should be: `='Balance Sheet'!E6-'Balance Sheet'!C6`. We can get the change in inventories by simply copying this formula down to B8. Note that for these asset accounts, the direction of the subtraction is 2003 value – 2004 value. For liability and equity accounts the direction of the subtraction is reversed. This will ensure that the correct sign is used.

The formula to calculate the change in accounts payable in B9 is: `='Balance Sheet'!C14-'Balance Sheet'!E14`. In B10, to get the change in other current liabilities, we use the formula: `='Balance Sheet'!C16-'Balance Sheet'!E16`. Now we calculate the total cash flows from operations in C11 with: `=SUM(B5:B10)`. Note that we have skipped over the short-term notes payable. That is because notes payable is not an operating current liability. Generally, any interest-bearing liability is included in the Cash Flows from Financing section.

Cash flows from investing are those cash flows generated from investments (or disinvestments) in long-term assets. In the case of EPI, that means plant and equipment. This change can be calculated in B13 by the formula: `='Balance Sheet'!E9-'Balance Sheet'!C9`. For consistency, we will calculate the total cash flows from investing in C14 with: `=B13`.

For the final section, our first item is the change in notes payable. This account increased from $200,000 in 2003 to $225,000 in 2004, representing a cash inflow of $25,000. In B16 enter the formula: `='Balance Sheet'!C15-'Balance Sheet'!E15`. Next, we can calculate the change in long-term debt with the formula: `='Balance Sheet'!C18-'Balance Sheet'!E18`.

Cash dividends paid to shareholders in 2004 were $22,000 (a use of funds). This is calculated with the formula:

Dividends Paid = Net Income – Change in Retained Earnings,

so in B18 enter the formula: `=-('Income Statement'!C15-('Balance Sheet'!C21-'Balance Sheet'!E21))`. Note that the parentheses are

important in this case, and that the result should be –22,000 (dividends paid are always a use of funds). Again, we can total the cash flows from financing in C19 with: `=SUM(B16:B18)`.

Finally, in C20 we calculate the net change in the cash balance by adding up the subtotals, so the formula is: `=SUM(C11:C19)`. Note that this should exactly equal the actual change in the cash balance from 2003 to 2004, otherwise you have made an error. The most common errors are likely to be either a wrong sign or an omitted item.

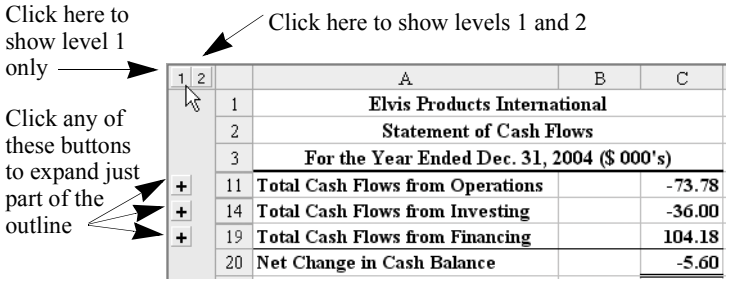
Since you no longer need the second copy of the worksheet, you may close either copy by clicking the Close button in the upper-right corner of the window. Note that choosing **F**ile **C**lose will also work, but it will close both copies. Make sure that your worksheet resembles that pictured in Exhibit 2-7.

Using Excel's Outliner

Most people were first introduced to outlining as a tool to help organize a paper by considering the major ideas first and progressively moving to the details. Excel's outliner works similarly, except that it is not really a tool for organizing ideas, but a tool to show or hide whatever level of detail is appropriate in a spreadsheet.

Excel can automatically build an outline based on the formulas that you have entered. It looks for cells that summarize information in other cells and considers those to be top level. For example, consider the statement of cash flows that we created in Exhibit 2-7. Once the outline is applied to this sheet, we can collapse it so that it appears like the screen fragment in Exhibit 2-8.

EXHIBIT 2-8
STATEMENT OF CASH FLOWS WITH ONLY LEVEL 1 DISPLAYED



To create the outline, open the file containing your financial statements (**F**ile **O**pen . . .) if necessary. Excel is sometimes smart enough to apply an outline automatically (**D**ata **G**roup and Outline **A**uto Outline), but we will do it manually to get exactly the result that we want. Select A4:C10 and then press Shift+Alt+Right Arrow (or **D**ata **G**roup and Outline **G**roup). In this case we want to group by rows, so just press Enter. You will see an outline symbol appear at the left of the selected cells. If you click on the symbol, the outline will collapse so that it shows only the summary cell. Clicking the outline symbol again will restore the display. To create the other parts of the outline, select A12:C13 and A15:C18 and repeat the above steps for each range. If you make a mistake, or decide that you don't like the outline feature, you can clear the outline by choosing **D**ata **G**roup and Outline **C**lear Outline from the menus.

Outlining is especially useful for presentations to people who don't need to see all of the details. It frees you from creating a separate summary worksheet. We could create an outline of an income statement Suppose that the income statement worksheet that we use inside the firm contains a breakdown of sales by product, several categories of cost of goods sold, etc. When we need to provide the income statement to those outside the firm we may not wish to provide all of that detail. Instead, simply print a copy from the outline with the appropriate level of detail. Note that if you print an outlined worksheet, only the levels displayed on-screen will print. However, if you copy an outlined worksheet, all of the details will be copied.

Summary

In this chapter we discussed the three primary financial statements: the income statement, the balance sheet, and the statement of cash flows. You should have a basic understanding of the purpose of each of these statements and know how to build them in Excel.

We demonstrated how worksheets can be linked so that formulas in one worksheet can reference data on another sheet. Custom number formatting was introduced, and we saw how the View Manager and the outliner can be useful tools for selectively displaying or hiding data.

Make sure that you have saved a copy of the EPI workbook because we will be making use of this data in future chapters.

TABLE 2-4
FUNCTIONS INTRODUCED IN THIS CHAPTER

Purpose	Function	Page
Total numbers or a range of numbers	**SUM**(***NUMBER1***,*NUMBER2*, . . .)	45

Problems

1. Using the data presented below:

Aspen Industries
Income Statement
For the Years Ended December 31, 2004 and 2003

	2004	2003
Sales	285,000	190,000
Cost of Goods Sold	215,000	143,000
Gross Profit	70,000	47,000
Operating Expenses		
Variable Expenses	28,500	19,000
Fixed Expenses	21,000	20,000
Depreciation	10,000	4,500
Total	59,500	43,500
Earnings Before Interest and Taxes	10,500	3,500
Interest Expense	6,100	3,000
Earnings Before Taxes	4,400	500
Taxes	1,540	175
Net Income	2,860	325
Notes:		
Tax Rate	35%	
Payout Ratio	30%	
Dividends	858	

Aspen Industries
Balance Sheet
As of December 31, 2004 and 2003

	2004	2003
Assets		
Cash	4,000	9,000
Accounts Receivable	16,000	12,500
Inventories	42,500	29,000
Total Current Assets	62,500	50,500
Land	26,000	20,000
Buildings and Equipment	100,000	70,000
Accumulated Depreciation	(38,000)	(28,000)
Total Fixed Assets	88,000	62,000
Total Assets	150,500	112,500
Liabilities and Owner's Equity		
Accounts Payable	22,298	10,500
Short-term Bank Notes	47,000	17,000
Total Current Liabilities	69,298	27,500
Long-term Debt	22,950	28,750
Common Stock	31,500	31,500
Retained Earnings	26,752	24,750
Total Liabilities and Owner's Equity	150,500	112,500

a. Recreate the income statement and balance sheet using formulas wherever possible. Each statement should be on a separate worksheet. Try to duplicate the formatting exactly.

b. On another worksheet, create a statement of cash flows for 2004. Do not enter any numbers directly on this worksheet. All formulas should be linked directly to the source on previous worksheets.

c. Using Excel's outlining feature, create an outline on the statement of cash flows that, when collapsed, shows only the subtotals for each section.

d. Suppose that sales were $320,000 in 2004 rather than $285,000. What is the 2004 net income and retained earnings?

e. Undo the changes from Part d, and change the tax rate to 40%. What is the 2004 net income and retained earnings?

2. Using the data from the previous problem:

a. Create a common-size income statement for 2003 and 2004. This statement should be created on a separate worksheet with all formulas linked directly to the income statement.

b. Create a common-size balance sheet for 2003 and 2004. This statement should be created on a separate worksheet with all formulas linked directly to the balance sheet.

Internet Exercise

1. EdgarScan is a service of the ABAS Technology Group of PricewaterhouseCoopers which provides free access to all filings made by public companies in the United States. The site can be accessed at http://edgarscan.pwcglobal.com/servlets/edgarscan. EdgarScan makes it easy to download financial statements directly into Excel with just a click of a button. Using your Internet browser, go to the EdgarScan Web site and enter a ticker

symbol or company name into the appropriate box. Click the Search button to see a list of the filings that are available. In the list, click on the most recent Form 10K.

a. On the page that appears, click on the link for the Excel Spreadsheet for the Income Statement. This will either open Excel with the data loaded, or will save an Excel file to your disk.

b. Repeat Part a for the Balance Sheet.

c. Now, repeat problems 1 and 2 using the data for your chosen company.

3 *The Cash Budget*

After studying this chapter, you should be able to:

1. *Explain the purpose of the cash budget and how it differs from an income statement.*
2. *Calculate a firm's expected total cash collections and disbursements for a particular month.*
3. *Calculate a firm's expected ending cash balance and short-term borrowing needs.*
4. *Demonstrate how Excel can be used to determine the optimal timing of major cash expenditures.*
5. *Use the Scenario Manager to evaluate different assumptions in a model.*
6. *Use the various tools that Excel provides to find and fix errors in formulas.*

Of all the topics covered in this book, perhaps no other task benefits so much from the use of spreadsheets as the cash budget. As we'll see, the cash budget can be a complex document with many interrelated entries. Manually updating a cash budget, especially for a large firm, is not a chore for which one volunteers. However, once the initial cash budget is set up in a spreadsheet, updating and playing "what if" becomes very easy.

A *cash budget* is simply a listing of the firm's anticipated cash inflows and outflows over a specified period. Unlike a pro forma income statement (discussed in Chapter

5), the cash budget includes only actual cash flows. For example, depreciation expense does not appear on the cash budget, but principal payments on debt obligations (which are not on the income statement) do. Because of its emphasis on cash income and expenditures, the cash budget is particularly useful for planning short-term borrowing and the timing of expenditures. As with all budgets, another important benefit of the cash budget comes from reconciling actual cash flows with those from the forecast.

We'll see that a cash budget is composed of three parts:

1. The worksheet area;
2. A listing of each of the cash inflows (collections) and outflows (disbursements);
3. Calculation of the ending cash balance and borrowing needs.

Throughout the chapter, we will create a complete cash budget with these three parts for Bithlo Barbecues, a small manufacturer of barbecue grills. The financial staff of the firm has compiled the following set of assumptions and forecasts to be used in the cash budgeting process:

1. Actual and expected sales through October are as given in Table 3-1.
2. 40% of sales are for cash. Of the remaining sales, 75% are collected in the following month and 25% are collected two months after the sale.
3. Inventory purchases are equal to 50% of the following month's sales (e.g., June purchases are 50% of expected July sales). 60% of purchases are paid for in the month following the purchase, and the remainder are paid in the following month.
4. Wages are forecasted to be equal to 20% of expected sales.
5. Leasing expense for the property, plant, and equipment is $10,000 per month.
6. Interest payments of $30,000 on long-term debt are due in June and September.
7. A $50,000 dividend will be paid to common shareholders in June.
8. Tax prepayments of $25,000 will be paid in June and September.
9. A $200,000 capital improvement is scheduled to be paid in July, but management is flexible on the scheduling of this outlay.

10. Bithlo Barbecues must keep a minimum cash balance of $15,000 by agreement with its bank. Its cash balance at the end of May was $20,000.

The Worksheet Area

The worksheet area is not necessarily a part of the cash budget. However, it is useful because it summarizes some of the most important calculations in the budget. This section includes a breakdown of expected sales, accounts receivable collections, and payments for materials (inventory) purchases.

Open a new workbook and rename Sheet1 to `Cash Budget`. Like any other financial statement, we begin the cash budget with the titles. In A1 enter: `Bithlo Barbecues`; in A2 type: `Cash Budget`; and in A3 enter: `For the Period June to September 2005`. Center these titles across columns A:I. Next, enter the names of the months from Table 3-1 in C4:I4 using the AutoFill feature (see page 11).

The starting point for a cash budget is the sales forecast. Many of the other forecasts in the cash budget are driven (at least indirectly) by this forecast. The sales forecast has been provided for us by Bithlo's marketing department in Table 3-1. In A5 enter the label `Sales`, and then copy the expected sales to C5:I5 in your worksheet.

TABLE 3-1
BITHLO BARBECUES ACTUAL AND EXPECTED SALES FOR 2005*

Month	Sales
April	291,000
May	365,000
June	387,000
July	329,000
August	238,000
September	145,000
October	92,000

*April and May sales are actual.

Note that sales have a strong seasonal component. In this case, barbecuing is mostly a summer phenomenon and we expect that sales will peak in June before falling dramatically in the fall and winter months. Such seasonality is important in many types of business; for example toy store sales in the fourth quarter may be 40% or more of annual sales.[1] Seasonal patterns must be included in your sales forecast if your cash budget is to be accurate.

Collections

For most firms, at least a portion of sales are made on credit. It is therefore important that the firm know how quickly it can expect to collect on those sales. In the case of Bithlo Barbecues, experience has shown that in the past about 40% of its sales are cash and 60% are on credit. Of the 60% of sales made on credit, about 75% will be collected during the month following the sale and the remaining 25% will be collected two months after the sale. In other words, 45% (= 0.60 x 0.75) of total sales in any month will be collected during the following month, and 15% (= 0.60 x 0.25) will be collected within two months.[2]

Our goal is to determine the total collections in each month. In A6 type: `Collections:`, and then in A7 enter the label: `Cash`. This will indicate the cash sales for the month. In A8 enter: `First Month` to indicate collections from the previous month. In A9 enter: `Second Month` to indicate collections on sales made two months previously. Since our estimates of the collection percentages may change, it is important that they not be entered directly into formulas. Instead, enter these percentages in B7:B9.

Since the budget is for June to September we will begin our estimates of collections in E7. (Note that April and May sales are included here only because we need to reference sales from the two previous months to determine the collections from credit sales.) To calculate the cash collections for June we multiply the expected June sales by the percentage of cash sales, so enter: `=E5*$B7` into E7. To calculate collections from cash sales for the other months, simply copy this formula to F7:H7.

---

1. In its 2001 Annual Report, management of Toys "R" Us, Inc., reported that fourth quarter sales represented an average of more than 40% of total annual sales for the past three years. Additionally, all of the firm's annual profit was earned in the fourth quarter of 2001. The company lost money in the other three quarters.
2. For simplicity, we assume that 100% of sales will be collected. Most firms would include an allowance for "bad debts."

Collections on credit sales can be calculated similarly. In E8, we will calculate June collections from May sales with the formula: `=D5*$B8`. Copy this formula to F8:H8. Finally, collections from sales two months ago, in E9, can be calculated with the formula: `=C5*$B9`. After copying this formula to F9:H9, calculate the total collections in row 10 for each month by using the **SUM** function. Check your numbers against those in Exhibit 3-1 and format your worksheet to match. This is a good time to save your workbook.

Purchases and Payments

In this section of the worksheet area, we calculate the payments that are made for inventory purchases. Bithlo Barbecues purchases inventory (equal to 50% of sales) the month before the sale is made. For example, June inventory purchases will be 50% of expected July sales. However, it does not pay for the inventory immediately. Instead, 60% of the purchase price is paid in the following month, and the other 40% is paid two months after the purchase.

EXHIBIT 3-1
CALCULATING COLLECTIONS IN THE WORKSHEET AREA

	A	B	C	D	E	F	G	H	I
1	**Bithlo Barbeques**								
2	**Cash Budget**								
3	**For the Period June to September 2005**								
4			**April**	**May**	**June**	**July**	**August**	**September**	**October**
5	Sales		291,000	365,000	387,000	329,000	238,000	145,000	92,000
6	*Collections:*								
7	Cash	40%			154,800	131,600	95,200	58,000	
8	First Month	45%			164,250	174,150	148,050	107,100	
9	Second Month	15%			43,650	54,750	58,050	49,350	
10	**Total Collections**				**362,700**	**360,500**	**301,300**	**214,450**	
11	Purchases	50%	182,500	193,500	164,500	119,000	72,500	46,000	
12	*Payments:*								
13	First Month	60%			116,100	98,700	71,400	43,500	
14	Second Month	40%			73,000	77,400	65,800	47,600	
15	**Total Payments**				**189,100**	**176,100**	**137,200**	**91,100**	

We first need to calculate the amount of inventory purchased in each month. As noted, this is 50% of the following month's sales. So in A11 type: `Purchases` and in B11 enter: `50%`. We will calculate April purchases in C11 with the formula: `=$B11*D5`. Copying this formula to D11:H11 completes the calculation of purchases.

Credit purchases are not cash outflows, so we need to calculate the actual cash payments for inventory in each month. This is very similar to the way we calculated total cash collections. First, enter labels. In A12 type: `Payments:`. In A13 and A14 enter: `First Month` and `Second Month` respectively, and enter: `Total Payments` in A15. Now enter `60%` in B13 and `40%` in B14. In June Bithlo Barbecues will pay for 60% of purchases made in May. So the formula in E13 is: `=$B13*D11`. Copy this to F13:H13 to complete the first month's payments. To calculate the June payment for April purchases in E14, use the formula: `=$B14*C11`. Copy this to F14:H14 and then calculate the total payments for each month in row 15.

At this point your worksheet should look like the one in Exhibit 3-1. Check your numbers carefully to make sure that they agree with those in the exhibit. To clarify the logic of these formulas, examine Exhibit 3-2 which is the same as Exhibit 3-1, except it has arrows drawn in to show the references for June.

EXHIBIT 3-2
THE WORKSHEET AREA OF A CASH BUDGET

	A	B	C	D	E	F	G	H	I
1	**Bithlo Barbeques**								
2	**Cash Budget**								
3	**For the Period June to September 2005**								
4			**April**	**May**	**June**	**July**	**August**	**September**	**October**
5	Sales		291,000	365,000	387,000	329,000	238,000	145,000	92,000
6	*Collections:*								
7	Cash	40%			154,800	131,600	95,200	58,000	
8	First Month	45%			164,250	174,150	148,050	107,100	
9	Second Month	15%			43,650	54,750	58,050	49,350	
10	**Total Collections**				**362,700**	**360,500**	**301,300**	**214,450**	
11	Purchases	50%	182,500	193,500	164,500	119,000	72,500	46,000	
12	*Payments:*								
13	First Month	60%			116,100	98,700	71,400	43,500	
14	Second Month	40%			73,000	77,400	65,800	47,600	
15	**Total Payments**				**189,100**	**176,100**	**137,200**	**91,100**	

Collections and Disbursements

This section of the cash budget is the easiest to set up in a spreadsheet because there are no complex relationships between the cells as there are in the worksheet area. The collections and disbursements area is very much like a cash-based income statement (i.e., there are no non-cash expenses). We simply list the cash inflows and outflows that are expected for each month.

We will begin by summarizing the cash collections for each month. Enter the label: `Collections` in A17. In E17:H17 the formulas simply reference the total collections that were calculated in E10:H10. So, for example, the formula in E17 is: `=E10`. Copy this formula to F17:H17.

In A18, enter the label: `Less Disbursements:`. The first cash outflow that we will enter is the inventory payment which was calculated in the worksheet area. Enter `Inventory Payments` as the label in A19 and the formula in E19 is: `=E15`. Wages are assumed to be equal to 20% of sales. In A20 add the label: `Wages` and in B20 type: `20%` which will be used to calculate the expected monthly wage expense. The formula to calculate wages in E20 is: `=$B20*E5`. Now copy these formulas to F19:H20. By now, you should be able to finish this section by entering the remaining labels and numbers as pictured in Exhibit 3-3.

EXHIBIT 3-3
COLLECTIONS AND DISBURSEMENTS

	A	B	C	D	E	F	G	H
17	Collections				362,700	360,500	301,300	214,450
18	*Less Disbursements:*							
19	Inventory Payments				189,100	176,100	137,200	91,100
20	Wages	20%			77,400	65,800	47,600	29,000
21	Lease Payment				10,000	10,000	10,000	10,000
22	Interest				30,000	0	0	30,000
23	Dividend (Common)				50,000	0	0	0
24	Taxes				25,000	0	0	25,000
25	Capital Outlays				0	200,000	0	0
26	**Total Disbursements**				**381,500**	**451,900**	**194,800**	**185,100**

There are a couple of points to note about this portion of the cash budget. First, we have assumed that the only cash inflows are from selling the firm's products. In other cases, however, it is possible that the firm might plan to sell some assets or bonds or stock. Any of these actions would bring cash into the firm and should be included under collections.

Second, we have included dividends, which do not appear on the income statement. The reason that they are on the cash budget is that dividends represent a very real cash expenditure for the firm. They don't appear on the income statement because dividends are paid from after-tax dollars.

Finally, Bithlo Barbecues has scheduled capital outlays of $200,000 in July. Even though they are paying the full cost in July, it is unlikely that they would be allowed to expense this entire amount during 2005. Instead, the income statement would

reflect the depreciation of these assets over a longer period of time. Regardless of tax laws or accounting conventions, it is important to include all expected cash inflows and outflows on the cash budget.

Calculating the Ending Cash Balance

This last section of the cash budget calculates the expected ending cash balance at the end of each month. This is the most important part of the cash budget because it helps the manager understand the firm's short-term borrowing requirements. Knowing the borrowing requirements in advance allows managers to arrange for financing when they need it and provides the time necessary to evaluate possible alternatives. Managers can also use this information to determine the best timing for major expenditures.

TABLE 3-2
CALCULATING THE ENDING CASH BALANCE

	Beginning Cash Balance
+	Total Collections
–	Total Disbursements
=	Unadjusted Cash Balance
+	Current Borrowing
=	Ending Cash Balance

Table 3-2 shows the series of calculations necessary to determine the firm's ending cash balance. Essentially, this is the same procedure we saw in Table 2-2 on page 57. In the next section we will add a few steps to this calculation, but the basic procedure is always as outlined in Table 3-2.

We have already made most of the calculations necessary to complete the cash budget. Before we finish this last section, however, we need to add another detail. The management of Bithlo Barbecues has decided that they would like to keep a minimum cash balance of $15,000 to meet any unexpected expenses. If the projected cash balance falls below this amount, they will need to borrow to bring the balance back to this minimum. In A32 enter the label: `Notes:`. We will use cells below A32 to indicate important assumptions about our cash budget. The first of these is the minimum cash balance requirement. In A33 enter the label: `Minimum Acceptable Cash` and in B33 enter: `15,000`.

In cells A27:A31 enter the labels as shown in Exhibit 3-4. (Notice that this is exactly the same as was outlined in Table 3-2.) We start with the unadjusted cash balance in May. Enter: `20,000` into D29. In D30 enter: `0` because the firm had no short-term borrowing needs in May. The ending cash balance for the month is simply the unadjusted cash balance plus current borrowing, so the formula in D31 is: `=sum(D29:D30)`. This formula will be the same for each month, so copy it across to E31:H31.

EXHIBIT 3-4
ENDING CASH BALANCE CALCULATION

	A	B	C	D	E	F	G	H
27	Beginning Cash Balance				20,000	15,000	15,000	121,500
28	Collections - Disbursements				(18,800)	(91,400)	106,500	29,350
29	Unadjusted Cash Balance			20,000	1,200	(76,400)	121,500	150,850
30	Current Borrowing			0	13,800	91,400	0	0
31	**Ending Cash Balance**			**20,000**	**15,000**	**15,000**	**121,500**	**150,850**
32	Notes:							
33	Minimum Acceptable Cash	15,000						

The beginning cash balance for any month is the same as the ending cash balance from the previous month. Therefore, we can simply reference the previous month's ending cash balance calculation. In E27 enter the formula: `=D31` and copy this across to F27:H27. At this point, your beginning cash balance for each month, except June, will be 0 because we have not yet entered any formulas in E28:H30.

Since we have already calculated the total collections and total disbursements, there is no need to have separate rows for those calculations in this section. Instead, we will calculate the net collections for June in E28 with the formula: `=E17-E26`. Copy this formula to F28:H28. For June, the result is $-18,800, which indicates that the firm expects to spend more than it will collect. In other words, the cash balance is expected to decline by $18,800 in June. This decline will be reflected in the unadjusted cash balance.

The unadjusted cash balance is what the cash balance would be if the firm did not have any short-term borrowing during the month. We simply add the beginning cash balance and the net collections for the month. The formula in E29 is: `=Sum(E27:E28)`. The result is $1,200, which is less than the firm's minimum acceptable cash balance of $15,000. Therefore, Bithlo Barbecues will need to borrow $13,800 to bring the balance up to this minimum.

How did we determine that the firm needs to borrow $13,800? It is probably obvious to you, even without giving it much thought. However, you need to think it

through carefully to create a formula which will work under all circumstances. We could use the following equation:

$$\text{Current Borrowing} = \text{Minimum Cash} - \text{Unadjusted Cash.} \quad \textbf{(3-1)}$$

In this case we find that Bithlo Barbecues needs to borrow:

$$\$13{,}800 = \$15{,}000 - \$1{,}200$$

Equation 3-1 works in this case, but it is not appropriate in all circumstances. Suppose, for example, that the unadjusted cash balance had been $20,000. This would suggest that the firm needs to borrow –$5,000, which is absurd.[3] In a case such as this, we would like to see current borrowing at 0.

The calculation that we need can be stated as follows: "**If** the unadjusted cash balance is less than the minimum, **then** we borrow an amount equal to minimum cash – unadjusted cash. **Otherwise**, current borrowing is zero." With the formulas that we have used so far, this type of calculation is impossible. However, Excel has a built in function that can handle situations where the result depends on some condition — the **IF** statement.

The **IF** statement returns one of two values, depending on whether a statement is true or false:

IF ***(LOGICAL_TEST, VALUE_IF_TRUE,*** *VALUE_IF_FALSE*)**.**

LOGICAL_TEST is any statement which can be evaluated as being either true or false, and ***VALUE_IF_TRUE*** and *VALUE_IF_FALSE* are the return values which depend on whether ***LOGICAL_TEST*** was true or false. If you are familiar with computer programming, you will recognize this as the equivalent of the If–Then–Else construct that is supported by most programming languages.

The formula to calculate the firm's borrowing needs for June, in E30, is: `=IF(E29<$B33,$B33-E29,0)`. Since the unadjusted cash balance is only $1,200, the result should indicate the need to borrow $13,800 as we found earlier. Copy this formula to F30:H30 to complete the calculation of current borrowing. Notice that, because of large positive net collections, the firm does not need to borrow funds in August or September.

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3. Unless, of course, you assume that negative borrowing is the same as investing. But we will consider investing excess funds in the next section.

We have already entered formulas for the ending cash balance in each month. You should now check your numbers and formatting against those in Exhibit 3-5.

EXHIBIT 3-5
A COMPLETED SIMPLE CASH BUDGET

	A	B	C	D	E	F	G	H	I
1	**Bithlo Barbeques**								
2	**Cash Budget**								
3	**For the Period June to September 2005**								
4			**April**	**May**	**June**	**July**	**August**	**September**	**October**
5	Sales		291,000	365,000	387,000	329,000	238,000	145,000	92,000
6	*Collections:*								
7	Cash	40%			154,800	131,600	95,200	58,000	
8	First Month	45%			164,250	174,150	148,050	107,100	
9	Second Month	15%			43,650	54,750	58,050	49,350	
10	**Total Collections**				**362,700**	**360,500**	**301,300**	**214,450**	
11	Purchases	50%	182,500	193,500	164,500	119,000	72,500	46,000	
12	*Payments:*								
13	First Month	60%			116,100	98,700	71,400	43,500	
14	Second Month	40%			73,000	77,400	65,800	47,600	
15	**Total Payments**				**189,100**	**176,100**	**137,200**	**91,100**	
17	Collections				362,700	360,500	301,300	214,450	
18	*Less Disbursements:*								
19	Inventory Payments				189,100	176,100	137,200	91,100	
20	Wages	20%			77,400	65,800	47,600	29,000	
21	Lease Payment				10,000	10,000	10,000	10,000	
22	Interest				30,000	0	0	30,000	
23	Dividend (Common)				50,000	0	0	0	
24	Taxes				25,000	0	0	25,000	
25	Capital Outlays				0	200,000	0	0	
26	**Total Disbursements**				**381,500**	**451,900**	**194,800**	**185,100**	
27	Beginning Cash Balance				20,000	15,000	15,000	121,500	
28	Collections - Disbursements				(18,800)	(91,400)	106,500	29,350	
29	Unadjusted Cash Balance			20,000	1,200	(76,400)	121,500	150,850	
30	Current Borrowing			0	13,800	91,400	0	0	
31	**Ending Cash Balance**			**20,000**	**15,000**	**15,000**	**121,500**	**150,850**	
32	Notes:								
33	Minimum Acceptable Cash	15,000							

At this point the managers of Bithlo Barbecues know that they will need to arrange to borrow $13,800 before June, and $91,400 before July. It is also obvious that they will have enough cash to pay off these borrowings in August, but we will postpone the repayment of loans until later in this chapter.

Using the Cash Budget for Timing Large Expenditures

Besides being useful for planning the firm's short-term borrowing needs, the cash budget can be useful in timing collections and expenditures. For example, suppose that the firm is concerned about the amount of borrowing that will be necessary in June and July. What we want to do is to see what happens if we make certain changes in our assumptions.

One way that they may be able to reduce the borrowing needs is to try to speed up collections on sales and to slow down the payments for inventory purchases (they will effectively be borrowing from suppliers instead of the bank). Suppose that the firm is able to collect 50% of sales during the following month, thereby reducing collections in the second month to 10%. Furthermore, assume that they can slow down their payments for inventory purchases to 50% in the first month after the purchase instead of the current 60%.

Change B8 to `50%`, B9 to `10%`, B13 to `50%`, and B14 to `50%`. You will see that borrowing will fall in June to $9,000 from $13,800. Borrowing in July will rise to $93,200 from $91,400. Therefore, the total amount of borrowing will decrease from the original $105,800 to $102,200. This has two benefits: it reduces the interest cost of borrowing (which we will consider in the next section), and it shifts that interest expense to a later point in time. Of course, there may also be an opportunity cost in the form of lost discounts due to paying suppliers later, and customers may go to competitors who offer better credit terms. Before moving on, make sure to change the percentages back to their original values.

As another example, consider Bithlo Barbecues' $200,000 expenditure currently planned for July 2005. This expenditure is the primary cause of the borrowing need in July. Indeed, without this $200,000 outlay, the firm wouldn't need to borrow in July.

Assuming that there is some flexibility in scheduling this outlay, in which month should the expenditure be made? The answer, of course, depends on a number of factors, but we might decide to make the decision based on minimizing borrowing needs. That is, schedule the project such that the firm's short-term borrowing needs are minimized. This might be especially important if the firm expected borrowing needs in excess of its line of credit in a given month.

You can experiment a bit by changing the month in which the capital expenditure is made. First, however, it would be helpful to know the total expected borrowing for the four-month period. In I30, enter the formula: `=Sum(E30:H30)` to calculate

total borrowing. Now, by moving the capital expenditure to different months, you should be able to verify the numbers in Table 3-3.

TABLE 3-3
OPTIMAL SCHEDULING FOR A CAPITAL EXPENDITURE

Month of Outlay	Total Four-month Borrowing
June	$ 213,800
July	$ 105,200
August	$ 13,800
September	$ 13,800

Obviously, by this criteria, the best time to schedule the outlay would be in either August or September. Before continuing, be sure to move the $200,000 outlay back to July.

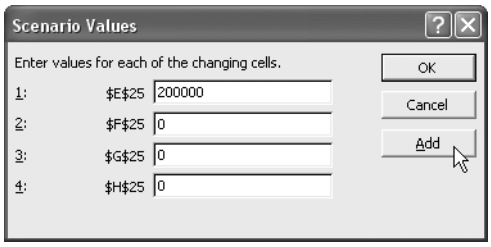
The Scenario Manager

In the previous section, we performed what has come to be called a "What if?" analysis. That is, we changed the timing of the large capital expenditure to see what would happen to the total amount of borrowing for the period. The problem with doing it "by hand" as we did is that you lose the original results of your analysis after it is done. Also, every person who looks at your spreadsheet will need to perform that same analysis. Excel provides a better way—the Scenario Manager. This tool allows us to store several scenarios (alternatives) in the spreadsheet and display them at will. Figure 3-1 shows the Scenario Manager dialog box before any scenarios have been created.

FIGURE 3-1
SCENARIO MANAGER DIALOG BOX WITH NO SCENARIOS DEFINED

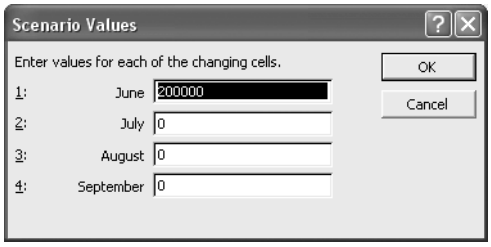
To access this tool, choose **T**ools Sc**e**narios from the menu. When the dialog box is showing, we can begin to create our four scenarios. To begin, click the **A**dd button. In the next dialog box enter: `Expenditure in June` for the Scenario **n**ame. The Changing cells are those cells that will be different under each scenario. In this case, they will be the capital outlay for each month, so enter: `E25:H25` and click the OK button. You will now be prompted to enter values for each of the changing cells for this scenario. Since our first scenario calls for the expenditure to be made in June, enter `200000` in the first box and `0` in each of the others. The Scenario Values dialog box should look like that in Figure 3-2. Now click the **A**dd button to create the next scenario. Repeat these steps until you have four scenarios with the expenditure occurring in different months.

FIGURE 3-2
SCENARIO VALUES DIALOG BOX FOR JUNE EXPENDITURE



Note that the Scenario Values dialog box prompts you for values using the cell addresses as labels. That can be confusing, especially if the cells are not visible on the screen. One way to make this situation better is to use defined names for the cells, as was discussed in Chapter 1 (page 9). First, close the Scenario Manager and then click on cell E25 and choose **I**nsert **N**ame **D**efine from the menus. Now, type `June` in the edit box and click on the **A**dd button. Now name the other cells similarly. Return to the Scenario Manager and select the "Expenditures in June" scenario. Click on the **E**dit button, then the OK button on the Edit Scenario dialog, and your Scenario Values dialog box should look like the one in Figure 3-3.

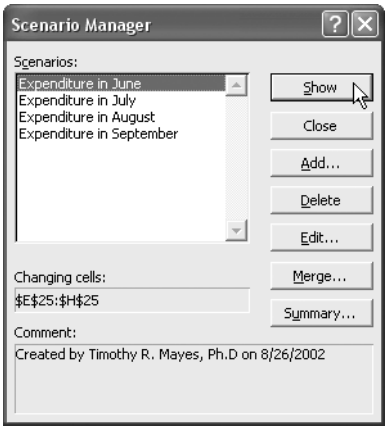
FIGURE 3-3
SCENARIO VALUES DIALOG BOX WITH DEFINED NAMES



Many of the other tools supplied with Excel work with range names in a similar way. This is a useful trick to remember as it can simplify entering data. As we will see shortly, using range names will also improve the Scenario Summary sheets.

After creating your scenarios, the Scenario Manager dialog box will look like the one in Figure 3-4.

FIGURE 3-4
SCENARIO MANAGER DIALOG BOX WITH FOUR SCENARIOS



To display a particular scenario, simply select it from the list and click the **S**how button. Excel will alter the contents of your changing cells to reflect the values that you entered. Of course, the entire worksheet will be recalculated and you can see the results under the selected scenario. Note that to see the entire worksheet you must click the Close button on the Scenario Manager dialog box. Take a look at the results of each scenario, but remember to reset the scenario to "Expenditure in July" (our default case) before continuing. If you forget to reset to the default scenario, Excel will always display the last chosen scenario. This can cause confusion when you later open your workbook.

Being able to quickly change between scenarios is pretty helpful, but the real advantage of the Scenario Manager is its ability to summarize the results of all of your scenarios. In this case, we would like to compare the total borrowing that results under each scenario to determine the best time for the expenditure. Recall that we added a formula in I30 to calculate the total borrowing for the period. Before continuing, define a name for this cell such as "Total_Borrowing." (Recall that we use the underscore in place of a space since spaces are not allowed in range names.)

Return to the Scenario Manager and click on the S**u**mmary button. You will be asked to enter **R**esult cells. A result cell is a cell (or a set of cells) that shows the end result of each scenario. In this case, we are interested in total borrowing, so enter: `I30` as the **R**esult cell and click the OK button. Excel will now create a

worksheet that summarizes your scenario results. For our scenarios, the results are in Exhibit 3-6. Note that these results are exactly the same as those in Table 3-3.

EXHIBIT 3-6
SCENARIO SUMMARY

	A	B	C	D	E	F	G
1	Scenario Summary						
2			Current Values:	Expenditure in June	Expenditure in July	Expenditure in August	Expenditure in September
4	Changing Cells:						
5		June	0	200,000	0	0	0
6		July	200,000	0	200,000	0	0
7		August	0	0	0	200,000	0
8		September	0	0	0	0	200,000
9	Result Cells:						
10		Total_Borrowing	105,200	213,800	105,200	13,800	13,800
11	Notes: Current Values column represents values of changing cells at						
12	time Scenario Summary Report was created. Changing cells for each						
13	scenario are highlighted in gray.						

Adding Interest and Investment of Excess Cash

In the previous section you created a basic cash budget for Bithlo Barbecues. In this section we will refine the calculation of the ending cash balance by considering two additional factors. First, we will add interest payments on borrowed funds, then we will consider the investment of excess cash.

Before beginning let's create a copy of the previous cash budget in the same workbook. Right-click the sheet tab labeled "Cash Budget" and select **M**ove or Copy from the menu. On the dialog box make sure to check the box labeled **C**reate a Copy and select (move to end) from the list. The copied sheet will now be named Cash Budget (2). Right-click the sheet tab and rename the new sheet `Complex Cash Budget`.

Next, we will need to make a few additions to the notes at the bottom of the worksheet. We will now assume that Bithlo Barbecues will invest any cash in excess of $40,000. In A34 add the label: `Maximum Acceptable Cash` and in B34 enter: `40,000`. Furthermore, the firm will have to pay interest on its short-term borrowings and will earn interest on invested funds. In A35 type: `Borrowing Rate (Annual)` and in B35 enter: `8%`. In A36 add the label: `Lending Rate (Annual)` and enter: `6%` in B36.

Since we are working with monthly time periods, we need to convert these annual rates into monthly rates of interest. So, in C35 and C36 enter the label: `Monthly`.

We will convert the annual rate to a monthly rate by dividing by 12. In D35 enter the formula: `=B35/12`, and copy this to D36. You should see that the monthly borrowing rate is 0.67% and the monthly lending rate is 0.50%.

We are now ready to expand the cash budget to include borrowing and lending and the interest expense and income. Before entering any new formulas we need to insert a few new rows. Select row 23 (the dividend on common stock), and then choose **I**nsert **R**ows from the menu. This will insert a row above the selection. In A23 enter the label: `Short-Term Interest Expense (Inc.)`. Next, select row 32 (the ending cash balance), insert a row, and enter: `Current Investing` into A32. Finally, select rows 34 and 35 and choose **I**nsert **R**ows from the menu. This will insert two rows above the selection. In A34 type: `Cumulative Borrowing (Investing)` and in A35 type: `Cumulative Interest Expense (Inc.)`. We need to calculate the cumulative amount that is borrowed/ invested so that we can calculate the monthly short-term interest expense/income.

We will start by entering the formulas to calculate the cumulative amount of borrowing (investing) in D34. Positive amounts will represent borrowing while negative numbers will represent investing. In order to calculate the *cumulative* amount, we need to add the previous period's cumulative amount to current borrowing and subtract current investing. For May, in D34, the formula is: `=C34+D31-D32`, and the result should be 0. Copy this formula to E34:H34. Note that at this point the result for each month should be equal to the cumulative current borrowing.

Short-term interest expense (income) can now be calculated by multiplying the cumulative amount of borrowing (investing) from the previous month by the appropriate interest rate. So, in E23 we will use an **IF** statement to determine which rate to use. If the cumulative amount of borrowing (investing) is positive, we will multiply it by the borrowing rate. Otherwise, use the lending rate. The formula for June, E23, is: `=IF(D34>0,D34*$D$39,D34*$D$40)`. In June, since the firm has not had previous borrowing or lending, the result should be 0. Copy this across to F23:H23. At this point, the last section of your worksheet should resemble the fragment in Exhibit 3-7.

EXHIBIT 3-7
THE WORKSHEET WITH INTEREST CALCULATIONS

	A	B	C	D	E	F	G	H
17	Collections				362,700	360,500	301,300	214,450
18	*Less Disbursements:*							
19	Inventory Payments				189,100	176,100	137,200	91,100
20	Wages	20%			77,400	65,800	47,600	29,000
21	Lease Payment				10,000	10,000	10,000	10,000
22	Interest				30,000	0	0	30,000
23	Short-term Interest Expense (Inc.)				0	92	702	702
24	Dividend (Common)				50,000	0	0	0
25	Taxes				25,000	0	0	25,000
26	Capital Outlays				0	200,000	0	0
27	**Total Disbursement**				**381,500**	**451,992**	**195,502**	**185,802**
28	Beginning Cash Balance				20,000	15,000	15,000	120,798
29	Collections - Disbursements				(18,800)	(91,492)	105,798	28,648
30	Unadjusted Cash Balance			20,000	1,200	(76,492)	120,798	149,446
31	Current Borrowing			0	13,800	91,492	0	0
32	Current Investing							
33	**Ending Cash Balance**			**20,000**	**15,000**	**15,000**	**120,798**	**149,446**
34	Cumulative Borrowing (Investing)			0	13,800	105,292	105,292	105,292
35	Cumulative Interest Expense (Inc.)							
36	Notes:							
37	Minimum Acceptable Cash	15,000						
38	Maximum Acceptable Cash	40,000						
39	Borrowing Rate (Annual)	8%	Monthly	0.67%				
40	Lending Rate (Annual)	6%	Monthly	0.50%				

We can now calculate the cumulative interest expense (income) in E35. To do this we simply add the previous month's interest expense (income) to the current month's interest expense (income). For June, the formula is: `=D35+E23`. This formula should be copied across to F35:H35.

Calculating Current Borrowing

Determining the amount of current borrowing and current investing is the most complex part of this cash budget. We have already calculated current borrowing, but since we are now considering investments and interest, the formula will need to be changed. For current borrowing, the logic can be explained this way: "If the unadjusted cash balance is less than the minimum acceptable cash, then borrow enough to bring the balance to the minimum. However, if the firm has some investments, reduce the amount of borrowing by the amount of the investments (or total borrowing needs, whichever is less). If the unadjusted cash balance is greater than the minimum and the firm has previous borrowing, then use the cash above the

minimum to reduce the outstanding borrowing." Writing a formula to implement this logic is complex, and it should be built in small pieces. After each piece, verify the result and then add on the next piece.

Writing this formula requires the use of nested **IF** statements. That is, we embed a second **IF** statement within the first. In pseudocode this is:

```
If Unadjusted Cash < Minimum Cash then {Firm needs to raise funds}
   If Cumulative Borrowing (Investing) < 0 then {Firm has investments it can sell}
      Current Borrowing = Minimum Cash + Cumulative Borrowing (Investing) – Unadjusted Cash
   Else Current Borrowing = Minimum Cash – Unadjusted Cash {Must Borrow}
Else {Firm doesn't need to raise funds}
   If Cumulative Borrowing (Investing) > 0 then {Use excess funds to reduce previous borrowings}
      Current Borrowing = –Minimum(Cumulative Borrowing (Investing), Unadjusted Cash – Minimum
Cash)
   Else Current Borrowing = 0
End If
```

The formula to calculate current borrowing in July, E31, is:
`=IF(E30<$B$37,IF(D34<0,MAX($B$37+D34-E30,0),$B$37-E30),IF(D34>0,-MIN(D34,E30-$B$37),0))`. Type this formula carefully, and then copy it to F31:H31. Note that we have also used the built-in **MAX** and **MIN** functions. **MAX** returns the largest and **MIN** returns the smallest of the supplied arguments. These functions are defined as:

MAX(*NUMBER1,* *NUMBER2*, . . .)

MIN(*NUMBER1,* *NUMBER2*, . . .)

In these functions, ***NUMBER1***, *NUMBER2*, etc**.** are the set of up to 30 arguments. In this formula, the **MAX** function is required to be sure that we don't end up with negative borrowing if the investments are more than sufficient to cover cash needs (i.e., we don't want to sell all of the investments if we don't need to). The **MIN** function is used when the firm has excess cash and has some outstanding loans to pay off. It finds the minimum of either (1) the cumulative amount of borrowing outstanding, or (2) the difference between the unadjusted cash balance and the minimum acceptable cash balance. Note that we had to use the negative of result of the **MIN** function in order to get the correct result.

Using the Formula Auditing Tools to Avoid Errors

Sometimes the logic you need to solve a problem can get a bit complicated, as above. It is important to carefully think it through and build your formulas one small piece at a time. In this way, we can slowly build up a large, complex formula that always works. That's exactly how the above formula was created. However, no matter how careful you are in building a complex formula there is always the possibility of errors creeping in. Fortunately, there are several ways to identify these errors before they become serious problems (i.e., cost you or your company real money).

One of the best ways to avoid errors is to thoroughly test your formulas. The easiest way to do this is to change some numbers that the formula depends on and make sure that you are still getting correct answers. For example, we might temporarily change our ending cash balance in May. Then, carefully work through the ending cash balance calculations to make sure they are working correctly.

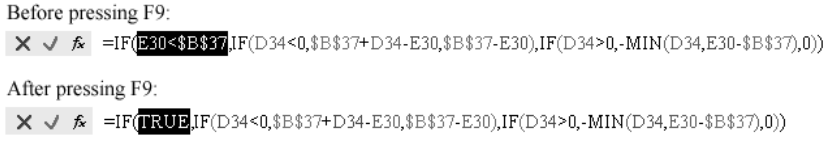
Debugging Formulas

Finding errors in the first version of a complex formula is almost guaranteed. Fortunately, Excel provides several tools to help find and correct the cause. In the following subsections we will take a short detour from our example to discuss these tools.

Using the F9 Function Key

In previous versions (before 2002), one of Excel's most useful and probably least known tools was the F9 function key. This is still available and very valuable. Normally, pressing F9 causes a worksheet to recalculate, but when you use it in the formula bar it shows the contents of a cell address or the result of a calculation. For example, select E31 and highlight the first condition in the **IF** statement as shown in Figure 3-5.

FIGURE 3-5
USING THE F9 KEY IN THE FORMULA BAR



When you press F9, Excel evaluates the expression "E30<$B$37" and then reports that the result is true (E30 is, in fact, less than B37). Note that we also could have highlighted just the "E30" part of this expression and, after pressing F9, Excel would show that the value in E30 is equal to 1,200. Now, applying the same technique to the other part of the expression would show that B37 is equal to 15,000. At this point, the first part of the formula would show as "1200<15000" which is obviously true. This technique is very useful for checking parts of an equation to make sure they are accurate.

One caveat to this trick is that if you now press Enter to return to the worksheet, your equation will be changed to include the results instead of reverting to the cell addresses. It is crucial to press the Esc key rather than Enter in order to avoid locking in the changes you've made.

Color-Coded Cell Addresses

Another member of the error-checking toolkit is the use of color-coding in formulas. When you create or edit a formula, Excel colors the cell addresses and highlights each of those cells in that same color. This allows you to easily see which cells are being used. If you notice that you've used an incorrect cell or range, you can grab the colored outline and expand, contract, or move it to another location. This will change the appropriate cell or range of cells in your formula.

Automatic Error Checking

For the last several versions Excel has had the Formula Auditing toolbar, but it has been greatly improved in Excel 2002. To see this toolbar go to **V**iew **T**oolbars and click on Formula Auditing.[4]

FIGURE 3-6
THE FORMULA AUDITING TOOLBAR

4. If the Formula Auditing toolbar is not on this menu, you'll need to choose **C**ustomize at the bottom of the menu. On the Toolbars tab, click the checkbox next to Formula Auditing. Its a good idea to look at some of the other toolbars to see what else you might find useful.

The first icon on the Formula Auditing toolbar is for error checking. Excel will examine your worksheet for common types of errors and will walk you through them. However, unless you have turned off background error checking (go to **T**ools **O**ptions Error Checking tab), Excel performs this error checking automatically. If background error checking is on, a green triangle will appear in the upper-left corner of the cell along with a Smart Tag that explains the error and offers a solution. Errors in logic cannot, of course, be detected, but many other types of errors can be.

Be aware that in some cases Excel will think you've made an error when you have not. Don't automatically accept the proposed fix. If this happens repeatedly, you can tell Excel to stop checking for that type of error, or turn off background error checking completely.

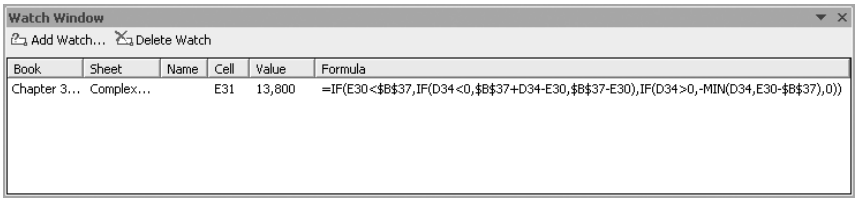
Tracing Precedent and Dependent Cells

The next five icons in the Formula Auditing toolbar are for tracing precedent or dependent cells. A precedent cell is one upon which a formula depends, while a dependent cell is one that depends on the result of the formula in the active cell. If the active cell contains a formula, clicking the Trace Precedents icon will display arrows from the precedent cells. The arrows in Exhibit 3-2 (page 72) were created in this way. The Trace Dependents icon works the same way, except that the arrows point to dependent cells.

The Watch Window

When working on a large worksheet, it is common to find yourself changing a value in one location and jumping to another to check the result. The Watch Window in Excel 2002 is a powerful tool which helps to speed up formula debugging by letting you watch a distant cell without having to scroll to it. To activate this tool click on the next to last icon on the Formula Auditing toolbar or go to **T**ools Formula A**u**diting Show **W**atch Window.
Once the Watch Window is displayed, you can choose one or more cells to watch by clicking the Add Watch button and choosing the cell. In Figure 3-7 we have selected E31. With this window displayed you can scroll to any part of the worksheet, change a cell value, and see what happens to E31. Note that if you close the Watch Window (or even save and close the workbook), the watch cells are not cleared. That allows you to open it again to continue watching the cell.

FIGURE 3-7
THE WATCH WINDOW



The Evaluate Formula Tool

Finally, perhaps the best new feature for formula debugging is the Evaluate Formula tool. This tool lets you step through a formula piece by piece as Excel evaluates it. It works much like the F9 function key, except that it will step through the entire formula one step at a time. To activate this tool click on the last icon on the Formula Auditing toolbar or go to **T**ools Formula A**u**diting Evaluate **F**ormula.

Figure 3-8 shows the Evaluate Formula dialog box with the formula in E31 ready to be evaluated. Note that E30 is underlined, indicating that it will be evaluated first. Simply click the **E**valuate button and "E30" will be replaced with "1200." Now, $B$37 will be underlined and ready to be evaluated. You can continue to click the **E**valuate button to work through the entire formula.

FIGURE 3-8
THE EVALUATE FORMULA TOOL

An additional feature is the Step **I**n function. For those expressions that themselves are the result of a formula, you can "step in" to the previous formula and evaluate it. For example, D34 is actually the result of the formula =C34+D31-D32. When D34 is underlined, clicking the Step **I**n button will allow you to evaluate this formula and then return to evaluating the rest of the original formula.

One of the most difficult tasks in the process of building a spreadsheet model is making sure that it works correctly under all conditions. Making use of the tips and tools discussed here can make the job much simpler. Let's now return to our cash budgeting example.

Calculating Current Investing

If Bithlo Barbecues has cash in excess of the maximum ($40,000 in this case) the cash should be invested in short-term securities. This is the essential idea behind the current investing item. Note that since we have added the Current Investing line, we must adjust our ending cash balance formula to take investing into account. The correct formula, in D33, is: `=SUM(D30:D31)-D32`. That is, our ending cash balance is now going to be the Unadjusted Cash Balance plus the Current Borrowing minus Current Investing. (Investing is a cash outflow so it must be subtracted.) Copy this formula to E33:H33.

The current borrowing formula was constructed so that the firm will first sell any existing short-term investments before borrowing. Therefore, if the sum of the unadjusted cash balance and current borrowing is less than the minimum required cash, the firm needs to sell some investments. Otherwise, if the unadjusted cash balance plus current borrowing is greater than the maximum acceptable cash, the firm must invest the excess.

To implement this logic we will again use nested **IF** statements. We also need to use the **AND** statement which allows us to evaluate several conditions and then returns true only if all of the arguments are true. The **AND** statement is defined as follows:

AND(*LOGICAL1*, *LOGICAL2*,…)

In this function, ***LOGICAL1***, *LOGICAL2*, etc. are up to 30 arguments which can be evaluated as true or false. We will use this statement to determine if both of the following conditions are true: (1) unadjusted cash + current borrowing is less than the minimum cash, and (2) cumulative investing is positive.

The formula to calculate the amount of current investing, in E32, is: `=IF(AND(E30+E31<$B$37,D34<0),E30+E31-$B$37, IF(E30+E31>$B$38,E30+E31-$B$38,0))`. Enter this formula and copy it across to F32:H32. Now copy the formula to D32 as well. Again, this is a complex formula, but it can be broken down into more understandable components:

If Unadjusted Cash + Borrowing < Minimum Cash **and** Cumulative Borrowing (Investing) < 0 then
  Current Investing = Unadjusted Cash + Borrowing – Minimum Cash
Else
  If Unadjusted Cash + Borrowing > Maximum Cash then
    Current Investing = Unadjusted Cash + Borrowing – Maximum Cash
  Else
    Current Investing = 0
End.

At this point, this portion of your cash budget should resemble that in Exhibit 3-8.

Working Through the Example

In order to understand the complex cash budget, you must work through it line-by-line. In this section, we will do just that. Follow along in Exhibit 3-8.

June (column E): The unadjusted cash balance in June is projected to be only $1,200. Since this is less than the $15,000 minimum, the firm needs to raise funds. In this case it has no investments to sell, so it must borrow $13,800 to bring the ending cash balance to $15,000.

July (column F): The firm is projecting that it will be overdrawn by $76,492. Again, it has no investments to sell and must borrow an additional $91,492. Note that its cumulative borrowing is now $105,292.

EXHIBIT 3-8
CALCULATING THE CASH BALANCE WITH BORROWING AND INVESTING

	A	B	C	D	E	F	G	H
28	Beginning Cash Balance				20,000	15,000	15,000	15,506
29	Collections - Disbursements				(18,800)	(91,492)	105,798	29,350
30	Unadjusted Cash Balance			20,000	1,200	(76,492)	120,798	44,856
31	Current Borrowing			0	13,800	91,492	(105,292)	0
32	Current Investing			0	0	0	0	4,856
33	**Ending Cash Balance**			**20,000**	**15,000**	**15,000**	**15,506**	**40,000**
34	Cumulative Borrowing (Investing)			0	13,800	105,292	0	(4,856)
35	Cumulative Interest Expense (Inc.)				0	92	794	794
36	Notes:							
37	Minimum Acceptable Cash	15,000						
38	Maximum Acceptable Cash	40,000						
39	Borrowing Rate (Annual)	8%	Monthly	0.67%				
40	Lending Rate (Annual)	6%	Monthly	0.50%				

August (column G): The firm is projecting an unadjusted cash balance of $120,798, well in excess of the maximum allowable cash. Before investing the excess, however, it needs to pay off the $105,292 of existing short-term debt. In this case, the firm can pay off the entire balance and still remain above the minimum cash requirement. However, after paying down the loans, its cash balance is not high enough to cause investment of excess funds.
September (column H): The firm is projecting that the unadjusted cash balance will be $44,856. In this case, there is no borrowing balance, so the $4,856 in excess of the maximum allowable cash can be invested and the ending cash balance will be $40,000. Note that the Cumulative Borrowing (Investing) in H34 is negative, indicating that the funds represent investments.

In any complex worksheet such as this one, it is important that you work through the calculations by hand to check the results. Never accept the output until you are sure that it is absolutely correct. With this in mind, let's change the maximum acceptable cash in B38 to `$15,000` and work through this alternative scenario. First, make sure that this portion of your worksheet is the same as that in Exhibit 3-9.

EXHIBIT 3-9
CASH BALANCE AFTER CHANGING MAXIMUM CASH TO $15,000

	A	B	C	D	E	F	G	H
28	Beginning Cash Balance				15,000	15,000	15,000	15,000
29	Collections - Disbursements				(18,775)	(91,492)	105,798	29,353
30	Unadjusted Cash Balance			20,000	(3,775)	(76,492)	120,798	44,353
31	Current Borrowing			0	13,775	91,492	(105,267)	0
32	Current Investing			5,000	(5,000)	0	531	29,353
33	**Ending Cash Balance**			**15,000**	**15,000**	**15,000**	**15,000**	**15,000**
34	Cumulative Borrowing (Investing)			(5,000)	13,775	105,267	(531)	(29,884)
35	Cumulative Interest Expense (Inc.)				(25)	67	769	766
36	Notes:							
37	Minimum Acceptable Cash	15,000						
38	Maximum Acceptable Cash	15,000						
39	Borrowing Rate (Annual)	8%	Monthly	0.67%				
40	Lending Rate (Annual)	6%	Monthly	0.50%				

June (column E): The firm is projecting the unadjusted cash balance to be –$3,775, but it does not borrow $18,775 (=$15,000 – [–$3,775]) because it has $5,000 in investments from May that reduce the borrowing need to only $13,775. Current Investing, therefore, is –$5,000.
July (column F): The unadjusted cash balance is projected to be –$76,492 and there are no investments that can be sold. Therefore the firm must borrow $91,492. The cumulative borrowing is now $105,267.
August (column G): The firm is expected to have a large surplus of funds which can be used to pay off the entire loan balance. Furthermore, it will have

$531 in excess of the maximum allowable cash which is available to invest.
September (column H): The unadjusted cash balance is expected to be $44,353 which is $29,353 in excess of the maximum. This amount can be invested.

You are encouraged to experiment by changing values throughout the cash budget to see what happens. In particular, changing the projected sales and/or the payment schedule can be very enlightening. For example, suppose that Bithlo Barbecues' management decides to slow down payments for inventory purchases. Specifically, assume that it decides to pay only 40% in the month after the purchase, and 60% two months after the purchase. You should find that this is not as good an idea as it sounds. Table 3-4 shows Cumulative Investing (Borrowing) before and after the change, assuming that the maximum cash is still $15,000.

TABLE 3-4
CUMULATIVE BORROWING (INVESTING)

Month	Before	After
May	(5,000)	(5,000)
June	13,775	11,575
July	105,267	108,852
August	(531)	12,178
September	(29,984)	(7,791)
Cumulative Interest Expense Through September	766	859

Summary

In this chapter we have seen that the cash budget is simply a listing of the firm's expected *cash* inflows and outflows over a period of time. Cash budgets are useful in determining the firm's short-term borrowing and investing needs, as well as scheduling transactions. The cash budget is composed of three sections: (1) the worksheet area; (2) collections and disbursements; and (3) the ending cash balance. We also saw how Excel's Scenario Manager tool can greatly simplify "What if?" analysis and display a table of the results.

One of the most important lessons in this chapter is that complex spreadsheets should be built up from simpler spreadsheets. In other words, start by building a simple version of the worksheet that covers the basics, and then gradually add the complex details. In this chapter, we started with a very simple cash budget, then added borrowing, interest on borrowing, and finally investing and the interest on invested funds. This method will make building the worksheet much easier and it will be less likely to contain errors. If you do find errors, we have covered some of the tools that Excel provides to help you find and fix them quickly. The Watch Window and Evaluate Formula tools are especially helpful in this regard.

TABLE 3-5
FUNCTIONS INTRODUCED IN THIS CHAPTER

Purpose	Function	Page
Returns a value based on a logical test	**IF(*LOGICAL_TEST, VALUE_IF_TRUE,*** *VALUE_IF_FALSE*)	76
Determines the minimum of a list of arguments	**MIN(*NUMBER1,*** *NUMBER2*,...)	86
Returns true only if all arguments are true	**AND(*LOGICAL1*,** *LOGICAL2*,...)	91

Problems

1. Littleton Electronics' ending cash balance as of January 31, 2005, (the end of its fiscal year 2004) was $25,000. Its expected cash collections and payments for the next six months are given in the following table.

Month	Collections	Payments
February	$15,000	$18,000
March	$17,500	$19,700
April	$21,300	$24,200
May	$26,000	$25,900
June	$32,000	$26,700
July	$37,500	$28,400

a. Calculate the firm's expected ending cash balance for each month.

b. Assuming that the firm must maintain an ending cash balance of at least $20,000, how much must they borrow during each month?

c. If the firm must pay 8% annual interest on its short-term borrowing, how does this affect your ending cash balance calculations?

d. Finally, how would your ending cash balance change if the firm uses any cash in excess of the minimum to pay off its short-term borrowing in each month?

2. Huggins and Griffin Financial Planners have forecasted revenues for the first six months of 2005 as shown in the following table.

Month	Revenue
November 2004	$48,000
December 2004	$45,000
January 2005	$25,000
February	$27,000
March	$30,000
April	$38,000
May	$40,000
June	$45,000

The firm collects 60% of its sales immediately, 39% one month after the sale, and 1% are written off as bad debts two months after the sale. The firm assumes that wages and benefits paid to clerical personnel will be $7,000 per month while commissions to sales associates average 25% of collectable sales. Each of the two partners is paid $5,000 per month or 20% of net sales, whichever is greater. Commissions and partner salaries are paid one month after the revenue is earned. Rent expense for their office space is $2,500 per month, and lease expense for office equipment is $800. Utilities average $175 per month, except in May and June when they average only $100. The ending cash balance in December 2004 was $12,000.

a. Create a cash budget for January to June 2005 and determine the firm's ending cash balance in each month assuming that the partners wish to maintain a minimum cash balance of $8,000.

b. Huggins and Griffin are thinking of obtaining a line of credit from their bank. Based on their expectations for the first six months of the year, what is the minimum amount that would be necessary? Round your answer to the next highest $1,000 and ignore interest charges on short-term debt. (Hint: Look up the **ROUNDUP** function in the online help.)

c. Create three scenarios (best case, base case, and worst case) assuming that sales are 10% better than expected, exactly as expected, or 10% worse than expected. What is the maximum that the firm would need to borrow to maintain its minimum cash balance in all three cases? Use the Scenario Manager and create a summary of your results. Would this change your answer in Part b?

3. You have recently been hired to improve the financial condition of Idaho Springs Hardware, a small chain of three hardware stores in the mountain communities of Colorado. On your first day the owner, Chuck Vitaska, told you that the biggest problem facing the firm has been periodic unexpected cash shortages that have made it necessary for him to delay wage payments to his employees. Having recently received a degree in finance, you immediately realize that your first priority is to develop a cash budget and to arrange for a short-term borrowing agreement with the firm's bank. After looking at the firm's past financial records, you developed a sales forecast for the remainder of the year which is presented in the following table.

Month	Sales
June 2005	$62,000
July	$73,000
August	$76,000
September	$70,000
October	$59,000
November	$47,000
December	$41,000

In addition to the seasonality of sales, you have observed several other patterns. Individuals account for about 40% of the firm's sales, and they pay in cash. The other 60% of sales are to contractors with credit accounts, and due to the credit policy, they have up to 60 days to pay. As a result, about 20% of sales to contractors are paid one month after the sale, and the other 80% is paid two months after the sale. Each month the firm purchases inventory equal to about 45% of the following month's sales. About 30% of this inventory is paid for in the month of delivery, while the remaining 70% is paid one month later.

Each month the company pays its hourly employees a total of $9,000, including benefits. Its salaried employees are paid $12,000, also including benefits. In the past the company has had to borrow to build its stores and for the initial inventories. This debt has resulted in monthly interest payments of $4,000 and monthly principal payments of $221. On average, maintenance at the stores is expected to cost about $700 per month, except in the October to December period when snow removal costs will add about $200 per month. Sales taxes are 7% of quarterly sales and must be paid in June, September, and December. Other taxes are also paid during those months and are expected to be about 4% of quarterly sales in each of those months. The owner wishes to maintain a cash balance of at least $12,000 to limit the risk of cash shortages. The cash balance at the end of May is expected to be $15,000 (before any borrowing or investing).

a. Create a simple cash budget for Idaho Springs Hardware for June to December. Note that your records indicate that sales in April and May were $51,000 and $57,000, respectively. January 2006 sales are expected to be $36,000. What would the ending cash balances be if the firm does not borrow to maintain its $12,000 minimum?

b. Now assume that the firm can borrow from the bank at a rate of 9% per annum to maintain its liquidity and meet its required minimum cash balance. In addition, if the firm has funds in excess of the minimum, it will use the excess to pay off any previous balance.

c. While negotiating a line of credit, the bank's cash management department offered to sweep any cash in excess of the minimum into a money market fund which will return an average of 4% per year after expenses. If you accept this offer, how will it affect the firm's ending cash balances and need to borrow in each month? Note that the firm must have paid off all short-term loans before any excess cash can be invested, and invested funds will be used instead of borrowing when needed.

d. After completing your cash budget, you begin to think of ways to further reduce the firm's borrowing needs. One idea that comes to mind is changing the firm's credit policy with contractors because they seem to always pay at the last minute. Three scenarios come to mind: (1) In the best case, contractors are required to pay for 100% of their purchases during the month after the sale. You believe that this would cause a 5% decline in sales. (2) In the base case, everything remains as already outlined. (3) In the worst case, contractors would be required to pay for 100% of their purchases during the month after the sale, and you believe that this would cause a 20% drop in sales. You decide to use the Scenario Manager to evaluate these scenarios. To summarize the impact of the change, you will examine the impact on the firm's maximum borrowing needs, and cumulative net interest cost (after accounting for investment earnings). In your opinion, should the firm change its credit policy?

4 *Financial Statement Analysis Tools*

After studying this chapter, you should be able to:

1. *Describe what financial ratios are and who uses them.*
2. *Define the five major categories of ratios (liquidity, efficiency, leverage, coverage, and profitability).*
3. *Calculate the common ratios for any firm by using income statement and balance sheet data.*
4. *Use financial ratios to assess a firm's past performance, identify its current problems, and suggest strategies for dealing with these problems.*
5. *Calculate the economic profit of a firm.*

In previous chapters we have seen how the firm's basic financial statements are constructed. In this chapter we will see how financial analysts can use the information contained in the income statement and balance sheet for various purposes.

You can use several tools to evaluate a company, but some of the most valuable are financial ratios. Ratios are an analyst's microscope; they allow us get a better view of the firm's financial health than just looking at the raw financial statements. Ratios are useful both to internal and external analysts of the firm. For internal

purposes, ratios can be useful in planning for the future, setting goals, and evaluating the performance of managers. External analysts use ratios to decide whether to grant credit, to monitor financial performance, to forecast financial performance, and to decide whether to invest in the company.

We will look at many different ratios, but you should be aware that these are, of necessity, only a sampling of the ratios that might be useful. Furthermore, different analysts may calculate ratios slightly differently, so you will need to know exactly how the ratios are calculated in a given situation. The keys to understanding ratio analysis are experience and an analytical mind.

We will divide our discussion of the ratios into five categories based on the information provided:

1. *Liquidity ratios* describe the ability of a firm to meets its current obligations.
2. *Efficiency ratios* describe how well the firm is using its investment in assets to produce sales.
3. *Leverage ratios* reveal the degree to which debt has been used to finance the firm's asset purchases.
4. *Coverage ratios* are similar to liquidity ratios in that they describe the ability of a firm to pay certain expenses.
5. *Profitability ratios* provide indications of how profitable a firm has been over a period of time.

Before we begin the discussion of individual financial ratios, open your Elvis Products International workbook from Chapter 2 and add a new worksheet named "Ratios."

Liquidity Ratios

The term "liquidity" refers to the speed with which an asset can be converted into cash without large discounts to its value. Some assets, such as accounts receivable, can easily be converted to cash with only small discounts. Other assets, such as buildings, can be converted into cash very quickly only if large price concessions are given. We therefore say that accounts receivable are more liquid than buildings.

All other things being equal, a firm with more liquid assets will be more able to meet its maturing obligations (i.e., its bills) than a firm with fewer liquid assets. As you might imagine, creditors are particularly concerned with a firm's ability to pay its bills. To assess this ability, it is common to use the current ratio and/or the quick ratio.

The Current Ratio

Generally, a firm's current assets are converted to cash (e.g., collecting on accounts receivables or selling its inventories) and this cash is used to retire its current liabilities. Therefore, it is logical to assess its ability to pay its bills by comparing the size of its current assets to the size of its current liabilities. The current ratio does exactly this. It is defined as:

$$\text{Current Ratio} = \frac{\text{Current Assets}}{\text{Current Liabilities}} \quad \textbf{(4-1)}$$

Obviously, the higher the current ratio, the higher the likelihood that a firm will be able to pay its bills. So, from the creditor's point of view, higher is better. However, from a shareholder's point of view this is not always the case. Current assets usually have a lower expected return than do fixed assets, so the shareholders would like to see that only the minimum amount of the company's capital is invested in current assets. Of course, too little investment in current assets could be disastrous for both creditors and owners of the firm.

We can calculate the current ratio for 2004 for EPI by looking at the balance sheet (Exhibit 2-5, page 54). In this case, we have:

$$\text{Current Ratio} = \frac{1290.00}{540.20} = 2.39 \text{ times}$$

meaning that EPI has 2.39 times as many current assets as current liabilities. We will determine later whether this is sufficient or not.

Exhibit 4-1 shows the beginnings of our "Ratios" worksheet. Enter the labels as shown.

EXHIBIT 4-1
RATIO WORKSHEET FOR EPI

	A	B	C	D	E
1	**Ratio**		**2004**		**2003**
2	**Liquidity Ratios**				
3	Current		2.39x		
4					

We can calculate the current ratio for 2004 in C3 with the formula: `='Balance Sheet'!C8/'Balance Sheet'!C17`. After formatting to show two decimal places, you will see that the current ratio is 2.39. We have temporarily left column D blank so that we can simply copy the formulas from column C to column E to get the 2003 ratios. We can later delete column D and the formulas will automatically adjust. This is much more efficient than reentering the formulas for 2003.

Notice that we have applied a custom number format (see page 47 to refresh your memory) to the result in C3. In this case, the format is `0.00"x"`. Any text that you include in quotes will be shown along with the number. However, the presence of the text in the display does not affect the fact that it is still a number and may be used for calculations. As an experiment, in D3 enter the formula: `=C3*2`. The result will be 4.78 just as if we hadn't applied the custom format. Now, in C4 type: `2.39x` and then copy the formula from D3 to D4. You will get a #VALUE error because the value in C4 is a text string, not a number. This is one of the great advantages to custom number formatting: We can have both text and numbers in a cell and still use the number for calculations.

The Quick Ratio

Inventories are often the least liquid of the firm's current assets.[1] For this reason, many believe that a better measure of liquidity can be obtained by ignoring inventories. The result is known as the quick ratio (sometimes called the acid-test ratio), and is calculated as:

$$\text{Quick Ratio} = \frac{\text{Current Assets} - \text{Inventories}}{\text{Current Liabilities}} \qquad \textbf{(4-2)}$$

1. That is why you so often see 50% off sales when firms are going out of business.

For EPI in 2004 the quick ratio is:

$$\text{Quick Ratio} = \frac{1290.00 - 836.00}{540.20} = 0.84 \text{ times}$$

Notice that the quick ratio will always be less than the current ratio. This is by design. However, a quick ratio that is too low relative to the current ratio may indicate that inventories are higher than they should be.

We can calculate EPI's 2004 quick ratio in C4 with the formula: `=('Balance Sheet'!C8-'Balance Sheet'!C7)/'Balance Sheet'!C17`. Copying this formula to E4 reveals that the 2003 quick ratio was 0.85. Be sure to remember to enter a label in column A for all of the ratios.

Efficiency Ratios

Efficiency ratios, as the name implies, provide information about how well the company is using its assets to generate sales. For example, if two firms have the same level of sales, but one firm has a lower investment in inventories, we would say that the firm with lower inventories is more efficient with respect to its inventory investment.

There are many different types of efficiency ratios that could be defined. However, we will illustrate five of the most common.

Inventory Turnover Ratio

The inventory turnover ratio measures the number of dollars of sales that are generated per dollar of inventory. It also tells us the number of times that a firm replaces its inventories during a year. It is calculated as:

$$\text{Inventory Turnover Ratio} = \frac{\text{Cost of Goods Sold}}{\text{Inventory}} \quad \textbf{(4-3)}$$

Note that it is also common to use sales in the numerator. Since the only difference between sales and cost of goods sold is a markup, this causes no problems. In addition, you will frequently see the average level of inventories throughout the year in the denominator. Whenever using ratios, you need to be aware of the method of calculation to be sure that you are comparing "apples to apples."

For 2004, EPI's inventory turnover ratio was:

$$\text{Inventory Turnover Ratio} = \frac{3{,}250.00}{836.00} = 3.89 \text{ times}$$

meaning that EPI replaced its inventories about 3.89 times during the year. Alternatively, we could say that EPI generated $3.89 in sales for each dollar invested in inventories.

To calculate the inventory turnover ratio for EPI, enter the formula: `='Income Statement'!C6/'Balance Sheet'!C7` into C6 and copy this formula to E6. Notice that this ratio has deteriorated somewhat from 4 times in 2003 to 3.89 times in 2004. Generally, high inventory turnover is considered to be good because it means that storage costs are low, but if it is too high the firm may be risking inventory outages and the loss of customers.

Accounts Receivable Turnover Ratio

Businesses grant credit for one main reason: to increase sales. It is important, therefore, to know how well the firm is managing its accounts receivable. The accounts receivable turnover ratio (and the average collection period, below) provides us with this information. It is calculated by:

$$\text{Accounts Receivable Turnover Ratio} = \frac{\text{Credit Sales}}{\text{Accounts Receivable}} \quad \textbf{(4-4)}$$

For EPI, the 2004 accounts receivable turnover ratio is (assuming that all sales are credit sales):

$$\text{Accounts Receivable Turnover Ratio} = \frac{3{,}850.00}{402.00} = 9.58 \text{ times}$$

So each dollar invested in accounts receivable generated $9.58 in sales. In cell C7 of your worksheet enter: `='Income Statement'!C5/'Balance Sheet'!C6`. The result is 9.58 which is the same as we found above. Copy this formula to E7 to get the 2003 accounts receivable turnover.

Whether or not 9.58 is a good accounts receivable turnover ratio is difficult to know at this point. We can say that higher is generally better, but too high might indicate that the firm is denying credit to creditworthy customers (thereby losing sales). If the ratio is too low, it would suggest that the firm is having difficulty collecting on its sales. This is particularly true if we find that accounts receivable are increasing faster than sales over a prolonged period.

Average Collection Period

The average collection period tells us, on average, how many days it takes to collect on a credit sale.

$$\text{Average Collection Period} = \frac{\text{Accounts Receivable}}{\text{Annual Credit Sales} / 360} \quad \textbf{(4-5)}$$

Note that the denominator is simply credit sales per day.[2] In 2004, it took EPI an average of 37.59 days to collect on their credit sales:

$$\text{Average Collection Period} = \frac{402.00}{3{,}850.00 / 360} = 37.59 \text{ days}$$

We can calculate the 2004 average collection period in C8 with the formula: `='Balance Sheet'!C6/('Income Statement'!C5/360)`. Copy this to E8 to find that in 2003 the average collection period was 36.84 days which was slightly better than 2004.

Note that this ratio actually provides us with the same information as the accounts receivable turnover ratio. In fact, it can easily be demonstrated by simple algebraic manipulation:

$$\text{Accounts Receivable Turnover Ratio} = \frac{360}{\text{Average Collection Period}}$$

or alternatively:

$$\text{Average Collection Period} = \frac{360}{\text{Accounts Receivable Turnover Ratio}}$$

Since the average collection period is (in a sense) the inverse of the accounts receivable turnover ratio, it should be apparent that the inverse criteria apply to judging this ratio. In other words, lower is usually better, but too low may indicate lost sales.

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2. The use of a 360-day year dates back to the days before computers. It was derived by assuming that there are 12 months, each with 30 days. You may also use 365 days; the difference is irrelevant as long as you are consistent.

Fixed Asset Turnover Ratio

The fixed asset turnover ratio describes the dollar amount of sales that are generated by each dollar invested in fixed assets. It is given by:

$$\text{Fixed Asset Turnover} = \frac{\text{Sales}}{\text{Net Fixed Assets}} \quad \textbf{(4-6)}$$

For EPI, the 2004 fixed asset turnover is:

$$\text{Fixed Asset Turnover} = \frac{3{,}850.00}{360.80} = 10.67 \text{ times}$$

So, EPI generated $10.67 for each dollar invested in fixed assets. In your "Ratios" worksheet, entering: `='Income Statement'!C5/'Balance Sheet'!C11` into C9 will confirm that the fixed asset turnover was 10.67 times in 2004. Again, copy this formula to E9 to get the 2003 ratio.

Total Asset Turnover Ratio

Like the other ratios discussed in this section, the total asset turnover ratio describes how efficiently the firm is using its assets to generate sales. In this case, we look at the firm's total asset investment:

$$\text{Total Asset Turnover} = \frac{\text{Sales}}{\text{Total Assets}} \quad \textbf{(4-7)}$$

In 2004, EPI generated $2.33 in sales for each dollar invested in total assets:

$$\text{Total Asset Turnover} = \frac{3{,}850.00}{1{,}650.80} = 2.33 \text{ times}$$

This ratio can be calculated in C10 on your worksheet with: `='Income Statement'!C5/'Balance Sheet'!C12`. After copying this formula to E10, you should see that the 2003 value was 2.34, essentially the same as 2004.

We can interpret the asset turnover ratios as follows: Higher is better. However, you should be aware that some industries will naturally have lower turnover ratios than others. For example, a consulting business will almost surely have a very low investment in fixed assets, and therefore a high fixed asset turnover ratio. On the other hand, an electric utility will have a large investment in fixed assets and a low fixed asset turnover ratio. This does not mean, necessarily, that the utility company

is more poorly managed than the consulting firm. Rather, each is simply responding to the demands of their industry.

At this point your worksheet should resemble the one in Exhibit 4-2. Notice that we have applied the custom format, discussed above, to most of these ratios. In C8, however, we used the custom format `0.00" days"` since the average collection period is measured in days.

EXHIBIT 4-2
EPI'S FINANCIAL RATIOS

	A	B	C	D	E	F
1	**Ratio**		**2004**		**2003**	
2	**Liquidity Ratios**					
3	Current		2.39x		2.33x	
4	Quick		0.84x		0.85x	
5	**Efficiency Ratios**					
6	Inventory Turnover		3.89x		4.00x	
7	A/R Turnover		9.58x		9.77x	
8	Average Collection Period		37.59 days		36.84 days	
9	Fixed Asset Turnover		10.67x		9.95x	
10	Total Asset Turnover		2.33x		2.34x	

Leverage Ratios

In physics, leverage refers to a multiplication of force. Using a lever and fulcrum, you can press down on one end of a lever with a given force, and get a larger force at the other end. The amount of leverage depends on the length of the lever and the position of the fulcrum. In finance, leverage refers to a multiplication of changes in profitability measures. For example, a 10% increase in sales might lead to a 20% increase in net income.[3] The amount of leverage depends on the amount of debt that a firm uses to finance its operations, so a firm which uses a lot of debt is said to be "highly leveraged."

Leverage ratios describe the degree to which the firm uses debt in its capital structure. This is important information for creditors and investors in the firm. Creditors might be concerned that a firm has too much debt and will therefore have

3. As we will see in Chapter 6, this would mean that the degree of combined leverage is 2.

difficulty in repaying loans. Investors might be concerned because a large amount of debt can lead to a large amount of volatility in the firm's earnings. However, most firms use some debt. This is because the tax deductibility of interest can increase the wealth of the firm's shareholders. We will examine several ratios that help to determine the amount of debt that a firm is using. How much is too much depends on the nature of the business.

The Total Debt Ratio

The total debt ratio measures the total amount of debt (long-term and short-term) that the firm uses to finance its assets:

$$\text{Total Debt Ratio} = \frac{\text{Total Debt}}{\text{Total Assets}} = \frac{\text{Total Assets} - \text{Total Equity}}{\text{Total Assets}} \quad \textbf{(4-8)}$$

Calculating the total debt ratio for EPI, we find that debt makes up about 58.45% of their capital structure:

$$\text{Total Debt Ratio} = \frac{964.81}{1{,}650.80} = 58.45\%$$

The formula to calculate the total debt ratio in C12 is: `='Balance Sheet'!C19/'Balance Sheet'!C12`. The result for 2004 is 58.45% which is higher than the 54.81% in 2003.

The Long-Term Debt Ratio

Many analysts believe that it is more useful to focus on just the long-term debt (LTD) instead of total debt. The long-term debt ratio is the same as the total debt ratio, except that the numerator includes only long-term debt:

$$\text{Long-Term Debt Ratio} = \frac{\text{Long-Term Debt}}{\text{Total Assets}} \quad \textbf{(4-9)}$$

EPI's long-term debt ratio is:

$$\text{Long-Term Debt Ratio} = \frac{424.61}{1{,}650.80} = 25.72\%$$

In C13, the formula to calculate the long-term debt ratio for 2004 is : `='Balance Sheet'!C18/'Balance Sheet'!C12`. Copying this formula to E13 reveals

that in 2003 the ratio was only 22.02%. Obviously, EPI has increased its long-term debt at a faster rate than it has added assets.

The Long-Term Debt to Total Capitalization Ratio

Similar to the previous two ratios, the long-term debt to total capitalization ratio tells us the percentage of long-term sources of capital that is provided by long-term debt (LTD). It is calculated by:

$$\text{LTD to Total Capitalization} = \frac{\text{LTD}}{\text{LTD} + \text{Preferred Equity} + \text{Common Equity}} \quad \textbf{(4-10)}$$

For EPI, we have:

$$\text{LTD to Total Capitalization} = \frac{424.61}{424.61 + 685.99} = 38.23\%$$

Since EPI has no preferred equity, its total capitalization consists of long-term debt and common equity. Note that common equity is the total of common stock and retained earnings. We can calculate this ratio in C14 of the worksheet with:`='Balance Sheet'!C18/('Balance Sheet'!C20+'Balance Sheet'!C21+'Balance Sheet'!C18)`. In 2003 this ratio was only 32.76%.

The Debt to Equity Ratio

The debt to equity ratio provides exactly the same information as the total debt ratio, but in a slightly different form that some analysts prefer:

$$\text{Debt to Equity} = \frac{\text{Total Debt}}{\text{Total Equity}} \quad \textbf{(4-11)}$$

For EPI, the debt to equity ratio is:

$$\text{Debt to Equity} = \frac{964.81}{685.99} = 1.41 \text{ times}$$

In C15, this is calculated as: `='Balance Sheet'!C19/'Balance Sheet'!C22`. Copy this to E15 to find that the debt to equity ratio in 2003 was 1.21times.

To see that the total debt ratio and the debt to equity ratio provide the same information, realize that:

$$\frac{\text{Total Debt}}{\text{Total Equity}} = \frac{\text{Total Debt}}{\text{Total Assets}} \times \frac{\text{Total Assets}}{\text{Total Equity}} \quad \textbf{(4-12)}$$

but from rearranging equation (4-8) we know that:

$$\frac{\text{Total Assets}}{\text{Total Equity}} = \frac{1}{1 - \text{Total Debt Ratio}} \quad \textbf{(4-13)}$$

so, by substitution we have:

$$\frac{\text{Total Debt}}{\text{Total Equity}} = \frac{\text{Total Debt}}{\text{Total Assets}} \times \frac{1}{1 - \dfrac{\text{Total Debt}}{\text{Total Assets}}} \quad \textbf{(4-14)}$$

We can convert the total debt ratio into the debt to equity ratio without any additional information (the result is not exact due to rounding):

$$\frac{\text{Total Debt}}{\text{Total Equity}} = 0.5845 \times \frac{1}{1 - 0.5845} = 1.41$$

The Long-Term Debt to Equity Ratio

Once again, many analysts prefer to focus on the amount of long-term debt that a firm carries. For this reason, many analysts like to use the long-term debt to total equity ratio:

$$\text{Long-Term Debt to Equity} = \frac{\text{LTD}}{\text{Preferred Equity} + \text{Common Equity}} \quad \textbf{(4-15)}$$

EPI's long-term debt to equity ratio is:

$$\text{Long-Term Debt to Equity} = \frac{424.61}{685.99} = 61.90\%$$

The formula to calculate EPI's 2004 long-term debt to equity ratio in C16 is: `='Balance Sheet'!C18/'Balance Sheet'!C22`. After copying this formula to E16, note that the ratio was only 48.73% in 2003.

At this point, your worksheet should look like the one in Exhibit 4-3.

EXHIBIT 4-3
EPI'S FINANCIAL RATIOS WITH THE LEVERAGE RATIOS

	A	B	C	D	E
1	**Ratio**		**2004**		**2003**
2	**Liquidity Ratios**				
3	Current		2.39x		2.33x
4	Quick		0.84x		0.85x
5	**Efficiency Ratios**				
6	Inventory Turnover		3.89x		4.00x
7	A/R Turnover		9.58x		9.77x
8	Average Collection Period		37.59 days		36.84 days
9	Fixed Asset Turnover		10.67x		9.95x
10	Total Asset Turnover		2.33x		2.34x
11	**Leverage Ratios**				
12	Total Debt Ratio		58.45%		54.81%
13	Long-term Debt Ratio		25.72%		22.02%
14	LTD to Total Capitalization		38.23%		32.76%
15	Debt to Equity		1.41x		1.21x
16	LTD to Equity		61.90%		48.73%

Coverage Ratios

The coverage ratios are similar to liquidity ratios in that they describe the quantity of funds available to "cover" certain expenses. We will examine two very similar ratios that describe the firm's ability to meet its interest payment obligations. In both cases, higher ratios are desirable to a degree. However, if they are too high, it may indicate that the firm is under-utilizing its debt capacity, and therefore not maximizing shareholder wealth.

The Times Interest Earned Ratio

The times interest earned ratio measures the ability of the firm to pay its interest obligations by comparing earnings before interest and taxes (EBIT) to interest expense:

$$\text{Times Interest Earned} = \frac{\text{EBIT}}{\text{Interest Expense}} \quad \textbf{(4-16)}$$

For EPI in 2004 the times interest earned ratio is:

$$\text{Times Interest Earned} = \frac{149.70}{76.00} = 1.97 \text{ times}$$

In your worksheet, the times interest earned ratio can be calculated in C18 with the formula: `='Income Statement'!C11/'Income Statement'!C12`. Copy the formula to E18 and notice that this ratio has declined rather precipitously from 3.35 in 2003.

The Cash Coverage Ratio

EBIT does not really reflect the cash that is available to pay the firm's interest expense. That is because a non-cash expense (depreciation) has been subtracted in the calculation of EBIT. To correct for this deficiency, some analysts like to use the cash coverage ratio instead of times interest earned. The cash coverage ratio is calculated as:

$$\text{Cash Coverage Ratio} = \frac{\text{EBIT + Non-Cash Expenses}}{\text{Interest Expense}} \quad \textbf{(4-17)}$$

The calculation for EPI in 2004 is:

$$\text{Cash Coverage Ratio} = \frac{149.70 + 20.00}{76.00} = 2.23 \text{ times}$$

Note that the cash coverage ratio will always be higher than the times interest earned ratio. The difference depends on the amount of depreciation expense, and therefore the investment and age of fixed assets.

The cash coverage ratio can be calculated in cell C19 of your "Ratios" worksheet with: `=('Income Statement'!C11+'Income Statement'!C10)/'Income Statement'!C12`. In 2003, the ratio was 3.65.

Profitability Ratios

Investors, and therefore managers, are particularly interested in the profitability of the firms that they own. As we'll see, there are many ways to measure profits. Profitability ratios provide an easy way to compare profits to earlier periods or to other firms. Furthermore, by simultaneously examining the first three profitability ratios, an analyst can discover categories of expenses that may be out of line.

Profitability ratios are the easiest of all of the ratios to analyze. Without exception, high ratios are preferred. However, the definition of high depends on the industry in which the firm operates. Generally, firms in mature industries with lots of competition will have lower profitability measures than firms in younger industries with less competition. For example, grocery stores will have lower profit margins than computer software companies. In the grocery business, a net profit margin of 3% would be considered quite high, but the same margin would be abysmal in the software business.

The Gross Profit Margin

The gross profit margin measures the gross profit relative to sales. It indicates the amount of funds available to pay the firm's expenses other than its cost of sales. The gross profit margin is calculated by:

$$\text{Gross Profit Margin} = \frac{\text{Gross Profit}}{\text{Sales}} \qquad \textbf{(4-18)}$$

In 2004, EPI's gross profit margin was:

$$\text{Gross Profit Margin} = \frac{600.00}{3{,}850.00} = 15.58\%$$

which means that cost of goods sold consumed about 84.42% (= 1 – 0.1558) of sales revenue. We can calculate this ratio in C21 with: `='Income Statement'!C7/'Income Statement'!C5`. After copying this formula to E21, you will see that the gross profit margin has declined from 16.55% in 2003.

The Operating Profit Margin

Moving down the income statement, we can calculate the profits that remain after the firm has paid all of its usual (non-financial) expenses.

The operating profit margin is calculated as:

$$\text{Operating Profit Margin} = \frac{\text{Net Operating Income}}{\text{Sales}} \quad \textbf{(4-19)}$$

For EPI in 2004:

$$\text{Operating Profit Margin} = \frac{149.70}{3{,}850.00} = 3.89\%$$

The operating profit margin can be calculated in C22 with the formula: `='Income Statement'!C11/'Income Statement'!C5`. Note that this is significantly lower than the 6.09% from 2003, indicating that EPI seems to be having problems controlling its costs.

The Net Profit Margin

The net profit margin relates net income to sales. Since net income is profit after all expenses, the net profit margin tells us the percentage of sales that remains for the shareholders of the firm:

$$\text{Net Profit Margin} = \frac{\text{Net Income}}{\text{Sales}} \quad \textbf{(4-20)}$$

The net profit margin for EPI in 2004 is:

$$\text{Net Profit Margin} = \frac{44.22}{3{,}850.00} = 1.15\%$$

which can be calculated on your worksheet in C23 with: `='Income Statement'!C15/'Income Statement'!C5`. This is lower than the 2.56% in 2003, because interest expense is increasing faster than sales.

Taken together, the three profit margin ratios that we have examined show a company that may be losing control over its costs. Of course, high expenses mean lower returns, and we'll see this confirmed by the next three profitability ratios.

Return on Total Assets

The total assets of a firm are the investment that the shareholders have made. Much like you might be interested in the returns generated by your investments, analysts are often interested in the return that a firm is able to get from its investments. The return on total assets is:

$$\text{Return on Total Assets} = \frac{\text{Net Income}}{\text{Total Assets}} \quad \textbf{(4-21)}$$

In 2004, EPI earned about 2.68% on its assets:

$$\text{Return on Total Assets} = \frac{44.22}{1650.80} = 2.68\%$$

For 2004, we can calculate the return on total assets in cell C24 with the formula: `='Income Statement'!C15/'Balance Sheet'!C12`. Notice that this is more than 50% lower than the 5.99% recorded in 2003. EPI's total assets obviously increased in 2004 at a faster rate than did its net income (which actually declined).

Return on Equity

While total assets represent the total investment in the firm, the owners' investment (common stock and retained earnings) usually represent only a portion of this amount (some is debt). For this reason it is useful to calculate the rate of return on the shareholder's invested funds. We can calculate the return on (total) equity as:

$$\text{Return on Equity} = \frac{\text{Net Income}}{\text{Total Equity}} \quad \textbf{(4-22)}$$

Note that if a firm uses no debt, then its return on equity will be the same as its return on assets. The higher a firm's debt ratio, the higher its return on equity will be relative to its return on assets.

In 2004 EPI's return on equity was:

$$\text{Return on Equity} = \frac{44.22}{685.99} = 6.45\%$$

which can be calculated in C25 with: `='Income Statement'!C15/'Balance Sheet'!C22`. Again, copying this formula to E25 reveals that this ratio has declined from 13.25% in 2003.

Return on Common Equity

For firms that have issued preferred stock in addition to common stock, it is often helpful to determine the rate of return on just the common stockholders' investment:

$$\text{Return on Common Equity} = \frac{\text{Net Income Available to Common}}{\text{Common Equity}} \quad \textbf{(4-23)}$$

Net income available to common equity is net income less preferred dividends. In the case of EPI, this ratio is the same as the return on equity because it has no preferred shareholders:

$$\text{Return on Common Equity} = \frac{44.22 - 0}{685.99} = 6.45\%$$

For EPI, the worksheet formula for the return on common equity is exactly the same as for the return on equity.

The Du Pont Analysis

The return on equity (ROE) is important to both managers and investors. The effectiveness of managers is often measured by changes in ROE over time. Therefore, it is important that they understand what they can do to improve the firm's ROE, and that requires knowledge of what causes changes in ROE over time. For example, we can see that EPI's return on equity dropped precipitously from 2003 to 2004. As you might imagine, both investors and managers are probably trying to figure out why this happened. The Du Pont system is one way to look at this problem.

The Du Pont system is a way to break down the ROE into its components. Let's first take another look at the return on assets (ROA):

$$\text{ROA} = \frac{\text{Net Income}}{\text{Total Assets}} = \frac{\text{Net Income}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Total Assets}} \quad \textbf{(4-24)}$$

So, the ROA shows the combined effects of profitability (as measured by the net profit margin) and the efficiency of asset usage (the total asset turnover). Therefore, the ROA could be improved by increasing profitability through expense reductions, or by increasing sales relative to total assets.

As mentioned earlier, the amount of leverage a firm uses is the linkage between the ROA and ROE. Specifically:

$$\text{ROE} = \frac{\text{Net Income}}{\text{Equity}} = \frac{\text{Net Income}}{\text{Total Assets}} \times \frac{\text{Total Assets}}{\text{Equity}} \quad \textbf{(4-25)}$$

Note that the second term in (4-25) is sometimes called the "equity multiplier" and from (4-13) we know it is equal to:

$$\frac{\text{Total Assets}}{\text{Total Equity}} = \frac{1}{1 - \text{Total Debt Ratio}} = \frac{1}{1 - \dfrac{\text{Total Debt}}{\text{Total Assets}}} \quad \textbf{(4-26)}$$

Substituting (4-26) into (4-25) and rearranging we have:

$$\text{ROE} = \frac{\text{Net Income}}{\text{Total Assets}} \div \left(1 - \frac{\text{Total Debt}}{\text{Total Assets}}\right) \quad \textbf{(4-27)}$$

We can now see that the ROE is a function of the firm's ROA and the total debt ratio. If two firms have the same ROA, the one using more debt will have a higher ROE.

We can make one more substitution to completely break down the ROE into its components. Since the first term in (4-27) is the ROA, we can replace it with (4-24):

$$\text{ROE} = \frac{\dfrac{\text{Net Income}}{\text{Sales}} \times \dfrac{\text{Sales}}{\text{Total Assets}}}{1 - \dfrac{\text{Total Debt}}{\text{Total Assets}}} \quad \textbf{(4-28)}$$

Or, to simplify it somewhat:

$$\text{ROE} = \frac{\text{Net Profit Margin} \times \text{Total Asset Turnover}}{1 - \text{Total Debt Ratio}} \quad \textbf{(4-29)}$$

To prove this to yourself, in A28 enter the label: `Du Pont ROE`. Now, in C28 enter the formula: `=(C23*C10)/(1-C12)`. The result will be 6.45% as we found earlier. Note that if a firm uses no debt then the denominator of equation (4-29) will be 1, and the ROE will be the same as the ROA.

Analysis of EPI's Profitability Ratios

Obviously, EPI's profitability has slipped rather dramatically in the past year. The sources of these declines can be seen most clearly if we look at all of EPI's ratios. Before continuing, remember that we left column D in the worksheet blank. We did this so that we could easily calculate the 2003 ratios by simply copying formulas from column C to column E. Now that calculation of the ratios has been completed, we can delete column D to get a better look for the worksheet. At this point your worksheet should resemble the one in Exhibit 4-4.

The gross profit margin in 2004 is lower than in 2003, but not significantly (at least compared to the declines in the other ratios). The operating profit margin, however, is significantly lower in 2004 than in 2003. This indicates potential problems in controlling the firm's operating expenses, particularly selling, general, and administrative expenses. The other profitability ratios are lower than in 2003 partly because of the "trickle down" effect of the increase in operating expenses. However, they are also lower because EPI has taken on a lot of extra debt in 2004, resulting in interest expense increasing faster than sales. This can be confirmed by examining EPI's common-size income statement (Exhibit 2-3, page 50).

Finally, the Du Pont analysis of the firm's ROE has shown us that it could be improved by any of the following: (1) Increasing the net profit margin; (2) Increasing the total asset turnover; or (3) Increasing the amount of debt relative to equity. Our ratio analysis has shown that operating expenses have grown considerably, leading to the decline in the net profit margin. Reducing these expenses should be the primary objective of management. Since the total asset turnover ratio is near the industry average, as we'll soon see, it may be difficult to increase this ratio. However, the firm's inventory turnover ratio is considerably below the industry average and inventory control may provide one method of improving the total asset turnover. An increase in debt is not called for, since the firm already has somewhat more debt than the industry average.

EXHIBIT 4-4
COMPLETED RATIO WORKSHEET FOR EPI

	A	B	C	D
1	**Ratio**		**2004**	**2003**
2	**Liquidity Ratios**			
3	Current		2.39x	2.33x
4	Quick		0.84x	0.85x
5	**Efficiency Ratios**			
6	Inventory Turnover		3.89x	4.00x
7	A/R Turnover		9.58x	9.77x
8	Average Collection Period		37.59 days	36.84 days
9	Fixed Asset Turnover		10.67x	9.95x
10	Total Asset Turnover		2.33x	2.34x
11	**Leverage Ratios**			
12	Total Debt Ratio		58.45%	54.81%
13	Long-term Debt Ratio		25.72%	22.02%
14	LTD to Total Capitalization		38.23%	32.76%
15	Debt to Equity		1.41x	1.21x
16	LTD to Equity		61.90%	48.73%
17	**Coverage Ratios**			
18	Times Interest Earned		1.97x	3.35x
19	Cash Coverage Ratio		2.23x	3.65x
20	**Profitability Ratios**			
21	Gross Profit Margin		15.58%	16.55%
22	Operating Profit Margin		3.89%	6.09%
23	Net Profit Margin		1.15%	2.56%
24	Return on Total Assets		2.68%	5.99%
25	Return on Equity		6.45%	13.25%
26	Return on Common Equity		6.45%	13.25%
27				
28	Du Pont ROE		6.45%	13.25%

Financial Distress Prediction

The last thing any investor wants is to invest in a firm that is nearing a bankruptcy filing or about to suffer through a period of severe financial distress. Starting in the late 1960's and continuing today, scholars and credit analysts have spent considerable time and effort trying to develop models that could identify such

companies in advance. The best-known of these models was created by Professor Edward Altman in 1968.[4] We will discuss Altman's original model and later one developed for privately-held companies.

The Original Z-Score Model

The Z-score model was developed using a statistical technique known as Multiple Discriminant Analysis. This technique allows an analyst to place a company into one of two (or more) groups depending on the score. If the score is below the cutoff point, it is placed into group 1 (soon to be bankrupt), otherwise it is placed into group 2. In fact, Altman also identified a third group that fell into a so-called "gray zone." These companies could go either way, but should definitely be considered greater credit risks than those in group 2. Generally, the lower the Z-score, the higher the risk of financial distress or bankruptcy.

The original Z-score model for publicly traded companies is:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + X_5 \quad \textbf{(4-30)}$$

where the variables are the following financial ratios:

X_1 = net working capital/total assets

X_2 = retained earnings/total assets

X_3 = EBIT/total assets

X_4 = market value of all equity/book value of total liabilities

X_5 = sales/total assets

Altman reports that this model is between 80–90% accurate if we use a cutoff point of 2.675. That is, a firm with a Z-score below 2.675 can reasonably be expected to experience severe financial distress, and possibly bankruptcy, within the next year.

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4. See E. Altman, "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy," *Journal of Finance*, September 1968. The models discussed in this section are from an updated version of this paper written in July 2000: E. Altman, "Predicting Financial Distress of Companies: Revisiting the Z-Score and ZETA Models." This paper may be obtained from http://www.defaultrisk.com/pp_score_14.htm.

The predictive ability of the model is even better if we use a cutoff point of 1.81. There are, therefore, three ranges of Z-scores:

$Z < 1.81$	Bankruptcy predicted within one year
$1.81 < Z < 2.675$	Financial distress, possible bankruptcy
$Z > 2.675$	No financial distress predicted

We can easily apply this model to EPI in the Ratios worksheet. However, first note that we haven't supplied information regarding the market value of EPI's common stock. In A29 enter the label: `Market Value of Equity` and in C29 enter `884,400`. The market value of the equity is found by multiplying the share price by the number of shares outstanding. Next, enter: `Z-Score` into A30, and in C30 enter the formula: `=1.2*('Balance Sheet'!C8-'Balance Sheet'!C17)/'Balance Sheet'!C12+1.4*('Balance Sheet'!C21/'Balance Sheet'!C12)+3.3*('Income Statement'!C11/'Balance Sheet'!C12)+0.6*(C29/'Balance Sheet'!C19)+('Income Statement'!C5/'Balance Sheet'!C12).` If you've entered the equation correctly, you will find that EPI's Z-score in 2004 is 3.92, which is safely above 2.675, so bankruptcy isn't predicted.

The Z-Score Model for Private Firms

Because variable X_4 in equation (4-30) requires knowledge of the firm's market capitalization (including both common and preferred equity), we cannot easily use the model for privately held firms. Estimates of the market value of these firms can be made, but the result is necessarily very uncertain. Alternatively, we could substitute the book value of equity for its market value, but that wouldn't be correct. Most publicly traded firms trade for several times their book value, so such a substitution would seem to call for a new coefficient for X_4. In fact, all of the coefficients in the model changed when Altman reestimated it for privately held firms.

The new model for privately held firms is:

$$Z' = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5 \quad \textbf{(4-31)}$$

where all of the variables are defined as before, except that X_4 uses the book value of equity. Altman reports that this model is only slightly less accurate than the one for publicly traded firms when we use the new cutoff points shown below.

$Z' < 1.21$	Bankruptcy predicted within one year
$1.23 < Z' < 2.90$	Financial distress, possible bankruptcy
$Z' > 2.90$	No financial distress predicted

Using Financial Ratios

Calculating financial ratios is a pointless exercise unless you understand how to use them. One overriding rule of ratio analysis is this: *A single ratio provides very little information, and may be misleading*. You should never draw conclusions from a single ratio. Instead, several ratios should support any conclusions that you make.

With that precaution in mind, there are several ways that ratios can be used to draw important conclusions.

Trend Analysis

Trend analysis involves the examination of ratios over time. Trends, or lack of trends, can help managers gauge their progress towards a goal. Furthermore, trends can highlight areas in need of attention. While we don't really have enough information on Elvis Products International to perform a trend analysis, it is obvious that many of its ratios are moving in the wrong direction.

For example, all of EPI's profitability ratios have declined in 2004 relative to 2003, some rather dramatically. Management should immediately try to isolate the problem areas. For example, the gross profit margin has declined only slightly, indicating that increasing materials costs are not a major problem (though a price increase may be called for). The operating profit margin has fallen by about 36%, and since we can't blame increasing costs of goods sold, we must conclude that operating costs have increased at a more rapid rate than revenues. This increase in operating costs has led, to a large degree, to the decline in the other profitability ratios.

One potential problem area for trend analysis is seasonality. We must be careful to compare similar time periods. For example, many firms generate most of their sales during the holidays in the fourth quarter of the year. For this reason they may begin building inventories in the third quarter when sales are low. In this situation, comparing the third quarter inventory turnover ratio to the fourth quarter inventory turnover would be misleading.

Comparing to Industry Averages

Aside from trend analysis, one of the most beneficial uses of financial ratios is to compare similar firms within a single industry. Most often this is done by comparing to the industry average ratios which are published by organizations such as Robert Morris Associates and Standard & Poor's. These industry averages provide a standard of comparison so that we can determine how well a firm is performing relative to its peers.

As an example of the use of industry averages, consider Exhibit 4-5 (page 126) which shows EPI's financial ratios and the industry averages for 2004. You can enter the industry averages from Exhibit 4-5 into your worksheet starting in B1 with the label: `Industry 2004`. In order to get the text to wrap, as we have done, choose F**o**rmat C**e**lls . . . and then the Alignment tab. Click on "Wrap Text" so that there is an X in the box. To enter the numbers, first select B3:B26, and notice that B3 will not be darkened. Type `2.70` into B3 and then press the Enter key. Notice that the active cell will change to B4 as soon as the Enter key is pressed. This may be a more efficient method of entering a lot of numbers because your fingers never have to leave the number keypad. This technique is especially helpful when entering numbers into multiple columns and discontiguous cells.

It should be obvious that EPI is not being managed as well as the average firm in the industry. From the liquidity ratios we can see that EPI is less able to meet its short-term obligations than the average firm, though they are probably not in imminent danger of missing payments. The efficiency ratios show us that EPI is not managing its assets as well as would be expected, especially their inventories. It is also obvious that EPI is using substantially more debt than its peers. The coverage ratios indicate that EPI has less cash to pay its interest expense than the industry average. This may be due to its carrying more than average debt. Finally, all of these problems have led to sub-par profitability measures which seem to be getting worse, rather than better.

It is important to note that industry averages may not be appropriate in all cases. In many cases it is probably more accurate to define the "industry" as the target

EXHIBIT 4-5
EPI'S RATIOS VS. INDUSTRY AVERAGES

	A	B	C	D
1	**Ratio**	**Industry 2004**	**2004**	**2003**
2	**Liquidity Ratios**			
3	Current	2.70x	2.39x	2.33x
4	Quick	1.00x	0.84x	0.85x
5	**Efficiency Ratios**			
6	Inventory Turnover	7.00x	3.89x	4.00x
7	A/R Turnover	10.70x	9.58x	9.77x
8	Average Collection Period	33.64 days	37.59 days	36.84 days
9	Fixed Asset Turnover	11.20x	10.67x	9.95x
10	Total Asset Turnover	2.60x	2.33x	2.34x
11	**Leverage Ratios**			
12	Total Debt Ratio	50.00%	58.45%	54.81%
13	Long-term Debt Ratio	20.00%	25.72%	22.02%
14	LTD to Total Capitalization	28.57%	38.23%	32.76%
15	Debt to Equity	1.00x	1.41x	1.21x
16	LTD to Equity	40.00%	61.90%	48.73%
17	**Coverage Ratios**			
18	Times Interest Earned	2.50x	1.97x	3.35x
19	Cash Coverage Ratio	2.80x	2.23x	3.65x
20	**Profitability Ratios**			
21	Gross Profit Margin	17.50%	15.58%	16.55%
22	Operating Profit Margin	6.25%	3.89%	6.09%
23	Net Profit Margin	3.50%	1.15%	2.56%
24	Return on Total Assets	9.10%	2.68%	5.99%
25	Return on Equity	18.20%	6.45%	13.25%
26	Return on Common Equity	18.20%	6.45%	13.25%

company's most closely related competitors. This group is probably far smaller (maybe only three to five companies) than the entire industry as defined by the 4-digit SIC code. The new 6-digit NAICS codes will improve, but not eliminate, this situation.[5]

5. North American Industry Classification System. This system was created by the U.S. Census Bureau and its Canadian and Mexican counterparts in 1997 and is slowly replacing the SIC codes. See http://www.census.gov/epcd/www/naics.html for more information.

Company Goals and Debt Covenants

Financial ratios are often the basis of company goal setting. For example, a CEO might decide that one goal of the firm should be to earn at least 15% on equity (ROE = 15%). Obviously, whether or not this goal is achieved can be determined by calculating the return on equity. Further, by using trend analysis managers can gauge progress towards meeting goals, and they can determine whether goals are realistic or not.

Another use of financial ratios can be found in covenants loan to contracts. When companies borrow money, the lenders (bondholders, banks, or other lenders) place restrictions on the company, very often tied to the values of certain ratios. For example, the lender may require that the borrowing firm maintain a current ratio of at least 2.0. Or, it may require that the firm's total debt ratio not exceed 40%. Whatever the restriction, it is important that the firm monitor its ratios for compliance, or the loan may be due immediately.

Automating Ratio Analysis

Ratio analysis is a very subjective endeavor. Different analysts are likely to render somewhat different judgements on a firm. Nonetheless, you can have Excel do a rudimentary analysis for you. Actually, the analysis could be made quite sophisticated if you are willing to put in the effort. The technique that we will illustrate is analogous to creating an expert system, though we wouldn't call it a true expert system at this point.

An *expert system* is a computer program that can diagnose problems or provide an analysis by using the same techniques as an expert in the field. For example, a medical doctor might use an expert system to diagnose a patient's illness. The doctor would tell the system about the symptoms and the expert system would consult its list of rules to generate a likely diagnosis.

Building a true ratio analysis expert system in Excel would be very time consuming, and there are better tools available. However, we can build a very simple system using only a few functions. Our system will analyze each ratio separately, and will only determine whether a ratio is either "Good," "Ok," or "Bad." To be really useful, the system would need to consider the interrelationships between the ratios, the industry that the company is in, etc. We leave it to you to improve the system.

As a first step in developing our expert system we need to specify the rules that will be used to categorize the ratios. In most cases, we have seen that the higher the ratio the better. Therefore, we would like to see that the ratio is higher in 2004 than in 2003, and that the 2004 ratio is greater than the industry average.

We can use Excel's built-in **IF** statement to implement our automatic analysis. Recall that the **IF** statement returns one of two values, depending on whether a statement is true or false:

IF(*LOGICAL_TEST*, *VALUE_IF_TRUE*, *VALUE_IF_FALSE*)

Where ***LOGICAL_TEST*** is any statement which can be evaluated as true or false, and ***VALUE_IF_TRUE*** and *VALUE_IF_FALSE* are the return values which depend on whether ***LOGICAL_TEST*** was true or false.

We actually want to make two tests to determine whether a ratio is "Good," "Ok," or "Bad." First, we will test to see if the 2004 ratio is greater than the 2003 ratio. To do this, we divide the 2004 value by the 2003 value. If the result is greater than one, then the 2004 ratio is greater than the 2003 ratio. Using only this test, our formula for the current ratio would be: `=IF(C3/D3>=1,"Good","Bad")` in E3. In this case the result should be "Good" since the 2004 value is greater than the 2003 value. If you copy this formula to E4, the result will be "Bad" since the 2004 quick ratio is lower than the 2003 quick ratio.

We can modify this formula to also take account of the industry average. If the 2004 ratio is greater than the 2003 ratio **and** the 2004 ratio is greater than the industry average, then the ratio is "Good". To accomplish this we need to use the **AND** function. This function will return true only if all arguments are true:

AND(*LOGICAL1*, *LOGICAL2*, . . .)

In this function ***LOGICAL1*** and ***LOGICAL2*** are the two required arguments that can each be evaluated to be either true or false. You can have up to 29 arguments, but only two are required. The modified function in E3 is now: `=IF(And(C3/D3>=1,C3/B3>=1),"Good","Bad")`. Now, the ratio will only be judged as "Good" if both conditions are true. Note that they are not for the current ratio.

One final improvement can be made by adding "Ok" to the possible outcomes. We will say that the ratio is "Ok" if the 2004 value is greater than the 2003 value, **or** the 2004 value is greater than the industry average. We can accomplish this by nesting a second **IF** statement inside the first in place of "Bad." For the second **IF** statement, we need to use Excel's **OR** function:

OR(*LOGICAL1*, *LOGICAL2*, . . .)

This function is identical to the **AND** function, except that it returns true if any of its arguments are true. The final form of our equation is: `=IF(AND(C3/D3>=1,C3/B3>=1),"Good",IF(OR(C3/D3>=1,C3/B3>=1),"Ok","Bad"))`. For the current ratio, this will evaluate to "Ok." You can now evaluate all of EPI's ratios by copying this formula to E4:E26 and clearing the unnecessary copies in E5, E11, E17, and E20.

One more change is necessary. Recall that for leverage ratios, lower is generally better. Therefore, change all of the ">=" to "<=" in E12:E16. You also need to make the same change in E8 for the average collection period. Your worksheet should now resemble that in Exhibit 4-6.

You should see that nearly all of EPI's ratios are judged to be "Bad." This is exactly what our previous analysis has determined, except that Excel has done it automatically. There are many changes that could be made to improve on this simple ratio analyzer, but we will leave that job as an exercise for you.

EXHIBIT 4-6
EPI'S RATIOS WITH AUTOMATIC ANALYSIS

	A	B	C	D	E
1	Ratio	Industry 2004	2004	2003	Analysis
2	**Liquidity Ratios**				
3	Current	2.70x	2.39x	2.33x	Ok
4	Quick	1.00x	0.84x	0.85x	Bad
5	**Efficiency Ratios**				
6	Inventory Turnover	7.00x	3.89x	4.00x	Bad
7	A/R Turnover	10.70x	9.58x	9.77x	Bad
8	Average Collection Period	33.64 days	37.59 days	36.84 days	Bad
9	Fixed Asset Turnover	11.20x	10.67x	9.95x	Ok
10	Total Asset Turnover	2.60x	2.33x	2.34x	Bad
11	**Leverage Ratios**				
12	Total Debt Ratio	50.00%	58.45%	54.81%	Bad
13	Long-term Debt Ratio	20.00%	25.72%	22.02%	Bad
14	LTD to Total Capitalization	28.57%	38.23%	32.76%	Bad
15	Debt to Equity	1.00x	1.41x	1.21x	Bad
16	LTD to Equity	40.00%	61.90%	48.73%	Bad
17	**Coverage Ratios**				
18	Times Interest Earned	2.50x	1.97x	3.35x	Bad
19	Cash Coverage Ratio	2.80x	2.23x	3.65x	Bad
20	**Profitability Ratios**				
21	Gross Profit Margin	17.50%	15.58%	16.55%	Bad
22	Operating Profit Margin	6.25%	3.89%	6.09%	Bad
23	Net Profit Margin	3.50%	1.15%	2.56%	Bad
24	Return on Total Assets	9.10%	2.68%	5.99%	Bad
25	Return on Equity	18.20%	6.45%	13.25%	Bad
26	Return on Common Equity	18.20%	6.45%	13.25%	Bad

Economic Profit Measures of Performance

Economic profit is the profit earned in excess of the firm's costs, including its implicit opportunity costs (primarily its cost of capital). Accounting profit (net income), however, measures profit as revenues minus all of the firm's explicit costs. It takes into account a firm's cost of debt capital (interest expense), but it ignores the implicit cost of the firm's equity capital. The concept of economic profit is an old one, but it has been revived in the past few years by consulting firms promising to improve the financial performance and executive compensation

practices of their clients.[6] Many large firms have switched to various measures of economic profit—some with good results and some not. In any case, the method has generated a lot of interest, and we will include a short discussion of measuring economic profit in this section.

The basic idea behind economic profit measures is that the firm cannot increase shareholder wealth unless it makes a profit in excess of its cost of capital.[7] Because we will be taking account of the cost of capital explicitly, we cannot use the normal accounting measures of profit directly. The adjustments to the financial statements vary depending on the firm and who is doing the calculations. At the moment, there is no completely accepted standard. With this in mind, we will present a simplified economic profit calculation.

Mathematically, economic profit is:

$$\text{Economic Profit} = \text{NOPAT} - \text{After-tax cost of operating capital} \quad \textbf{(4-32)}$$

where NOPAT is net operating profit after taxes. The after-tax cost of operating capital is the dollar cost of all interest-bearing debt instruments (i.e., bonds and notes payable) plus the dollar cost of preferred and common equity. Generally, the firm's after-tax cost of capital (a percentage amount) is calculated and then multiplied by the amount of operating capital to obtain the dollar cost.

To calculate the economic profit, we must first calculate NOPAT, total operating capital and the firm's cost of capital. For our purposes in this chapter, the cost of capital will be given.[8] NOPAT is the after-tax operating profit of the firm:

$$\text{NOPAT} = \text{EBIT}(1 - \text{tax rate}) \quad \textbf{(4-33)}$$

Note that the NOPAT calculation does not include interest expense because it will be explicitly accounted for when we subtract the cost of all capital.

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6. The leader in this effort is the consulting firm Stern Stewart and Company who refer to economic profit by the copyrighted name Economic Value Added (EVA).
7. Economic profit is also measured by NPV, which is introduced in Chapter 10. The primary difference is that in this chapter we are trying to calculate the actual economic profit that was earned over some previous time period (usually the previous year). NPV measures the expected economic profit of a future investment.
8. Chapter 9 covers the calculations necessary to calculate a firm's after-tax weighted average cost of capital.

Total operating capital is the sum of non-interest-bearing current assets and net fixed assets, less non-interest-bearing current liabilities. We ignore interest-bearing current assets because they are not operating assets, and we ignore interest-bearing current liabilities (e.g., notes payable) because the cost of these liabilities is included in the cost of capital.

We will demonstrate the calculation of economic profit using the Elvis Products International data for 2003 and 2004. Make sure that the workbook containing EPI's financial statements is open, and insert a new worksheet for our economic profit calculations. Set up your new worksheet as shown in Exhibit 4-7 and rename the sheet "Economic Profit."

EXHIBIT 4-7
ECONOMIC PROFIT CALCULATION FOR EPI

	A	B	C	D
1	**Elvis Products International**			
2	**Economic Profit Calculations**			
3		**2004**		**2003**
4	Tax Rate	40%		40%
5	NOPAT			
6	Total Operating Capital			
7	After-tax Cost of Capital	13%		13%
8	Dollar Cost of Capital			
9	Economic Profit			

Note that we are assuming that the firm's cost of capital is 13%, and the tax rate is 40%. All of the other numbers must be calculated as discussed above.

Recall that NOPAT is simply EBIT times 1– the tax rate, so in B5 enter the formula: `='Income Statement'!C11*(1-B4)`. You should see that EPI has generated an operating profit of $89,820 in 2004. Copy this formula to D5 to get the NOPAT for 2003.

The next step is to calculate the amount of operating capital. Since EPI has no short-term investments, we merely add current assets to net fixed assets and then subtract current liabilities less notes payable. In B6 enter the formula: `='Balance Sheet'!C8+'Balance Sheet'!C11-('Balance Sheet'!C17'Balance Sheet'!C15)`. You result should show that total operating capital for 2004 was $1,335,600. Copy the formula to D6.

To calculate the dollar cost of capital in B8, enter the formula: `=B7*B6`, and copy this to D8. Recall that economic profit is simply NOPAT minus the dollar cost of capital, so we can calculate the economic profit in B9 with the formula: `=B5-B8`. You should find that EPI earned an economic profit of $-83,808 in 2004. Copy this formula to D9 and you will see that EPI's economic profit in 2003 was $-28,876. Now, delete column C which was left blank to facilitate copying of the formulas.

This example shows how misleading accounting measures of profit (particularly net income) can be. In this case, EPI reported positive profits in both 2003 and 2004, but it was actually decreasing shareholder wealth over the past two years. This result essentially confirms the results from our ratio analysis. EPI's management has not been doing a good job, at least over this period. Your economic profit worksheet should now look like the one in Exhibit 4-8.

EXHIBIT 4-8
EPI'S COMPLETED ECONOMIC PROFIT WORKSHEET

	A	B	C
1	**Elvis Products International**		
2	**Economic Profit Calculations**		
3		**2004**	**2003**
4	Tax Rate	40%	40%
5	NOPAT	89,820	125,460
6	Total Operating Capital	1,335,600	1,187,200
7	After-tax Cost of Capital	13%	13%
8	Dollar Cost of Capital	173,628	154,336
9	Economic Profit	(83,808)	(28,876)

Summary

In this chapter we have seen how various financial ratios can be used to evaluate the financial health of a company, and therefore the performance of the managers of the firm. You have also seen how Excel can make the calculation of ratios quicker and easier than doing it by hand. We looked at five categories of ratios: *Liquidity ratios* measure the ability of a firm to pays its bills; *efficiency ratios* measure how well the firm is making use of its assets to generate sales; *leverage ratios* describe how much debt the firm is using to finance its assets; *coverage ratios* tell how much cash the firm has available to pay specific expenses; and *profitability ratios* measure how profitable the firm has been over a period of time.

We have also seen how Excel can be programmed to do a rudimentary ratio analysis automatically, using only a few of the built-in logical functions. Table 4-1 provides a summary of the ratio formulas that were presented in this chapter. Finally, we looked at the concept of economic profit and saw how it can give a much clearer picture of a firm's financial health than traditional accounting profit measures.

TABLE 4-1
SUMMARY OF FINANCIAL RATIOS

Name of Ratio	Formula	Page
Liquidity Ratios		
Current Ratio	$\frac{\text{Current Assets}}{\text{Current Liabilities}}$	103
Quick Ratio	$\frac{\text{Current Assets} - \text{Inventories}}{\text{Current Liabilities}}$	104
Efficiency Ratios		
Inventory Turnover	$\frac{\text{Cost of Goods Sold}}{\text{Inventory}}$	105
Accounts Receivable Turnover	$\frac{\text{Credit Sales}}{\text{Accounts Receivable}}$	106
Average Collection Period	$\frac{\text{Accounts Receivable}}{\text{Annual Credit Sales} / 360}$	107
Fixed Asset Turnover	$\frac{\text{Sales}}{\text{Net Fixed Assets}}$	108
Total Asset Turnover	$\frac{\text{Sales}}{\text{Total Assets}}$	108
Leverage Ratios		
Total Debt Ratio	$\frac{\text{Total Debt}}{\text{Total Assets}}$	110
Long-Term Debt Ratio	$\frac{\text{Long-Term Debt}}{\text{Total Assets}}$	110

TABLE 4-1 (CONTINUED)
SUMMARY OF FINANCIAL RATIOS

Name of Ratio	Formula	Page
LTD to Total Capitalization	$\frac{\text{LTD}}{\text{LTD + Preferred Equity + Common Equity}}$	111
Debt to Equity	$\frac{\text{Total Debt}}{\text{Total Equity}}$	111
LTD to Equity	$\frac{\text{LTD}}{\text{Preferred Equity + Common Equity}}$	112
Coverage Ratios		
Times Interest Earned	$\frac{\text{EBIT}}{\text{Interest Expense}}$	113
Cash Coverage Ratio	$\frac{\text{EBIT + Non-Cash Expenses}}{\text{Interest Expense}}$	114
Profitability Ratios		
Gross Profit Margin	$\frac{\text{Gross Profit}}{\text{Sales}}$	115
Operating Profit Margin	$\frac{\text{Net Operating Income}}{\text{Sales}}$	116
Net Profit Margin	$\frac{\text{Net Income}}{\text{Sales}}$	116
Return on Total Assets	$\frac{\text{Net Income}}{\text{Total Assets}}$	117
Return on Equity	$\frac{\text{Net Income}}{\text{Total Equity}}$	117
Return on Common Equity	$\frac{\text{Net Income Available to Common}}{\text{Common Equity}}$	118
Du Pont Analysis of ROE	$\frac{\text{Net Profit Margin} \times \text{Total Asset Turnover}}{1 - \text{Total Debt Ratio}}$	119

TABLE 4-2
FUNCTIONS INTRODUCED IN THIS CHAPTER

Purpose	Function	Page
Return a value dependent on test	**IF(*LOGICAL_TEST*, *VALUE_IF_TRUE*,** *VALUE_IF_FALSE*)	128
Returns true if all arguments true	**AND(*LOGICAL1*, *LOGICAL2*,…)**	129
Returns true if one argument is true	**OR(*LOGICAL1*, *LOGICAL2*,…)**	129

Problems

1. Copy the Aspen Industries financial statements from Problem 1 in Chapter 2 into a new workbook.

   a. Set up a ratio worksheet similar to the one in Exhibit 4-4, page 121, and calculate all of the ratios for Aspen Industries.

   b. Identify at least two areas of potential concern using the ratios. Identify at least two areas that have shown improvement.

   c. In 2004 Aspen Industries' ROE increased dramatically. Explain, in words, why this increase occurred using the Du Pont method as shown in equation (4-29).

   d. Aspen Industries has shown an accounting profit in each of the past two years. Calculate their economic profit for these years and compare it to net income. Assume that Aspen's cost of capital is 11%.

   e. Using Altman's model for privately held firms, calculate the Z-score for Aspen Industries. Does it appear that the firm is in imminent danger of bankruptcy?

Internet Exercise

2. Choose your own company and repeat the analysis from Problem 1. You can get the data from MoneyCentral Investor at http://moneycentral.msn.com/investor/home.asp. To retrieve the data for your company, go to the Stocks area and enter the ticker symbol. Now choose Financial Results and then Statements from the menu on the left side of the screen. Display the annual income statement, select the entire data section and copy. Now paste this data directly into a new worksheet. The data will be pasted in HTML format. In Excel 2002 a Smart Tag will appear that will allow you to either "Keep Source Formatting" or "Match Destination Formatting." Experiment to see which one you like best. Repeat these steps for the balance sheet.

   (Note: At the time of this writing, MoneyCentral uses data from Media General Financial Services. The data have been consolidated into consistent categories for easy comparison of different companies. However, there are frequent mistakes. If you need error free data, you should use a source such as Standard & Poor's Compustat or the SEC's Edgar database.)

5 *Financial Forecasting*

After studying this chapter, you should be able to:

1. *Explain how the "percent of sales" method is used to develop pro-forma financial statements, and how to construct such statements in Excel.*
2. *Use the* **TREND** *function for forecasting sales or any other trending variables.*
3. *Perform a regression analysis with Excel's built-in regression tools.*

Forecasting is an important activity for a wide variety of business people. Nearly all of the decisions made by financial managers are made on the basis of forecasts of one kind or another. For example, in Chapter 3, we've seen how the cash budget can be used to forecast short-term borrowing and investing needs. Every item in the cash budget is itself a forecast. In this chapter we will examine several methods of forecasting. The first, the percent of sales method, is the simplest. We will also look at more advanced techniques, such as regression analysis.

The Percent of Sales Method

Forecasting financial statements is important for a number of reasons. Among these reasons are planning for the future and providing information to the company's investors. The simplest method of forecasting income statements and balance sheets is the percent of sales method. This method has the added advantage of requiring relatively little data to make a forecast.

The fundamental premise of the percent of sales method is that many (but not all) income statement and balance sheet items maintain a constant relationship to the level of sales. For example, if the cost of goods sold has averaged 65% of sales over the last several years, we would assume that this relationship would hold for the next year. If sales were expected to be $10 million next year, our cost of goods forecast would be $6.5 million (10 million $\times$ 0.65 = 6.5 million). Of course, this method assumes that the forecasted level of sales is already known.

Forecasting the Income Statement

As an example of income statement forecasting, consider the Elvis Products International statements that you created in Chapter 2. The income statement is recreated here in Exhibit 5-1. Recall that we have used a custom number format to display this data in thousands of dollars. Also, we are only showing the Dollar custom view here.

The level of detail that you have in an income statement will affect how many items will fluctuate directly with sales. In general, we will proceed through the income statement line by line asking the question, "Is it likely that this item will change directly with sales?" If the answer is yes, then we calculate the percentage of sales and multiply the result by the sales forecast for the next period. Otherwise, we will take one of two actions: Leave the item unchanged, or use other information to change the item.[1]

For EPI only one income statement item will clearly change with sales: the cost of goods sold. One other item, selling, general, and administrative expense (SG&A), is a conglomeration of many accounts, some of which will probably change with

1. Realize that you may have important information regarding one or more of these items. For example, if you know that the lease for the company's headquarters building has a scheduled increase, then you should be sure to include this information in your forecast for fixed costs.

sales and some which won't. For our purposes we choose to believe that, on balance, SG&A will change along with sales.

EXHIBIT 5-1
EPI'S INCOME STATEMENTS FOR 2003 AND 2004

	A	C	E
1	**Elvis Products International**		
2	**Income Statement**		
3	**For the Year Ended Dec. 31, 2004 ($ 000's)**		
4		***2004***	***2003***
5	Sales	3,850.00	3,432.00
6	Cost of Goods Sold	3,250.00	2,864.00
7	***Gross Profit***	***600.00***	***568.00***
8	Selling and G&A Expenses	330.30	240.00
9	Fixed Expenses	100.00	100.00
10	Depreciation Expense	20.00	18.90
11	***EBIT***	***149.70***	***209.10***
12	Interest Expense	76.00	62.50
13	***Earnings Before Taxes***	***73.70***	***146.60***
14	Taxes	29.48	58.64
15	***Net Income***	***44.22***	***87.96***

The other items don't change as a result of a change in sales. Depreciation expense, for example, depends on the amount and age of the firm's fixed assets. Interest expense is a function of the amount and maturity structure of debt in the firm's capital structure. Taxes depend directly on the firm's taxable income, though this indirectly depends on the level of sales. All of the other items on the income statement are calculated.

To generate our income statement forecast, we first determine the percentage of sales for each of the prior years for each item that changes. In this case for 2004 we have:

$$\text{Cost of Goods Sold 2004 Percentage of Sales} \quad \frac{\$3,250,000}{3,850,000} = 0.8442 = 84.42\%$$

$$\text{SG\&A Expense 2004 Percentage of Sales} \quad \frac{\$330,300}{3,850,000} = 0.0858 = 8.58\%$$

The 2003 percentages (83.45% and 6.99%, respectively) can be found in exactly the same manner. We now calculate the average of these percentages and use this average as our estimate of the 2005 percentage of sales. The forecast is then found

by multiplying these percentages by next year's sales forecast. Assuming that sales are forecasted to be $4,300,000, then for 2005 we have:

Cost of Goods Sold 2005 Forecast	$4,300,000 × 0.8393 = 3,609,108
SG&A Expense 2005 Forecast	$4,300,000 × 0.0779 = 334,803

Exhibit 5-2 shows a completed forecast for the 2005 income statement. To create this forecast in your worksheet, begin by choosing the "All" view of the income statement. Now, select columns B and C and then choose **I**nsert **C**olumns. This will create two blank columns into which we will enter our forecasts for 2005. In B4 enter: `2005%*` and in C4 enter: `2005*`.[2] Because the 2005 income statement will be calculated in exactly the same way as 2004, the easiest way to proceed is to copy E5:E15 into C5:C15. This will save you from having to enter formulas to calculate subtotals and such (e.g., EBIT). In column B we will calculate the average percentage of sales for each item. In B5 enter the formula: `=AVERAGE(D5,F5)` and copy this formula down through the range B6:B15. Note that we are making use of the common-size data we previously created.[3] Next change the 2005 sales, in C5, to: `4,300,000`. All that remains is to enter the formulas for forecasting cost of goods sold and SG&A. In C6 we enter the formula to calculate the cost of goods sold forecast as: `=B6*C$5` and copy this to C8 so that it reads: `=B8*C$5`. Your worksheet should now look like the one in Exhibit 5-2.

Forecasting Assets on the Balance Sheet

We can forecast the balance sheet in exactly the same way as the income statement. The main difference in this case is that we cannot make use of the common-size information that we created in Chapter 2. This is because the common-size balance sheet calculates the percentages based on total assets not on sales. If necessary, open your EPI workbook and switch to the "Balance Sheet" worksheet before continuing.

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2. The * indicates a footnote that informs the reader that these are forecasts. In some cases, a table might have more than one footnote. In these cases you should enter a number after the label, then select that number and use F**o**rmat C**e**lls to change the font Effects so that it is Sup**e**rscript.
3. If we didn't already have the common-size information, we could have achieved an identical result with the formula: `=Average(E5/E$5,G5/G$5)`.

EXHIBIT 5-2
PERCENT OF SALES FORECAST FOR 2005

	A	B	C	D	E	F	G
1	**Elvis Products International**						
2	**Pro-forma Income Statement**						
3	**For the Year Ended Dec. 31, 2004 ($ 000's)**						
4		***2005%****	***2005***	***2004%***	***2004***	***2003%***	***2003***
5	Sales	100.00%	4,300.00	100.00%	3,850.00	100.00%	3,432.00
6	Cost of Goods Sold	83.93%	3,609.11	84.42%	3,250.00	83.45%	2,864.00
7	***Gross Profit***	16.07%	***690.89***	15.58%	***600.00***	16.55%	***568.00***
8	Selling and G&A Expenses	7.79%	334.80	8.58%	330.30	6.99%	240.00
9	Fixed Expenses	2.76%	100.00	2.60%	100.00	2.91%	100.00
10	Depreciation Expense	0.54%	20.00	0.52%	20.00	0.55%	18.90
11	***EBIT***	4.99%	***236.09***	3.89%	***149.70***	6.09%	***209.10***
12	Interest Expense	1.90%	76.00	1.97%	76.00	1.82%	62.50
13	***Earnings Before Taxes***	3.09%	***160.09***	1.91%	***73.70***	4.27%	***146.60***
14	Taxes @ 40%	1.24%	64.04	0.77%	29.48	1.71%	58.64
15	***Net Income***	1.86%	***96.05***	1.15%	***44.22***	2.56%	***87.96***
16	*Forecasted						
17	Notes:						
18	Tax Rate	40%					

Because we cannot make use of the common-size information, our formulas will be somewhat more complex than for the income statement. However, this should pose no difficulty if you follow along carefully and keep in mind the general premise of the percent of sales method.

Create the percent of sales balance sheet for 2005 by selecting column B and inserting a new column (**I**nsert **C**olumns). In B4 type the label: `2005*`. As before, the star indicates a footnote which says that the information is a forecast. Like we did with the income statement, we will move, line by line, through the balance sheet to determine which items will vary with sales.

The firm's cash balance is the first, and perhaps most difficult, item with which we need to work. Does the cash balance vary, in constant proportion, with sales? Your first response might be, "Of course it does. As the firm sells more goods, it accumulates cash." This line of reasoning neglects two important facts. The firm has other things to do with its cash aside from accumulating it, and, because cash is a low-return (perhaps zero- or negative-return when inflation is considered) asset,

firms should seek to minimize the amount of their cash balance.[4] For these reasons, even though the cash balance will probably change, it probably will not change by the same percentage as sales. Therefore, we will simply use the cash balance from 2004 as our forecast, so enter: `=D5` into cell B5.

The next two items, accounts receivable and inventory, are much easier. Both of these accounts are likely to fluctuate roughly in proportion to sales. Using the same methodology that we used for the pro-forma income statement, we will find the average percentage of sales for the past two years and multiply that amount by our sales forecast for 2005. For the accounts receivable, the formula in B6 is: `=Average(D6/'Income Statement'!E$5,F6/'Income Statement'!G$5)*'Income Statement'!C$5`. Instead of typing the references to the income statement, it is easier to insert them by displaying both the income statement and balance sheet (choose **W**indow **N**ew Window from the menus) and selecting the appropriate cells with the mouse. Since we will use the same formula for Inventory, we can simply copy this formula down to B7. Total Current Assets in B8 is a calculated value, so we can copy the formula directly from cell D8.

In cell B9 we have the 2005 gross plant and equipment. This is the historical purchase price of the buildings and equipment that the firm owns. Even though the firm will probably buy and sell (or otherwise dispose of) many pieces of equipment, there is no reason to believe that these actions are directly related to the level of sales. Furthermore, no firm builds new plants (or other buildings) every time sales increase. For these reasons we will leave the plant and equipment unchanged from 2004. Only if we know of plans to change the level of plant and equipment should we enter a different number in B9. In this case we will simply insert the formula: `=D9` into this cell.

Accumulated Depreciation will definitely increase in 2005, but not because of the forecasted change in sales. Instead, Accumulated Depreciation will increase by the amount of the Depreciation Expense for 2005. To determine the accumulated depreciation for 2005 we will add 2005's depreciation expense to 2004's accumulated depreciation. The formula is: `=D10+'Income Statement'!E10`.

4. Within reason, of course. Firms need some amount of cash to operate, but the amount needed does not necessarily vary directly with the level of sales.

To complete the asset side of the balance sheet, we note that both Net Fixed Assets and Total Assets are calculated values. We can simply copy the formulas from D11:D12 and paste them into B11:B12.

Forecasting Liabilities on the Balance Sheet

Once the assets are completed the rest of the balance sheet is comparatively simple because we can mostly copy formulas already entered. Before continuing however, we need to distinguish among the types of financing sources. We have already seen that the types of financing that a firm uses can be divided into three categories:

- Current liabilities
- Long-term liabilities
- Owner's equity

These categories are not sufficiently distinguished for our purposes here. Instead, we will divide the liabilities and equity of a firm into two categories:

- *Spontaneous sources of financing* — These are the sources of financing that arise during the ordinary course of doing business. An example is the firm's accounts payable. Once the credit account is established with a supplier, no additional work is required to obtain credit; it just happens spontaneously when the firm makes a purchase. Note that not all current liabilities are spontaneous sources of financing (e.g., short-term notes payable, long-term debt due in one year, etc.).
- *Discretionary sources of financing* — These are the financing sources which require a large effort on the part of the firm to obtain. In other words, the firm must make a conscious decision to obtain these funds. Furthermore, the firm's upper-level management will use its discretion to determine the appropriate type of financing to use. Examples of this type of financing include any type of bank loan, bonds, and common and preferred stock.

Generally speaking, spontaneous sources of financing can be expected to vary directly with sales. Changes in discretionary sources, on the other hand, will not have a direct relationship to changes in sales. We always leave discretionary sources of financing unchanged for reasons that will soon become clear.

Returning now to our forecasting problem, the first item to consider is accounts payable. As noted above, accounts payable is a spontaneous source of financing and will, therefore, change directly with sales. To enter the formula, all that is necessary is to copy the formula from one of the other items that we have already completed. Copy the contents of B6 (or B7, it doesn't matter which) and paste it into B14. The result should indicate a forecasted accounts payable of $189.05.

The next item to consider is the short-term notes payable. Since this is a discretionary source of financing, we will leave it unchanged from 2004. In reality, we might handle this item differently if we had more information. For example, if we knew that the notes would be retired before the end of 2005, we would change our forecast to zero. Alternatively, if the payments on the notes include both principal and interest, our forecast would be the 2004 amount less principal payments that we expect to make in 2005. Since we are leaving it unchanged, the formula in B15 is: `=D15`.

If we assume that the "other current liabilities" account represents primarily accrued expenses, then it is a spontaneous source of financing. We can, therefore, simply copy the formula from B14 and paste it into B16. The forecasted amount is $163.38.

Long-term debt, in B18, and common stock, in B20, are both discretionary sources of financing. We will leave these balances unchanged from 2004. In B18 the formula is `=D18` and in B20 the formula is `=D20`.

The final item which we must consider is the retained earnings balance. Recall that retained earnings is an accumulation account. That is, the balance in any year is the accumulated amount that has been added in previous years. The amount which will be added to retained earnings, is given by:

Change in Retained Earnings = Net Income – Dividends

where the dividends are those which are paid to both the common and preferred stockholders. The formula for the retained earnings balance will require that we reference forecasted 2005 net income from the income statement, and the dividends from statement of cash flows. Note that we are assuming that 2005 dividends will be the same as the 2004 dividends. We can reference these cells in exactly the same way as before, so the formula is: `=D21+'Income Statement'!C15+'statement of Cash Flows'!B18`. The results should show that we are forecasting retained earnings to be $300.04 in 2005.

At this point, you should go back and calculate the subtotals in B17, B19, and B22. Finally, we calculate the total liabilities and owner's equity in B23 with `=B19+B22`.

Discretionary Financing Needed

Sharp-eyed readers will notice that our *pro-forma* balance sheet does not balance. While this appears to be a serious problem, it actually represents one of the purposes of the *pro-forma* balance sheet. The difference between total assets and total liabilities and owner's equity is referred to as *discretionary financing needed* (DFN). In other words, this is the amount of discretionary financing that the firm thinks it will need to raise in the next year. Because of the amount of time and effort required to raise these funds, it is important that the firm be aware of its needs well in advance. The *pro-forma* balance sheet fills this need. Frequently, the firm will find that it is forecasting a higher level of assets than liabilities and equity. In this case, the managers would need to arrange for more liabilities and/or equity to finance the level of assets needed to support the volume of sales expected. This is referred to as a *deficit* of discretionary funds. If the forecast shows that there will be a higher level of liabilities and equity than assets, the firm is said to have a *surplus* of discretionary funds. Remember that, in the end, the balance sheet must balance. The "plug figure" necessary to make this happen is the DFN.

We should add an extra line at the bottom of the pro-forma balance sheet to calculate the discretionary financing needed. Type `Discretionary Financing Needed` in A24, and in B24 add the formula `=B12-B23`. This calculation tells us that EPI expects to have $9,880.50 more in discretionary funds than are needed to support its forecasted level of assets. In this case, EPI is forecasting a surplus of discretionary funds. We have applied the same custom format (#.00,) to this number as to the rest of the balance sheet.

To make clear that this amount is a surplus (note that the sign is the opposite of what might be expected), we can have Excel inform us whether we will have a surplus or deficit of discretionary funds. To do this requires that we make use of the **IF** statement. Realize that if the discretionary financing needed is a positive number, then we have a deficit; otherwise we have a surplus. So the formula in

C24 is: `=IF(B24>0,"Deficit","Surplus")`.[5] Your balance sheet should now resemble that in Exhibit 5-3.

EXHIBIT 5-3
EPI'S PRO-FORMA BALANCE SHEET FOR 2005

	A	B	C	D	E	F
1	**Elvis Products International**					
2	**Pro-forma Balance Sheet**					
3	**As of Dec. 31, 2004 (000's)**					
4	***Assets***	***2005****	***2004%***	***2004***	***2003%***	***2003***
5	Cash and Equivalents	52.00	3.15%	52.00	3.92%	57.60
6	Accounts Receivable	444.51	24.35%	402.00	23.91%	351.20
7	Inventory	914.90	50.64%	836.00	48.69%	715.20
8	*Total Current Assets*	*1411.40*	*78.14%*	*1290.00*	*76.53%*	*1124.00*
9	Plant & Equipment	527.00	31.92%	527.00	33.43%	491.00
10	Accumulated Depreciation	186.20	10.07%	166.20	9.95%	146.20
11	*Net Fixed Assets*	*340.80*	*21.86%*	*360.80*	*23.47%*	*344.80*
12	***Total Assets***	**1752.20**	**100.00%**	**1650.80**	**100.00%**	**1468.80**
13	***Liabilities and Owner's Equity***					
14	Accounts Payable	189.05	10.61%	175.20	9.91%	145.60
15	Short-term Notes Payable	225.00	13.63%	225.00	13.62%	200.00
16	Other Current Liabilities	163.38	8.48%	140.00	9.26%	136.00
17	*Total Current Liabilities*	*577.43*	*32.72%*	*540.20*	*32.79%*	*481.60*
18	Long-term Debt	424.61	25.72%	424.61	22.02%	323.43
19	*Total Liabilities*	*1002.04*	*58.45%*	*964.81*	*54.81%*	*805.03*
20	Common Stock	460.00	27.87%	460.00	31.32%	460.00
21	Retained Earnings	300.04	13.69%	225.99	13.87%	203.77
22	*Total Shareholder's Equity*	*760.04*	*41.55%*	*685.99*	*45.19%*	*663.77*
23	***Total Liabilities and Owner's Equity***	**1762.08**	**100.00%**	**1650.80**	**100.00%**	**1468.80**
24	Discretionary Financing Needed	-9.88	Surplus			
25	* Forecasted					

5. You could also design a custom number format. One possible format is: `#,###.00," Deficit";#,###.00," Surplus"`. The benefit of this approach is that you don't need to use a separate cell and you don't need to enter a formula. Of course, this method may require that the column be wider in some instances.

Other Forecasting Methods

The primary advantage of the percent of sales forecasting method is its simplicity. There are many other more sophisticated forecasting techniques that can be implemented in a spreadsheet program. In this section we will look at two of these that are particularly useful.

Linear Trend Extrapolation

Suppose that you were asked to perform the percent of sales forecast for EPI. The first step in that analysis requires a sales forecast. Since EPI is a small company, nobody regularly makes such forecasts and you will have to generate your own. Where do you start?

Your first idea might be to see if there has been a clear trend in sales over the past several years and to extrapolate that trend, if it exists, to 2005. To see if there has been a trend, you first gather data on sales for EPI for the past five years. Table 5-1 presents the data that you have gathered.

TABLE 5-1
EPI SALES FOR 2000 TO 2004

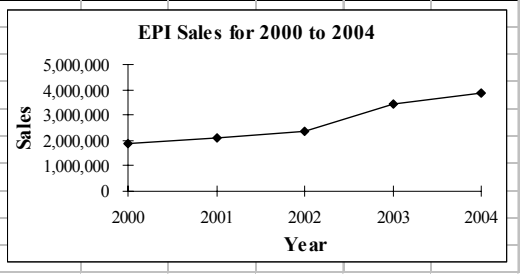
Year	Sales
2000	1,890,532
2001	2,098,490
2002	2,350,308
2003	3,432,000
2004	3,850,000

Add a new worksheet to your EPI workbook, and rename it "Trend Forecast" so that it can be easily identified. Enter the labels and data from Table 5-1 into your worksheet beginning in A1.

The easiest way to see if there has been a trend in sales is to create a chart which plots the sales data versus the years. Create this chart using the Chart Wizard by first selecting A1:B6. Make sure to select an XY chart and to enter the title as "EPI Sales for 2000 to 2004." Your worksheet should resemble that in Exhibit 5-4.

EXHIBIT 5-4
EPI TREND FORECAST WORKSHEET

	A	B
1	Year	Sales
2	2000	1,890,532
3	2001	2,098,490
4	2002	2,350,308
5	2003	3,432,000
6	2004	3,850,000
7		
8		
9		
10		



Examining the chart leads to the conclusion that sales have definitely been increasing over the past five years, but not at a constant rate. There are several ways to generate a forecast from this data, even though the sales are not increasing at a constant rate.

One of these methods is to let Excel determine a linear trend. That is, let Excel fit a straight line to the data and extrapolate that line to 2005 (or beyond). The line that is generated is in the form of:

$$Y = mX + b$$

which you should recognize as the same equation used in algebra courses to describe a straight line. In this equation, m is the slope and b is the intercept.

To determine the parameters for this line (m and b), Excel uses regression analysis which we will examine later. To generate a forecast based on the trend, we need to use the **TREND** function which is defined as:

TREND(*KNOWN_Y'S*, *KNOWN_X'S*, *NEW_X'S*, *CONST*)

In the **TREND** function definition, ***KNOWN_Y'S*** is the range of the data that we wish to forecast (the dependent variable) and *KNOWN_X'S* is the optional range of data (the independent variable) that we want to use to determine the trend in the dependent variable. Since the **TREND** function is generally used to forecast a time-based trend, *KNOWN_X'S* will usually be a range of years, though it can be any set of consecutive numbers (e.g., 1, 2, 3,…). *NEW_X'S* is a continuation of the *KNOWN_X'S* for which we don't yet know the value of the dependent variable. *CONST* is a True/False

variable that tells Excel whether or not to include an intercept in its calculations (generally, this should be set to true or omitted).

Using the **TREND** function is easier than it may at first seem. To generate a forecast for 2005, first enter `2005` into A7. This will provide us with the *NEW_X'S* value that we will use to forecast 2005 sales. Next, enter the **TREND** function as: `=TREND(B$2:B$6,A$2:A$6,A7,TRUE)` into B7. The result is a sales forecast of $4,300,000, which is the same sales forecast that we used in the percent of sales forecasting method for the financial statements.

We can extend our forecast to 2006 and 2007 quite easily. To do this, first enter `2006` into A8 and `2007` into A9. Now copy the formula from B7 to B8:B9. You should see that the forecasted sales for 2006 and 2007 are $4,825,244 and $5,350,489, respectively.

An interesting feature of charts in Excel is that we can tell Excel to add a trend line to the chart. Adding this line requires no more work than making a menu choice; we do not have to calculate the data ourselves. To add a trend line to our chart, select the plot line and click on it with the right mouse button. Click on Add T**r**endline . . . and then click on the OK button on the resulting dialog box to see the default linear trend line. You can also show trend lines that aren't linear. For example, if sales had been increasing at an increasing rate, you might want to fit an exponential trend instead of a linear one. Excel also offers five other trend lines that it can calculate, including a moving average of user-determined length.

Excel can even do a forecast automatically in the chart! (Note that you will not get the actual numerical forecast using this method.) First, delete the trend line that we added by selecting it and then pressing the Delete key on your keyboard, or right-click the trend line and choose Cle**a**r from the shortcut menu. Now, select the original plot line again, and insert a linear trend line. Before clicking on the OK button, click on the Options tab. In the Forecast section, set Forward to 1 unit. After clicking on the OK button you will see a trend line which extends to 2005. We could also extend the forecast to 2006 or 2007 by setting Forward to 2 or 3. Note that we don't have to first delete the trend line before showing the forecast. Instead, you could have right-clicked the existing trend line, chosen F**o**rmat Trendline and the Options tab, and entered the forecast period as before.

Recall that we said that Excel generates the equation for the trend line and uses this equation to make the forecast. We can have Excel show this equation on the chart by selecting the appropriate options. Right-click on the trend line and choose F**o**rmat Trendline from the short-cut menu. Select the Options tab and then click on

Display **E**quation on Chart. Click on the OK button and you should see the equation appear on the chart.

The equation that Excel displays is:

$$y = 525245x - 1E+09$$

which is Excel's way of saying:

$$y = 525245x - 1{,}000{,}000{,}000$$

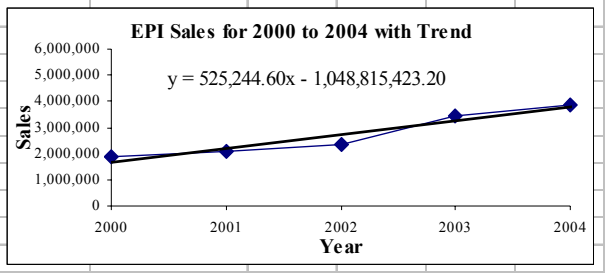
However, you should be suspicious of rounding problems any time you see scientific notation. In some cases the rounding isn't important, but in this case it is. We can fix the problem by right-clicking on the equation and choosing F**o**rmat Data Labels from the shortcut menu. Now select the Number tab and apply another format. You should now see that the equation is actually:[6]

$$y = 525{,}244.60x - 1{,}048{,}815{,}423.20$$

We can see that this equation does indeed generate the forecast for 2005 by substituting 2005 for x.[7] At this point, your worksheet should look like the one in Exhibit 5-5.

EXHIBIT 5-5
EPI TREND FORECAST WORKSHEET

	A	B	C	D	E	F	G	H
1	Year	Sales						
2	2000	1,890,532						
3	2001	2,098,490						
4	2002	2,350,308						
5	2003	3,432,000						
6	2004	3,850,000						
7	2005	4,300,000						
8	2006	4,825,244						
9	2007	5,350,489						
10								



6. You could even apply the custom number format that we've used for the financial statements.
7. Note that even this equation is slightly off. Using the **LINEST** function, we find that the actual equation is: $y = 525{,}244.60(2005) - 1{,}048{,}815{,}423.35 = 4{,}300{,}000$

Regression Analysis

The term *regression analysis* is a sophisticated-sounding term for a rather simple concept: fitting the best line to a data set. As simple as it sounds, the mathematics behind regression analysis are beyond the scope of this book. However, Excel can easily handle quite complex regression models with minimal knowledge on your part. We will make use of Excel's regression tools without delving too deeply into the underlying mathematics.

As we've noted, regression analysis is a technique for fitting the best line to a data set: a very powerful tool for determining the relationship between variables and for forecasting. You could, for example, simply plot the data and draw in what appears to be the line which best fits the data, but there is no guarantee that the line you choose is actually the best line. In regression analysis, the best line is defined as the one that minimizes the sum of the squared errors. The errors are the difference between the actual data point and that predicted by the model.

In our previous example, we used regression analysis (disguised within the **TREND** function) to forecast EPI's level of sales for 2005. Aside from forecasting, the second major use of regression analysis is to understand the relationship between variables. In this section we will use Excel's regression tool to perform a regression analysis.[8]

Consider the following example in which we will make use of regression analysis to try to get a better forecast of next year's cost of goods sold for EPI. Table 5-2 provides the historical data for sales and cost of goods sold.

TABLE 5-2
EPI'S HISTORICAL SALES AND COST OF GOODS

Year	Sales	Cost of Goods
2000	$ 1,890,532	$ 1,570,200
2001	2,098,490	1,695,694
2002	2,350,308	1,992,400
2003	3,432,000	2,864,000
2004	3,850,000	3,250,000

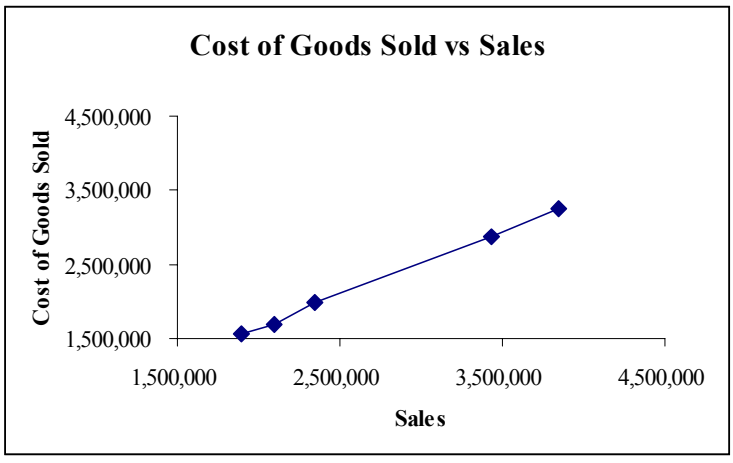
8. The regression tool is not a built-in function in the same sense as **TREND**. Instead, it is a part of the data analysis tools included with Excel. There is a regression function, **LINEST**. However, this function is more complex to use because it returns an array of values instead of a single value. Furthermore, the return values are not labeled. See the online help for more information.

Recall that we previously calculated the average percentage of sales for 2003 and 2004 and used that average to generate our forecast for 2005. Suppose, however, that you are concerned that there may possibly be a more systematic relationship between sales and cost of goods sold. For example, it is entirely possible that as sales rise, cost of goods sold will rise at slower rate. This may be due to efficiencies in the production process, quantity discounts on materials, etc. Alternatively, there may be another relationship, or none at all. Regression analysis can help us to gain a better understanding of the historical relationship, and, hopefully, better forecasts of the future cost of goods sold.

Before running the regression, let's create a chart of the data to help get a visual picture of the historical relationship. Enter the data from Table 5-2 into a new worksheet beginning in cell A1. Now select B2:C6 and create an XY Scatter chart of the data. To facilitate our visualization, change the scale on each axis as follows: Select the axis, right-click it and choose F**o**rmat Axis. Now, select the Scale tab and change the Mi**n**imum to `1,500,000`, the Ma**x**imum to `4,500,000`, and the M**a**jor unit to `1,000,000`. This will ensure that the scale of each axis is the same, which makes it much easier to see the relationship between our two variables.

The chart in Figure 5-1 shows what appears to be a pretty consistent relationship. Furthermore, the slope of the line is something less than 45 degrees so we know

FIGURE 5-1
CHART OF COST OF GOODS SOLD VS. SALES



that a change in sales of $1 will lead to a change in cost of goods sold of less than $1. The problem is that we can't know the exact relationship from reading the chart. What we can do is to run a regression analysis on the data to find the exact slope and intercept of best-fitting line for this data.

Excel provides several functions to calculate the parameters of a regression equation. For example, the **TREND**, **LINEST**, and **FORECAST** functions all use linear regression to generate equation parameters or forecasts. There are also functions for non-linear regression (e.g., **GROWTH AND LOGEST**). However, Excel also includes another method that we will cover here: the regression tool in the Data Analysis ToolPak.[9] This tool works very much like any statistical program that you may have used. It will ask for the data and then output a table of the regression results.

To run the regression tool, choose **T**ools **D**ata Analysis from the menus. Next, select Regression from the list of analysis tools that are available. Figure 5-2 shows the dialog box. (Note that the data are already filled in.)

Before running the analysis, we need to determine the theoretical relationship between the variables of interest. In this case we are hypothesizing that the level of sales can be used to predict the cost of goods sold. Therefore we say that the cost of goods sold is dependent on sales. So the cost of goods sold is referred to as the dependent (Y) variable, and sales is the independent (X) variable.[10] Our mathematical model is:

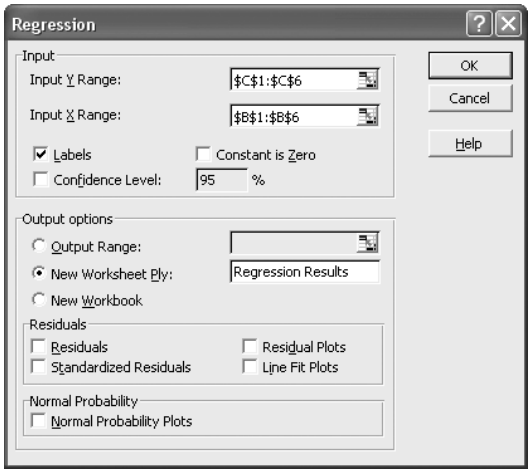
$$\text{Cost of Goods Sold}_t = \alpha + \beta(\text{Sales}_t) + \tilde{e}_t \qquad \textbf{(5-1)}$$

where α is the intercept, β is the slope of the line, and $\tilde{e}$ is the random error term in period *t*.

9. Note that the Data Analysis ToolPak is generally not a part of the default installation of Excel. To see if it is installed on your PC, look on the **T**ools menu. If you have an item called **D**ata Analysis, then it is installed. If not, go to **T**ools Add-**I**ns and see if you have an item called Analysis ToolPak. If so, make sure there is a check mark next to it. If not, you will need to insert your installation CD and install the Analysis ToolPak.

10. Many regression models have more than one independent variable. These models are known as multiple regressions and Excel can handle them just as easily as our bi-variate regression.

FIGURE 5-2
THE REGRESSION TOOL



There are many options on this dialog box, but for our simple problem we are only concerned with four of them. First, we need to tell Excel where the dependent (Y) variable data are located. In the "Input **Y** Range" edit box enter `$C$1:$C$6`, or merely select this range with the mouse. In the "Input **X** Range" edit box enter `$B$1:$B$6`. Since we have included the labels in our input ranges, we must make sure that a check mark is in the **L**abels box. Finally, we want to tell Excel to create a new worksheet within the current workbook for the output. Click on the box to the left of "New Worksheet **P**ly:" in the Output section, and type `Regression Results` in the edit box to give a name to the new worksheet. After clicking the OK button, Excel will calculate the regression statistics and create a new worksheet named "Regression Results." We could also have Excel enter the output in the same worksheet by specifying the **O**utput Range. Note that you only need to specify the upper-left corner of the area where you want the output. (Beware that Excel has a minor bug. When you click on the radio button for the **O**utput Range the cursor will return to the edit box for the Y range. Before selecting your output range, you must click in the proper edit box, otherwise you will overwrite your Y range. This bug has existed in the past several versions of Excel.)

EXHIBIT 5-6
REGRESSION RESULTS

	A	B	C	D	E	F	G
1	SUMMARY OUTPUT						
2							
3	*Regression Statistics*						
4	Multiple R	99.91%					
5	R Square	99.83%					
6	Adjusted R Square	99.77%					
7	Standard Error	35,523.08					
8	Observations	5					
9							
10	ANOVA						
11		*df*	*SS*	*MS*	*F*	*Significance F*	
12	Regression	1	2.20596E+12	2.20596E+12	1748.14121	3.01101E-05	
13	Residual	3	3785666909	1261888970			
14	Total	4	2.20975E+12				
15							
16		*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
17	Intercept	(63,680.8247)	58,134.6760	(1.0954)	0.3534	(248,691.4831)	121,329.8337
18	Sales	0.8583	0.0205	41.8108	0.0000	0.7929	0.9236

Exhibit 5-6 shows the output of the regression tool (it has been reformatted to make it a bit easier to read). The output may appear to be complex if you are not familiar with regression analysis. However, we are primarily concerned with the output which gives the parameters of the regression line.[11] In cells B17:B18 are the parameters of the regression equation. If we substitute these numbers into Equation (5-1) we find:

$$\text{Cost of Goods Sold}_t = -63{,}680.82 + 0.8583(\text{Sales}_t) + \tilde{e}_t.$$

The equation tells us that, all other things being equal, each dollar increase in sales will lead to an $0.86 increase in cost of goods sold.

Before we use this equation to make our forecast, let's evaluate it to make sure that there is a statistically significant relationship between the variables. We will begin by looking at the R Square (R^2) in cell B5. The R^2 is the coefficient of determination and tells us the proportion of the total variation in the dependent variable that is explained by the independent variable. In this case, sales are able to

11. We are not trying to minimize the importance of this other output. On the contrary, it would be foolish to attempt to use regression methods for any important purpose without understanding the model completely. We are merely trying to illustrate how Excel can be used for this type of analysis as simply as possible.

explain nearly 100% of the variability in the cost of goods sold. That is a stronger relationship than you will normally find, but it indicates that this equation is likely to work very well, as long as we have a good forecast of next years' sales.

Next, we look at the t-statistics for our regression coefficients (D18, normally we aren't too concerned with the significance of the intercept). Usually, we want to know whether a coefficient is statistically distinguishable from zero (i.e., "statistically significant"). Note that the magnitude of the coefficient is not the issue. If the coefficient for sales is significantly different from zero, then we know that sales is useful in predicting cost of goods sold. The t-statistic tells us how many standard deviations away from zero the coefficient is. Obviously, the higher this number, the more confidence we have that the coefficient is different from zero. In this case, the t-statistic is 41.81. A general rule of thumb is that, for large samples, a t-statistic greater than about 2.00 is significant at the 95% confidence level or more. Even though we don't have a large sample, we can be quite sure that the coefficient for sales is significant. Note that we can also use the p-value (E18) to determine the exact confidence level. Simply subtract the p-value from 1 to find the confidence level. Here, the p-value is 0.00003, so we are essentially 100% (actually, 99.997%) confident that our coefficient is significant.

We are very confident that the coefficient for sales is not zero, but we don't know for sure that the correct value is 0.8583. That number is simply the best point estimate given our set of sample data. Note that in F18:G18 we have numbers labeled "Lower 95%" and "Upper 95%." This gives us a range of values between which we can be 95% sure the true value of this coefficient lies. In other words, we can be 95% confident that the true change in cost of goods sold per dollar change in sales is between \$0.7929 and \$0.9236. Of course, there is a small chance (5%) that the true value lies outside of this range. As an aside, note that the 95% confidence range for the intercept contains 0. This indicates that we cannot statistically distinguish the intercept coefficient from zero (this is also confirmed by the rather high p-value for the intercept). However, since we are merely using this model for forecasting, the significance of the intercept is not important.

We are now quite confident that our model is useful for forecasting cost of goods sold.[12] To make a forecast for the 2005 cost of goods sold, we merely plug our 2005 sales forecast into the equation:

$$\text{Cost of Goods Sold}_{2005} = -63{,}680.82 + 0.8583(4{,}300{,}000) = 3{,}626{,}854.68$$

12. One issue that we have ignored is the fact that we are using quite a small sample with only five observations. This reduces our confidence somewhat. It would be preferable to use higher frequency data such as quarterly sales and cost of goods sold.

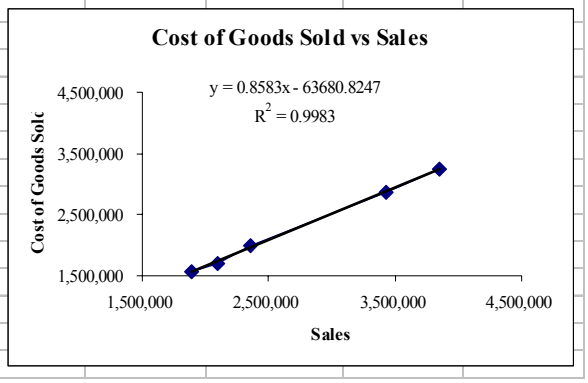
Recall that using the percent of sales method our forecast for 2005 cost of goods sold was $3,609,107.56. Our regression result agrees fairly closely with this number, so either number is probably usable for a forecast. However, note that both of these methods depend critically on our sales forecast. Without a good forecast of sales, all of our other forecasts are questionable.

To generate this forecast yourself, return to your worksheet with the data from Table 5-2. In A7 enter: `2005*` for the year and in B7 enter the sales forecast of `4,300,000`. Now, calculate the forecast by using the regression output. The equation in C7 is: `='Regression Results'!B17+'Regression Results'!B18*B7`.

As we did with the **TREND** function, we can replicate this regression directly in the XY chart that was completed earlier. Simply right-click on one of the data points, and choose Add Trendline. Now, using the Options tab, place the equation on the chart and have the trend line extended to forecast one period ahead. Your worksheet should now look like the one in Exhibit 5-7. As you can see, our regression line nearly perfectly matches the chart of the original data, this confirms our analysis of the regression results.

EXHIBIT 5-7
COMPLETED REGRESSION WORKSHEET WITH FORECAST

	A	B	C	D	E
1	Year	Sales	Cost of Goods		
2	2000	1,890,532	1,570,200		
3	2001	2,098,490	1,695,694		
4	2002	2,350,308	1,992,400		
5	2003	3,432,000	2,864,000		
6	2004	3,850,000	3,250,000		
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					



Summary

In this chapter we have examined three methods of forecasting financial statements and variables. We used the percent of sales technique to forecast the firm's income statement and balance sheet based upon an estimated level of sales. We used a time-trend technique to forecast sales as an input to the percent of sales method. Finally, we looked at regression analysis to help generate a better forecast of the cost of goods sold by using the relationship between that and sales over the past five years.

We have barely scratched the surface of forecasting methodologies. However, we hope that this chapter has stimulated an interest in this important subject. If so, be assured that Excel, either alone or through an add-in program, can be made to handle nearly all of your forecasting problems. Please remember that any forecast is almost assuredly wrong. We can only hope to get reasonably close to the actual future outcome. How close you get depends upon the quality of your model and the inputs to that model.

TABLE 5-3
FUNCTIONS INTRODUCED IN THIS CHAPTER

Purpose	Function	Page
Forecast future outcomes based on a time-trend	**TREND(*KNOWN_Y'S*, *KNOWN_X'S*, *NEW_X'S*, *CONST*)**	150

Problems

1. Using the data in the file P&G.xls (downloadable from the test support site at http://mayes.swlearning.com) forecast the June 30, 2003, income statement and balance sheet for Proctor & Gamble. Use the percent of sales method and the following assumptions: (1) Sales in FY 2003 will be $41,736; (2) The tax rate will be 35%; and (3) Each item which changes with sales will be the five-year average percentage of sales.

   a. What is the discretionary financing needed in 2003? Is this a surplus or deficit?

b. Create a chart of Cash vs. Sales and add a linear trend line. Does there appear to be a consistent trend in this relationship?

c. Use the regression tool to verify your results from Part b. Is the trend statistically significant? Use at least three methods to show why or why not.

d. Use the Scenario Manager to set up three scenarios:
1) Best Case — Sales are 10% higher than expected.
2) Base Case — Sales are exactly as expected.
3) Worst Case — Sales are 10% less than expected.
What is the DFN under each scenario?

2. Use the same data as in Problem 1.

a. Recalculate the percentage of sales income statement, but this time use the **TREND** function to forecast depreciation expense, other income, and interest expense.

b. Recalculate the percentage of sales balance sheet, but this time use the **TREND** function to forecast cash, property plant and equipment (gross), intangibles, and other non-current assets.

c. Do these new values appear to be more realistic than the original values? Does this technique make sense for each of these items? Might other income statement or balance sheet items be forecasted in this way?

Internet Exercise

1. Since you are reading this after the end of Proctor & Gamble's fiscal year 2003, how do your forecasts from the previous problems compare to the actual FY 2003 results? Does it appear that more information would have helped to generate better forecasts? Insert Proctor & Gamble's actual sales for 2003 into your forecast. Does this improve your forecast of earnings?

2. Choose your own company and the repeat the analysis from Problem 1. You can get the data from MoneyCentral Investor at http://moneycentral.msn.com/investor/home.asp. To retrieve the data for your company, go to the Stocks area and enter the ticker symbol. Now choose Financial Results and then Statements from the menu on the left side of the screen. Display the annual income statement, select the entire data section, and copy. Now paste this data directly into a new worksheet. Repeat these steps for the balance sheets.

6 *Break-Even and Leverage Analysis*

After studying this chapter, you should be able to:

1. *Differentiate between fixed and variable costs.*
2. *Calculate operating and cash break-even points, and find the number of units that need to be sold to reach a target level of EBIT.*
3. *Define the terms "business risk" and "financial risk," and describe the orgins of each of these risks.*
4. *Use Excel to calculate the DOL, DFL, and DCL and explain the significance of each of these risk measures.*
5. *Explain how the DOL, DFL, and DCL change as the firm's sales level changes.*

In this chapter we will consider the decisions that managers make regarding the cost structure of the firm. These decisions will, in turn, impact the decisions they make regarding methods of financing the firm's assets (i.e., its capital structure) and pricing the firm's products.

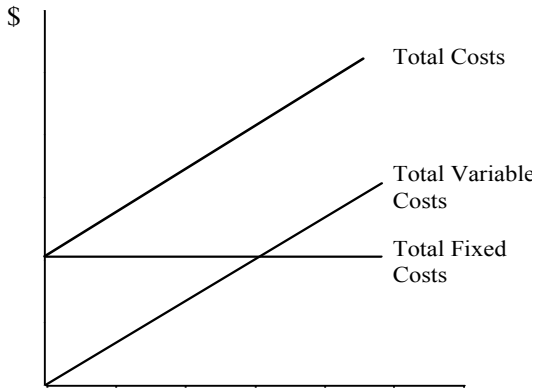
In general, we will assume that the firm faces two kinds of costs:

1. *Variable costs* are those costs that are expected to change at the same rate as the firm's sales. Variable costs are constant per unit, so as more units are sold total variable costs will rise. Examples of variable costs include sales commissions, costs of raw materials, hourly wages, etc.

2. *Fixed costs* are those costs that are constant, regardless of the quantity produced, over some relevant range of production. Total fixed cost per unit will decline as the number of units increases. Examples of fixed costs include rent, salaries, depreciation, etc.

Figure 6-1 illustrates these costs.[1]

FIGURE 6-1
TOTAL FIXED AND TOTAL VARIABLE COSTS



Break-Even Points

We can define the *break-even point* as the level of sales (either units or dollars) that causes profits (however measured) to equal zero. Most commonly, we define the break-even point as the unit sales required for earnings before interest and taxes (EBIT) to be equal to zero. This point is often referred to as the *operating break-even point*.

Define Q as the quantity sold, P is the price per unit, V is the variable cost per unit, and F as total fixed costs. With these definitions, we can say:

1. Most firms will also have some semi-variable costs which are fixed over a certain range of output, but will change if output rises above that level. For simplicity, we will assume that these costs are fixed.

$$Q(P - V) - F = \text{EBIT} \tag{6-1}$$

If we set EBIT in equation (6-1) to zero, we can solve for the break-even quantity (Q^*):

$$Q^* = \frac{F}{P - V} \tag{6-2}$$

Assume, for example, that a firm is selling widgets for $30 per unit while variable costs are $20 per unit and fixed costs total $100,000. In this situation, the firm must sell 10,000 units to break even:

$$Q^* = \frac{100{,}000}{30 - 20} = 10{,}000 \text{ units}$$

The quantity $P - V$ is often referred to as the *contribution margin* per unit, because this is the amount that each unit sold contributes to coverage of the firm's fixed costs. Using equation (6-1) you can verify that the firm will break even if it sells 10,000 widgets:

$$10{,}000(30 - 20) - 100{,}000 = 0$$

We can now calculate the firm's break-even point in dollars by simply multiplying Q^* by the price per unit:

$$\$BE = P \times Q^* \tag{6-3}$$

In this example, the result shows that the firm must sell $300,000 worth of widgets to break even.

Note that we can substitute equation (6-2) into (6-3):

$$\$BE = P \times \frac{F}{(P - V)} = \frac{F}{(P - V)/P} = \frac{F}{CM\%} \tag{6-4}$$

So, if we know the contribution margin as a percentage of the selling price (*CM*%), we can easily calculate the break-even point in dollars. In the previous example, *CM*% is 33.33% so the break-even point in dollars must be:

$$\$BE = \frac{100{,}000}{0.3333} = \$300{,}000$$

which confirms our earlier result.

Calculating Break-Even Points in Excel

We can, of course, calculate break-even points in Excel. Consider the income statement for Spuds and Suds, a very popular sports bar which serves only one product: a plate of gourmet french fries and a pitcher of imported beer for $16 per serving. The income statement is presented in Exhibit 6-1.

EXHIBIT 6-1
INCOME STATEMENT FOR SPUDS AND SUDS

	A	B
1	**Spuds and Suds**	
2	**Income Statement**	
3	**For the Year Ended Dec. 31, 2004**	
4		**2004**
5	Sales	$ 2,500,000
6	Less: Variable Costs	1,500,000
7	Less: Fixed Costs	400,000
8	*Earnings Before Interest and Taxes*	*600,000*
9	Less: Interest Expense	100,000
10	*Earnings Before Taxes*	*500,000*
11	Taxes	200,000
12	*Net Income*	*300,000*
13		
14	Less: Preferred Dividends	100,000
15	*Net Income Available to Common*	*200,000*
16	Common Shares Outstanding	1,000,000
17	*Earnings per Share*	*$ 0.20*
18		
19	**Assumptions**	
20	Price per Unit	$ 16.00
21	Unit Sales	156,250
22	Variable Costs as a Percent of Sales	60%
23	Tax Rate	40%

Before calculating the break-even point, enter the labels into a new worksheet as shown in Exhibit 6-1. Since we will be expanding this example, it is important that you enter formulas where they are appropriate. Before doing any calculations, enter the numbers in B20:B23.

We will first calculate the dollar amount of sales (in B5) by multiplying the per unit price by the number of units sold: `=B20*B21`. Variable costs are always 60% of sales (as shown in B22), so the formula in B6 is: `=B22*B5`. Both Fixed Costs (in B7) and Interest Expense (in B9) are constants so they are simply entered directly. The simple subtraction and multiplication required to complete the income statement through B12 should be obvious.

In B14:B17 we have added information that is not immediately useful, but the figures will become central when we discuss operating and financial leverage. In cell B14 we have added preferred dividends, which will be subtracted from net income. The result (in B15), is net income available to the common shareholders. Preferred dividends, are simply input into B14, and the formula in B15 is: `=B12-B14`. In B16, enter the number of common shares outstanding: `1,000,000`. Earnings per share is then calculated as: `=B15/B16` in cell B17.

Now we can calculate the break-even points. In cell A25 enter the label: `Break-even Point (Units)`. Next, copy this label to A26, and change the word "Units" to `Dollars`. In B25, we can calculate the break-even point in units using equation (6-2). The formula is: `=B7/(B20-B6/B21)`. Notice that we have to calculate the variable cost per unit by dividing total variable costs (B6) by the number of units sold (B21). You can see that Spuds and Suds must sell 62,500 units in order to break even and that they are well above this level. We can calculate the break-even point in dollars simply by multiplying the unit break-even point by the price per unit. In B26 enter the formula: `=B25*B20`. You will see that the result is $1,000,000.

Other Break-Even Points

Recall that we found the break-even point by setting EBIT, in equation (6-1), equal to zero. However, there is no reason that we can't set EBIT equal to any amount that we might desire. For example, if we define $\text{EBIT}_{\text{Target}}$ as the target level of EBIT, we find that the firm can earn the target EBIT amount by selling:

$$Q^*_{\text{Target}} = \frac{F + \text{EBIT}_{\text{Target}}}{P - V} \qquad \textbf{(6-5)}$$

Consider that Spuds and Suds might want to know the number of units that they need to sell in order to have EBIT equal $800,000. Mathematically, we can see that:

$$Q^*_{800,000} = \frac{400,000 + 800,000}{16 - 9.60} = 187,500 \text{ units}$$

need to be sold to reach this target. You can verify that this number is correct by typing `187,500` into B21, and checking the value in B8. To return the worksheet to its original values, enter `156,250` into B21, or by choosing **E**dit **U**ndo Typing '187500' in B21.

Recall from page 46 that we defined cash flow as net income plus non-cash expenses. We do this because the presence of non-cash expenses (principally depreciation) in the accounting numbers distort the actual cash flows. We can make a similar adjustment to our break-even calculations by setting $EBIT_{Target}$ equal to the negative of the depreciation expense. This results in a type of break-even that we refer to as the *cash break-even point*:

$$Q^*_{Cash} = \frac{F - \text{Depreciation}}{P - V} \qquad \textbf{(6-6)}$$

Note that the cash break-even point will always be lower than the operating break-even point because we don't have to cover the depreciation expense.

Using Goal Seek to Calculate Break-Even Points

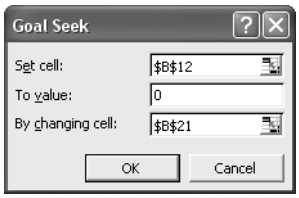
As we've shown, the break-even point can be defined in numerous ways. We don't even need to define it in terms of EBIT. Suppose that we wanted to know how many units need to be sold to break even in terms of net income. We could easily derive a formula (just use equation (6-5) and set $EBIT_{Target}$ = Interest Expense), but that's not necessary.

Excel has a tool, called Goal Seek, to help with problems like this.[2] To use Goal Seek you must have a target cell with a formula and another cell that it depends on. For example, Net Income in B12 depends indirectly on the Unit Sales in B21. So, by changing B21, we change B12. When we use Goal Seek, we'll simply tell it to keep changing B21 until B12 equals zero.

2. For more complicated problems use the Solver add-in.

Bring up the Goal Seek tool by choosing **T**ools **G**oal Seek from the menu. Fill in the dialog box as shown in Figure 6-2 and click the OK button. You should find that Unit Sales of 78,125 will cause Net Income to be equal to zero. You can experiment with this tool to verify the other break-even points that we've found.

FIGURE 6-2
THE GOAL SEEK TOOL



Leverage Analysis

In Chapter 4 (page 111) we defined leverage as a multiplication of changes in sales into even larger changes in profitability measures. Firms that use large amounts of operating leverage will find that their earnings before interest and taxes will be more variable than those who do not. We would say that such a firm has high *business risk*. Business risk is one of the major risks faced by a firm, and can be defined as the variability of EBIT.[3] The more variable a firm's revenues, relative to its costs, the more variable its EBIT will be. Also, the likelihood that the firm won't be able to pay its expenses will be higher. As an example, consider a software company and a grocery chain. It should be apparent that the future revenues of the software company are much more uncertain than those for the grocery chain. This uncertainty in revenues causes the software company to have a much greater amount of business risk than the grocery chain. The software company's management can do little about this business risk; it is simply a function of the industry in which they operate. Software is not a necessity of life. People do, however, need to eat. For this reason, the grocery business has much lower business risk.

3. The use of EBIT for this analysis assumes that the firm has no extraordinary income or expenses. Extraordinary income and/or expenses are one-time events that are not a part of the firm's ordinary business operations. If the firm does have these items, one should use its net operating income (NOI) instead of EBIT.

Business risk results from the environment in which the firm operates. Such factors as the competitive position of the firm in its industry, the state of its labor relations, and the state of the economy all affect the amount of business risk a firm faces. In addition, as we will see, the degree to which the firm's costs are fixed (as opposed to variable) will affect the amount of business risk. To a large degree, these components of business risk are beyond the control of the firm's managers.

In contrast, the amount of *financial risk* is determined directly by management. Financial risk refers to the probability that the firm will be unable to meet its fixed financing obligations (which includes both interest and preferred dividends). Obviously, all other things being equal, the more debt a firm uses to finance its assets, the higher its interest cost will be. Higher interest costs lead directly to a higher probability that the firm won't be able to pay. Since the amount of debt is determined by managerial choice, the financial risk that a firm faces is also determined by management.

Managers need to be aware that they face both business risk and financial risk. If they are in an industry with high business risk, they should control the overall amount of risk by limiting the amount of financial risk that they face. Alternatively, firms that face low levels of business risk can better afford more financial risk.

We will examine these concepts in more detail by continuing with our Spuds and Suds example.

The Degree of Operating Leverage

Earlier we mentioned that a firm's business risk can be measured by the variability of its earnings before interest and taxes. Obviously, if a firm's costs are all variable, then any variation in sales will be reflected by exactly the same variation in EBIT. However, if a firm has some fixed expenses, EBIT will be more variable than sales. We refer to this concept as *operating leverage*.

We can measure operating leverage by comparing the percentage change in EBIT to a given percentage change in sales. This measure is called the *degree of operating leverage* (DOL):

$$\text{DOL} = \frac{\%\Delta \text{ in EBIT}}{\%\Delta \text{ in Sales}} \qquad \textbf{(6-7)}$$

So, if a 10% change in sales results in a 20% change in EBIT, we would say that the degree of operating leverage is 2. As we will see, this is a symmetrical concept. As long as sales are increasing, a high DOL is desirable. However, if sales begin to decline, a high DOL will result in EBIT declining at an even faster pace than sales.

To make this concept more concrete, let's extend the Spuds and Suds example. Assume that management believes that unit sales will increase by 10% in 2005. Furthermore, they expect that variable costs will remain at 60% of sales and fixed costs will stay at $400,000. Copy B4:B26 to C4:C26, and enter: `=B21*1.1` into C21.[4] (Note that you have just created a percent of sales income statement forecast for 2005, just as we did in Chapter 5.) Change the label in C4 to `2005*` and you have completed the changes.

Before continuing, notice that the operating break-even point (C25:C26) has not changed. This will always be the case if fixed costs are constant and variable costs are a constant percentage of sales. The break-even point is always driven by the level of fixed costs.

Since we wish to calculate the DOL for 2004, we first need to calculate the percentage changes in EBIT and Sales. In A28 enter the label: `% Change in Sales from Prior Year`, and in A29 enter: `% Change in EBIT from Prior Year`. To calculate the percentage changes enter: `=C5/B5-1` in cell C28 and then: `=C8/B8-1` in C28. You should see that sales increased by 10% while EBIT increased by 16.67%. According to equation (6-7) the DOL for Spuds and Suds in 2004 is:

$$\text{DOL} = \frac{16.67\%}{10.00\%} = 1.667$$

4. Do not use AutoFill to make the copy. When using AutoFill on a single-column range like this, it will add 1 to any of the constants in the range. For example, the 400,000 in B7 will be changed to 400,001 in C7. When using AutoFill on a single cell with a constant, it will not add 1. This inconsistency can cause errors and confusion so you must be aware of it.

So, any change in sales will be multiplied by 1.667 times in EBIT. To see this, recall that the formula in C21 increased the 2004 unit sales by 10%. Temporarily, change this formula to: `=B21*1.20`. You should see that if sales increase by 20%, EBIT will increase by 33.33%. Recalculating the DOL, we see that it is unchanged:

$$\text{DOL} = \frac{33.33\%}{20.00\%} = 1.667$$

Furthermore, if we change the formula in C21 to `=B21*0.90`, so that sales decline by 10%, we find that EBIT declines by 16.67%. In this case the DOL is:

$$\text{DOL} = \frac{-16.67\%}{-10.00\%} = 1.667$$

So leverage is indeed a double-edged sword. You can see that a high DOL would be desirable as long as sales are increasing, but very undesirable when sales are decreasing. Unfortunately, most businesses don't have the luxury of instantaneously altering their DOL.

Calculating the DOL with equation (6-7) is actually more cumbersome than is required. With this equation, we need to use two income statements. However, a more direct method of calculating the DOL is to use the following equation:

$$\text{DOL} = \frac{Q(P-V)}{Q(P-V)-F} = \frac{\text{Sales} - \text{Variable Costs}}{\text{EBIT}} \qquad \textbf{(6-8)}$$

For Spuds and Suds in 2004, we can calculate the DOL using equation (6-8):

$$\text{DOL} = \frac{2{,}500{,}000 - 1{,}500{,}000}{600{,}000} = 1.667$$

which is exactly as we found with equation (6-7).

Continuing with our example, enter the label: `Degree of Operating Leverage` in A32. In B32 we will calculate the DOL for 2004 with the formula: `=(B5-B6)/B8`. You should get the same result as before. If you copy the formula from B32 to C32, you will find that in 2005 the DOL will decline to 1.57. We will examine this decline in the DOL later. Your worksheet should now appear similar to the one in Exhibit 6-2.

EXHIBIT 6-2
SPUDS AND SUDS BREAK-EVEN AND LEVERAGE WORKSHEET

	A	B	C
1	**Spuds and Suds**		
2	**Income Statement**		
3	**For the Year Ended Dec. 31, 2004**		
4		**2004**	**2005***
5	Sales	$2,500,000	$2,750,000
6	Less: Variable Costs	1,500,000	1,650,000
7	Less: Fixed Costs	400,000	400,000
8	*Earnings Before Interest and Taxes*	*600,000*	*700,000*
9	Less: Interest Expense	100,000	100,000
10	*Earnings Before Taxes*	*500,000*	*600,000*
11	Taxes	200,000	240,000
12	*Net Income*	*300,000*	*360,000*
13			
14	Less: Preferred Dividends	100,000	100,000
15	*Net Income Available to Common*	*200,000*	*260,000*
16	Common Shares Outstanding	1,000,000	1,000,000
17	*Earnings per Share*	*$ 0.20*	*$ 0.26*
18			
19	**Assumptions**		
20	Price per Unit	$ 16.00	$ 16.00
21	Unit Sales	156,250	171,875
22	Variable Costs as a Percent of Sales	60%	60%
23	Tax Rate	40%	40%
24			
25	Operating Break-even Point (Units)	62,500	62,500
26	Operating Break-even Point (Dollars)	1,000,000	1,000,000
27			
28	% Change in Sales from Prior Year		10.00%
29	% Change in EBIT from Prior Year		16.67%
30			
31			
32	Degree of Operating Leverage	1.67	1.57

The Degree of Financial Leverage

Financial leverage is similar to operating leverage, but the fixed costs that we are interested in are the fixed financing costs. These are the interest expense and preferred dividends.[5] We can measure financial leverage by relating percentage changes in earnings per share (EPS) to percentage changes in EBIT. This measure is referred to as the *degree of financial leverage* (DFL):

$$\text{DFL} = \frac{\%\Delta \text{ in EPS}}{\%\Delta \text{ in EBIT}} \quad \textbf{(6-9)}$$

For Spuds and Suds we have already calculated the percentage change in EBIT, so all that remains is to calculate the percentage change in EPS. In A30 add the label: `% Change in EPS from Prior Year`, and in C30 add the formula: `=C17/B17-1`. Note that EPS is expected to increase by 30% in 2005 compared to only 16.67% for EBIT. Using equation (6-9) we find that the degree of financial leverage employed by Spuds and Suds in 2004 is:

$$\text{DFL} = \frac{30.00\%}{16.67\%} = 1.80$$

Therefore, any change in EBIT will be multiplied by 1.80 times in earnings per share. Like operating leverage, financial leverage works both ways. When EBIT is increasing, EPS will increase even more. And, when EBIT decreases EPS will decline by a larger percentage.

As with the DOL, there is a more direct method of calculating the degree of financial leverage:

$$\text{DFL} = \frac{\text{EBIT}}{\text{EBT} - \frac{\text{PD}}{(1-t)}} \quad \textbf{(6-10)}$$

In equation (6-10), PD is the preferred dividends paid by the firm, and t is the tax rate paid by the firm. The second term in the denominator, $\text{PD}/(1-t)$, requires some explanation. Since preferred dividends are paid out of after-tax dollars, we must determine how many *pre-tax* dollars are required to meet this expense. In this case, Spuds and Suds pays taxes at a rate of 40%, so they require $166,666.67 in pre-tax dollars in order to pay $100,000 in preferred dividends:

$$\frac{100{,}000}{(1-0.40)} = 166{,}666.67$$

5. Preferred stock, as we'll see in Chapter 8, is a hybrid security; similar to both debt and equity securities. How it is treated is determined by one's goals. When discussing financial leverage we treat preferred stock as if it were a debt security.

We can use equation (6-10) in the worksheet to calculate the DFL for Spuds and Suds. In cell A33, enter the label: `Degree of Financial Leverage`. In B33, enter: `=B8/(B10-B14/(1-B23))`. You should find that the DFL is 1.80, which is the same as we found by using equation (6-9). Copying this formula to C33 reveals that in 2005 we expect the DFL to decline to 1.62.

The Degree of Combined Leverage

Most firms make use of both operating and financial leverage. Since they are using two kinds of leverage, it is useful to understand the combined effect. We can measure the total leverage employed by the firm by comparing the percentage change in sales to the percentage change in earnings per share. This measure is called the *degree of combined leverage* (DCL):

$$\text{DCL} = \frac{\%\Delta \text{ in EPS}}{\%\Delta \text{ in Sales}} \qquad \textbf{(6-11)}$$

Since we have already calculated the relevant percentage changes, it is a simple matter to determine that the DCL for Spuds and Suds in 2004 was:

$$\text{DCL} = \frac{30.00\%}{10.00\%} = 3.00$$

Therefore, any change in sales will be multiplied three-fold in EPS. Recall that we earlier said that the DCL was a combination of operating and financial leverage. You can see this if we rewrite equation (6-11) as follows:

$$\text{DCL} = \frac{\%\Delta \text{ in EBIT}}{\%\Delta \text{ in Sales}} \times \frac{\%\Delta \text{ in EPS}}{\%\Delta \text{ in EBIT}} = \frac{\%\Delta \text{ in EPS}}{\%\Delta \text{ in Sales}}$$

Therefore, the combined effect of using both operating and financial leverage is multiplicative rather than simply additive. Managers should take note of this and use caution in increasing one type of leverage while ignoring the other. They may end up with more total leverage than anticipated. As we have just seen, the DCL is the product of DOL and DFL, so we can rewrite equation (6-11) as:

$$\text{DCL} = \text{DOL} \times \text{DFL} \qquad \textbf{(6-12)}$$

To calculate the DCL for Spuds and Suds in your worksheet, first enter the label: `Degree of Combined Leverage` into A34. In B34, enter the formula:

=B32*B33, and copy this to C34 to find the expected DCL for 2005. At this point, your worksheet should look like the one in Exhibit 6-3.

Extending the Example

Comparing the three leverage measures for 2004 and 2005 shows that in all cases the firm will be using less leverage in 2005. Recall that the only change in 2005 was that sales were increased by 10% over their 2004 level. The reason for the decline in leverage is that fixed costs (both operating and financial) have become a smaller portion of the total costs of the firm. This will always be the case: *As sales increase above the break-even point, leverage will decline regardless of the measure that is used.*

We can see this by extending our Spuds and Suds example. Suppose that management is forecasting that sales will increase by 10% each year for the foreseeable future. Furthermore, because of contractual agreements, the firm's fixed costs will remain constant through at least 2008. In order to see the changes in the leverage measures under these conditions, copy C4:C34 and paste into D4:F34.[6] This will create pro-forma income statements for three additional years. Change the labels in D4:F4 to 2006*, 2007* and 2008*.

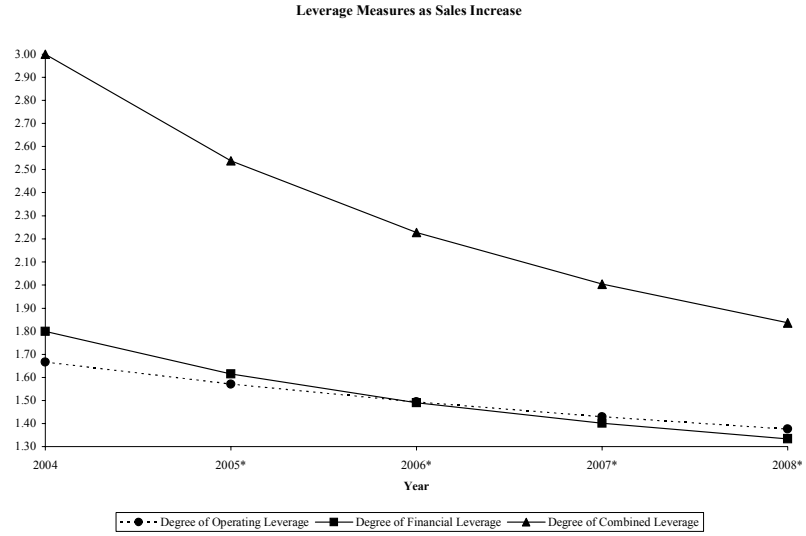
6. Again, you should be aware of the AutoFill problem as noted in footnote 4. In this case, we can get around the problem by selecting B4:C34 (two columns) before doing the AutoFill. This will allow Excel to recognize that the constants are not changing across the two columns, so it will not change them during the AutoFill operation. Note that if you do a normal Copy and Paste you will not have this problem.

EXHIBIT 6-3
SPUDS AND SUDS WORKSHEET WITH THREE MEASURES OF LEVERAGE

	A	B	C
1	**Spuds and Suds**		
2	**Income Statement**		
3	**For the Year Ended Dec. 31, 2004**		
4		**2004**	**2005***
5	Sales	$2,500,000	$2,750,000
6	Less: Variable Costs	1,500,000	1,650,000
7	Less: Fixed Costs	400,000	400,000
8	*Earnings Before Interest and Taxes*	*600,000*	*700,000*
9	Less: Interest Expense	100,000	100,000
10	*Earnings Before Taxes*	*500,000*	*600,000*
11	Taxes	200,000	240,000
12	*Net Income*	*300,000*	*360,000*
13			
14	Less: Preferred Dividends	100,000	100,000
15	*Net Income Available to Common*	*200,000*	*260,000*
16	Common Shares Outstanding	1,000,000	1,000,000
17	*Earnings per Share*	*$ 0.20*	*$ 0.26*
18			
19	**Assumptions**		
20	Price per Unit	$ 16.00	$ 16.00
21	Unit Sales	156,250	171,875
22	Variable Costs as a Percent of Sales	60%	60%
23	Tax Rate	40%	40%
24			
25	Operating Break-even Point (Units)	62,500	62,500
26	Operating Break-even Point (Dollars)	1,000,000	1,000,000
27			
28	% Change in Sales from Prior Year		10.00%
29	% Change in EBIT from Prior Year		16.67%
30	% Change in EPS from Prior Year		30.00%
31			
32	Degree of Operating Leverage	1.67	1.57
33	Degree of Financial Leverage	1.80	1.62
34	Degree of Combined Leverage	3.00	2.54

You should see that the DOL, DFL, and DCL are all decreasing as sales increase. This is easier to see if we create a chart. Select A32:F34 and use the Chart Wizard to create a line chart of the data. Be sure to choose the Series tab and set B4:F4 as the Category (X) axis labels. You should end up with a chart that resembles the one in Figure 6-3.

FIGURE 6-3
CHART OF VARIOUS LEVERAGE MEASURES AS SALES INCREASE



Obviously, as we stated earlier, the amount of leverage declines as the sales level increases. One caveat to this is that in the real world fixed costs are not necessarily the same year after year. Furthermore, variable costs do not always maintain an exact percentage of sales. For these reasons, leverage may not decline as smoothly as depicted in our example. However, the general principal is sound and should be understood by all managers.

Summary

We started this chapter by discussing the firm's operating break-even point. The break-even point is determined by a product's price, and the amount of fixed and variable costs. The amount of fixed costs also played an important role in the determination of the amount of leverage a firm employs. We studied three measures of leverage:

1. The *degree of operating leverage* (DOL) measures the degree to which the presence of fixed costs multiplies changes in sales into even larger changes in EBIT.
2. The *degree of financial leverage* (DFL) measures the change in EPS relative to a change in EBIT. Financial leverage is a direct result of managerial decisions about how the firm should be financed.
3. The *degree of combined leverage* (DCL) provides a measure of the total leverage used by the firm. This is the product of the DOL and DFL.

We also introduced the Goal Seek tool which is very useful whenever you know the result that you want, but not the input value required to get that result.

TABLE 6-1
SUMMARY OF EQUATIONS

Name	Equation	Page
Operating Break-Even Level in Units	$Q^* = \frac{F}{P - V}$	165
Operating Break-Even Level in Dollars	$\$BE = P \times Q^*$ or $\$BE = \frac{F}{CM\%}$	165 165
Cash Break-Even Point in Units	$Q^*_{\text{Cash}} = \frac{F - \text{Depreciation}}{P - V}$	168

TABLE 6-1 (CONTINUED)
SUMMARY OF EQUATIONS

Name	Equation	Page
Degree of Operating Leverage (DOL)	$\text{DOL} = \frac{\%\Delta \text{ in EBIT}}{\%\Delta \text{ in Sales}}$	170
	or	
	$\text{DOL} = \frac{Q(P-V)}{Q(P-V)-F}$	172
Degree of Financial Leverage (DFL)	$\text{DFL} = \frac{\%\Delta \text{ in EPS}}{\%\Delta \text{ in EBIT}}$	174
	or	
	$\text{DFL} = \frac{\text{EBIT}}{\text{EBT} - \frac{\text{PD}}{(1-t)}}$	174
Degree of Combined Leverage (DCL)	$\text{DCL} = \frac{\%\Delta \text{ in EPS}}{\%\Delta \text{ in Sales}}$	175
	or	
	$\text{DCL} = \text{DOL} \times \text{DFL}$	175

Problems

1. Meyerson's Bakery is considering the addition of a new line of pies to its product offerings. It is expected that each pie will sell for $10 and the variable costs per pie will be $3. Total fixed operating costs are expected to be $20,000. Meyerson's faces a marginal tax rate of 35%, will have interest expense associated with this line of $3,000, and expects to sell about 2,500 pies in the first year.

   a. Put together an income statement for the pie line's first year. Is the line expected to be profitable?

   b. Calculate the operating break-even point in both units and dollars.

c. How many pies would Meyerson's need to sell in order to achieve earnings, before interest and taxes, of $15,000?

d. Use the Goal Seek tool to determine the selling price per pie that would allow Meyerson's to break even in terms of its net income.

2. Income Statements for Caterpillar, Inc., from 1997 to 2001 appear below.

	A	B	C	D	E	F
1	**Caterpillar Inc.**					
2	**Annual Income Statements**					
3	**For the Fiscal Years 1997 to 2001**					
4		**Dec-01**	**Dec-00**	**Dec-99**	**Dec-98**	**Dec-97**
5	Sales	20,450	20,175	19,702	20,977	18,925
6	Cost of Sales	13,583	13,475	13,536	14,166	12,636
7	Gross Operating Profit	6,867	6,700	6,166	6,811	6,289
8	Selling, General & Admin. Expense	3,730	3,253	3,167	3,204	2,760
9	Depreciation & Amortization	1,169	1,022	945	865	738
10	EBIT	1,968	2,425	2,054	2,742	2,791
11	Other Income, Net	146	55	176	189	250
12	Interest Expense	942	980	829	753	580
13	Pre-tax Income	1,172	1,500	1,401	2,178	2,461
14	Income Taxes	367	447	455	665	796
15	**Total Net Income**	**805**	**1,053**	**946**	**1,513**	**1,665**
16						
17	Dividends Paid per Share	1.38	1.33	1.25	1.10	0.90
18	Preferred Dividends	0.00	0.00	0.00	0.00	0.00

a. Enter the data into your worksheet. Assume that 50% of SG&A expense is a variable cost, with the balance being a fixed cost.

b. Given that Caterpillar is a manufacturing company, would you expect that it would have more operating leverage or financial leverage?

c. Calculate the degree of operating leverage, degree of financial leverage, and the degree of combined leverage for each of the five years. Does it appear that Caterpillar's leverage measures have been increasing or decreasing over this period?

d. Create a chart that shows how the various leverage measures have changed over this five-year period.

Internet Exercise

1. Following the instructions from Internet Exercise 2 in Chapter 5, get the income statements for the company of your choice for the past five years from MSN Investor. Choose a company that is not in a manufacturing industry. Now repeat the analysis from Problem 2 above. What differences do you note between the leverage measures for your company and Caterpillar, Inc.?

7 *The Time Value of Money*

After studying this chapter, you should be able to:

1. *Explain the concept of the time value of money.*
2. *Calculate the present value and future value of a stream of cash flows using Excel.*
3. *Explain the types of cash flows encountered in financial analysis, and how to adjust for each type in making time value calculations in Excel.*
4. *Differentiate between the alternative compounding periods, and use Excel to compare present and future values under different compounding schemes.*

"A bird in the hand is worth more than two in the bush." That old aphorism, when translated into the language of finance, becomes "A dollar today is worth more than a dollar tomorrow." Intuitively, it probably makes sense, but why? Stated very simply, you can take that dollar today and invest it with the expectation of having more than a dollar tomorrow.

Because money can be invested to grow to a larger amount, we say that money has a "time value." This concept of a time value of money underlies much of the theory of financial decision making.

Future Value

Imagine that you have $1,000 available to invest. If you earn interest at the rate of 10% per year, then you will have $1,100 at the end of one year. The mathematics behind this example are quite simple:

$$1{,}000 + 1{,}000(0.10) = 1{,}100$$

In other words, after one year you will have your original $1,000 (the *principal* amount) plus the interest earned. Since you won't have the $1,100 until one year in the future, we refer to this amount as the *future value*. The amount that you have today, $1,000, is referred to as the *present value*. If, at the end of the year, you choose to make the same investment again, then at the end of the second year you will have:

$$1{,}000 + 1{,}000(0.10) + 100(0.10) + 1{,}000(0.10) = 1{,}210$$

The $1,210 at the end of the second year can be broken down into its components: the original principal, the first year's interest, the interest earned in the second year on the first year's interest, and the second year's interest on the original principal. Note that we could restate the second year calculation to be:

$$1{,}100 + 1{,}100(0.10) = 1{,}210$$

or, by factoring out the 1,100 we get:

$$1{,}100(1 + 0.10) = 1{,}210$$

Notice that in the second year the interest is earned on both the original principal and the interest earned during the first year. The idea of earning interest on previously earned interest is known as *compounding*. This is why the total interest earned in the second year is $110 versus only $100 the first year.

Returning to our original one-year example, we can generalize the formula for any one-year investment, as follows:

$$FV = PV + PV(i)$$

Where FV is the future value, PV is the present value, and i is the one-year interest rate (compounding rate). The above equation is not in its simplest form. We can

factor PV from both terms on the right-hand side, simplifying the future value equation to:

$$FV = PV(1 + i) \quad \textbf{(7-1)}$$

Recall that in our two-year example, we earned interest on both the principal and interest from the first year. In other words, the first year FV became the second year PV. Symbolically, the second year FV is:

$$FV_2 = FV_1(1 + i)$$

Substituting $PV(1 + i)$ for FV_1 and simplifying, we have:

$$FV_2 = PV(1 + i)(1 + i) = PV(1 + i)^2$$

We can actually further generalize our future value equation. Realize that the exponent (on the right-hand side) is the same as the subscript (on the left-hand side) in the future value equation. When we were solving for the future value at the end of the first year, the exponent was 1. When we were solving for the future value at the end of the second year, the exponent was 2. In general, the exponent will be equal to the number of the year for which we wish to find the future value.

$$FV_N = PV(1 + i)^N \quad \textbf{(7-2)}$$

Equation (7-2) is the basis for all of the time value equations that we will look at in the sections ahead. Using this version of the equation you can see that investing $1,000 for two years at 10% per year will leave you with $1,210 at the end of two years. In other words:

$$FV_2 = 1{,}000(1.10)^2 = 1{,}210$$

Using Excel to Find Future Values

It is easy enough to calculate future values with a hand calculator, especially a financial calculator. But, as we will see in the sections and chapters ahead, it is often necessary to use future values in worksheets. Excel makes these calculations easy with the use of the built-in function **Fv**.

Fv(*Rate*, *Nper*, *Pmt*, *PV*,*Type*)

There are five parameters to the **Fv** function. ***RATE*** is the interest rate per period (year, month, day, etc.), ***NPER*** is the total number of periods, and ***PV*** is the present value. ***PMT*** and *TYPE* are included to handle annuities (a series of equal payments, equally spaced over time), which we will deal with later. For problems of the type that we are currently solving, we will set both ***PMT*** and *TYPE* to 0.[1]

Let's set up a simple worksheet to calculate the future value of a single sum. Starting with a blank worksheet, enter the labels and numbers as shown in Exhibit 7-1.

EXHIBIT 7-1
FUTURE VALUE OF A SINGLE CASH FLOW

	A	B
1	**Future Value Calculations**	
2	Present Value	1000.00
3	Years	1
4	Rate	10%
5	Future Value	

We want to use the **Fv** function to calculate the future value of $1,000 for one-year at 10% per year. In B5 enter the formula: `=FV(B4,B3,0,-B2,0)`. The result, $1,100, is exactly the same as we found earlier. Note that we have entered –B2 for the ***PV*** parameter. The reason for the negative sign is because Excel realizes that either the ***PV*** or ***FV*** must be a cash outflow. If we had not used the negative sign, the result (***FV***) would have been negative. Users of financial calculators will recognize this as the cash flow sign convention.

You can now experiment with different values for the parameters. Try replacing the `1` in B3 with a `2`. Excel immediately updates the result in B5 with $1,210, just as we found in the second part of our example. To see just how powerful compounding can be, insert `30` into B3. The result, $17,449.40, indicates that each $1,000 invested at 10% per year will grow to $17,449.40 after just 30 years. If we double the investment, to `$2,000`, then we should double the future value. Try it; you should get a result of $34,898.80, exactly twice what we got with a $1,000 investment. In general, any money invested for 30 years at 10% per year will grow to 17.449 times its initial value. To see even more powerful examples of compounding, try increasing the interest rate.

1. The *TYPE* parameter tells Excel whether the cash flows occur at the end (0) or beginning (1) of the period.

Present Value

Our future value equation can be solved for any of its variables. We may wish to turn our example problem around to solve for the present value. Suppose that the problem is restated as, "What initial investment is required so that you will accumulate $1,210 after two years if you earn an interest rate of 10% per year?" In this case, we want to solve for the present value—we already know the future value.

Mathematically, all we need to do is to solve the future value equation (7-2) for the present value:

$$PV = \frac{FV_N}{(1+i)^N} \tag{7-3}$$

Of course, we already know that the answer must be $1,000:

$$PV = \frac{1{,}210}{(1.10)^2} = 1{,}000$$

In Excel, we can solve problems of this type by using the built-in **PV** function:

PV(*RATE*, *NPER*, *PMT*, *FV*,*TYPE*)

The parameters to the **PV** function are exactly the same as those for the **FV** function, except that ***PV*** is replaced by ***FV***. For this example, in cells D1:E5, set up the worksheet as shown in Exhibit 7-2.

EXHIBIT 7-2
PRESENT VALUE OF A SINGLE CASH FLOW

	A	B	C	D	E
1	**Future Value Calculations**			**Present Value Calculations**	
2	Present Value	1000.00		Future Value	$1,210.00
3	Years	2		Years	2
4	Rate	10%		Rate	10%
5	Future Value	$1,210.00		Present Value	

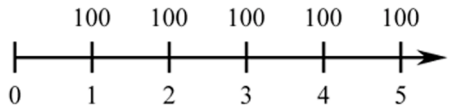
In cell E5 place the formula: `=PV(E4,E3,0,-E2,0)`. Again, we enter the future value reference as negative so that the present value result will be positive. The result will be $1,000, exactly as expected.

We have purposely constructed our future value and present value examples side-by-side in the worksheet to demonstrate that present value and future value are inverse functions. Let's change our worksheet to make this concept clear. We want to link the references in the present value function to the cells used in the future value function. This will allow changes in the future value parameters to change the present value parameters. First, select E2 and enter: `=B5`, in E3 type: `=B3`, and in E4 enter: `=B4`. Now, regardless of the changes made to the future value side of the worksheet, the present value should be equal to the value in B2. Try making some changes to the inputs in B2, B3, and B4. No matter what changes you make, the calculated present value (in E5) is always the same as the present value input in B2. This is because the present value and future value are inverse functions.

Annuities

Thus far we have examined the present and future values of single cash flows (also referred to as lump sums). These are powerful concepts that will allow us to deal with more complex cash flows. *Annuities* are a series of nominally equal cash flows, equally spaced in time. Examples of annuities abound. Your car payment is an annuity, so is your mortgage (or rent) payment. If you don't already, you may someday own annuities as part of a retirement program. The cash flow pictured in Figure 7-1 is another example.

FIGURE 7-1
A TIMELINE FOR AN ANNUITY CASH FLOW



How do we find the value of a stream of cash flows such as that pictured in Figure 7-1? The answer involves the *principle of value additivity.* This principle says that "the value of a stream of cash flows is equal to the sum of the values of the components." As long as the cash flows occur at the same time, they can be added together. Therefore, if we can move each of the cash flows to the same time period, we can add them to find the value as of that time period. Cash flows can be moved around in time by compounding or discounting.

Present Value of an Annuity

One way to find the present value of an annuity is to find the present value of each of the cash flows separately and add them together. Equation (7-4) summarizes this method:

$$PV_A = \sum_{t=1}^{N} \frac{Pmt_t}{(1+i)^t} \tag{7-4}$$

where PV_A is the present value of the annuity, t is the time period, N is the total number of payments, Pmt_t is the payment in period t, and i is the discount rate.

Of course, this equation works fine for any annuity (or any stream of cash flows), but it can be very tedious for annuities with more than just a few payments. Imagine finding the current balance (i.e., present value) of a mortgage with more than 300 payments to go before it is paid off! We can find a closed-form solution (the above equation is an "open-form" solution because the number of additions is indefinite) by taking the summation:

$$PV_A = Pmt\left[\frac{1-\frac{1}{(1+i)^N}}{i}\right] \quad \textbf{(7-5)}$$

where all terms are as previously defined. Notice that we have dropped the subscript *t*, because this solution does not depend on our taking the present values separately. Instead, since each payment is the same, we can value the whole annuity in one step.

Let's find the present value of the cash flow pictured in Figure 7-1. Assuming that the discount rate for this cash flow is 8%, the equation is:

$$PV_A = 100\left[\frac{1-\frac{1}{(1.08)^5}}{0.08}\right] = 399.271$$

This means that if you were to deposit $399.27 into an account today which pays 8% interest per year, you could withdraw $100 at the end of each year for the next five years and be left with a balance of $0.00 at the end of the five years.

Recall from our earlier discussion of single cash flows that we can use Excel's built-in **PV** function to find present values. To recap, the **PV** function is defined as:

PV(***RATE***, ***NPER***, ***PMT***, ***FV***, *TYPE*)

When dealing with single cash flows we set ***PMT*** and *TYPE* to 0. Those parameters are used only in the case of annuities. ***PMT*** will be set to the dollar amount of the periodic payment. *TYPE* is an optional binary (0 or 1) variable which controls whether Excel assumes the payment occurs at the end (0) or the beginning (1) of the period. For the time being, we will assume that all payments occur at the end of the period (that is, they are *regular* annuities).

EXHIBIT 7-3
PRESENT VALUE OF AN ANNUITY

	A	B
1	**Present Value of an Annuity**	
2	Payment	100
3	Interest Rate	8%
4	Number of Payments	5
5	Present Value	

Set up a worksheet with the data pictured in Exhibit 7-3 in cells A1:B5. In B5 we wish to find the present value of the annuity presented in Figure 7-1, so enter: `=PV(B3,B4,B2,0,0)`. Note that we have entered the payment as a positive number and the result is –$399.27. The interpretation is that if you were to make a deposit of (a cash outflow) $399.27 today, you could make a withdraw of (a cash inflow) $100 each year for the next five years. Had we made the payment (B2) negative instead, the present value would have been a positive $399.27. The answer is the same, except for the sign, but the interpretation is different. In this case, the interpretation is that if you were to take out a loan of $399.27 (a cash inflow) today, you would need to repay $100 (a cash outflow) per year for each of the next five years to retire the loan.

We can, of course, experiment with various parameters. For example, suppose that instead of five withdrawals of $100 each, you wanted to make ten withdrawals of $50 each. How much would you need to deposit into this account in order to deplete the account after 10 withdrawals? Change the number of payments in B4 to: `10`, and the payment in B2 to: `50`. After these changes, you will see that an initial deposit of only $335.50 will allow you to achieve your goal.

Returning now to our original example, reset the payment amount to `100` and the number of payments to `5`. How much would you have to deposit if you want to make your first withdrawal today, rather than one year from today? To answer this question, realize that the only thing we have changed is the timing of the first withdrawal. We will still make a total of five withdrawals of $100 each, but they occur at the beginning of each period. In B5, change the *TYPE* parameter to `1`, from `0` originally, so that the formula is now: `=PV(B3,B4,B2,0,1)`. The result is –$431.21 indicating that, because the first withdrawal occurs immediately, you will have to make a larger initial deposit. Note that the amount of the deposit must be larger because you will not earn the first year's interest before making the first withdrawal.

Another way to look at this is that we are effectively depositing $331.21 (= $431.21 deposit - $100 withdrawal) in order to be able to make four future withdrawals of $100 each. To see that this is the case, change the **PV** formula back to its original form (*TYPE* = 0) and change the number of payments to 4. The present value is then shown to be $331.21, exactly as claimed.

Future Value of an Annuity

Imagine that you have recently begun planning for retirement. One of the attractive options available is to set up an Individual Retirement Account (IRA). What makes the IRA so attractive is that you can deposit up to $3,000 per year,[2] and the investment gains will accrue tax-free until you begin to make withdrawals after age 59½. Furthermore, depending on your situation, the IRA deposits may reduce your taxable income.

To determine the amount that you will have accumulated in your IRA at retirement, you need to understand the future value of an annuity. Recalling the principle of value additivity, we could simply find the future value of each year's investment and add them together at retirement. Mathematically this is:

$$FV_A = \sum_{t=1}^{N} [Pmt_t(1+i)^{N-t}] \qquad \textbf{(7-6)}$$

Alternatively, we could use the closed-form solution of Equation (7-6):

$$FV_A = Pmt\left[\frac{(1+i)^N - 1}{i}\right] \qquad \textbf{(7-7)}$$

Assume that you are planning on retirement in 30 years. If you deposit $3,000 each year into your IRA account which will earn an average of 7.5% per year, how much will you have after 30 years? Because of the large number of deposits, equation (7-7) will be easier to use than equation (7-6) though we could use either one. The solution is:

$$FV_A = 3{,}000\left[\frac{(1.075)^{30} - 1}{0.075}\right] = 310{,}198.21$$

---

2. As of this writing, current tax laws call for this amount to be stepped up each year until 2008 when it will reach $5,000.

As usual, Excel provides a built-in function to handle problems such as this one. The **FV** function, which we used to find the future value of a single sum earlier, will also find the future value of an annuity. Its use is nearly identical to the **PV** function; the only difference is the substitution of **PV** for **FV**. Set up a new worksheet like the one in Exhibit 7-4.

EXHIBIT 7-4
FUTURE VALUE OF AN ANNUITY

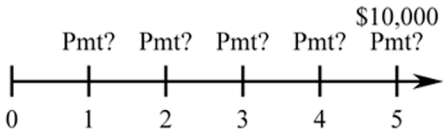
	A	B
1	**Future Value of an Annuity**	
2	Payment	3000
3	Interest Rate	7.50%
4	Number of Payments	30
5	Future Value	

In B5 place the formula: `=FV(B3,B4,-B2,0,0)`. The result, $310,198.21, agrees exactly with the result from the formula. What if that amount is less than you had hoped for? One solution is to start making the investments this year, rather than next (i.e, the beginning of this period rather than the end of this period). To see the effect of this change all that needs to be done is to change the *TYPE* parameter to `1` so that the formula is now: `=FV(B3,B4,-B2,0,1)`. That minor change in your investment strategy will net you a little over $23,000 extra at retirement. Perhaps a better alternative is to accept a little extra risk (we assume that you are young enough that this makes sense) by investing in stock mutual funds which will return an average of about 10% per year over the 30-year horizon. In this case, still assuming that you start investing right now, you will have $542,830.27 at retirement. Significantly better!

Solving for the Annuity Payment

Suppose that we want to know the amount that we have to deposit in order to accumulate a given sum after a number of years. For example, assume that you are planning to purchase a house five years from now. Since you are currently a student, you will begin saving for the $10,000 down payment one year from today. How much will you need to save each year, if your savings will earn a rate of 4% per year? Figure 7-2 diagrams the problem.

FIGURE 7-2
A TIMELINE FOR ANNUAL SAVINGS TO OBTAIN $10,000 IN FIVE YEARS



In this case, we wish to solve for the payment you would have to make each year. The future value of the annuity is already known, so the **FV** function would be inappropriate. What we need is Excel's **PMT** function:

PMT(*RATE*,*NPER*,*PV*,*FV*,*TYPE*)

The parameters for the **PMT** function are similar to those for the **PV** and **FV** functions, except that it has ***PV*** and ***FV*** parameters in place of the ***PMT*** parameter.

EXHIBIT 7-5
ANNUITY PAYMENT WHEN PV OR FV IS KNOWN

	A	B
1	**Solving for an Annuity Payment**	
2	Present Value	0
3	Future Value	$10,000
4	Number of Payments	5
5	Interest Rate	4%
6	Annual Payment Amount	

Enter the information from Exhibit 7-5 into cells A1:B6 of a new worksheet. In cell B6 enter the **PMT** function: `=PMT(B5,B4,-B2,B3,0)`. The result indicates that you will have to save $1,846.27 per year (a cash outflow) in order to accumulate $10,000 for the down payment in five years.

The **PMT** function allows *both* ***PV*** and ***FV*** to be inputs. In the previous example, it was assumed that ***PV*** was 0. However, let's suppose that you have recently inherited $3,000 from your uncle, and that you want to use this money to begin saving now for that down payment. Since the $3,000 will grow to only $3,649.96 after five years at 4% per year (this can be verified by using the worksheet created

for Exhibit 7-1) you will still need to save some amount every year. How much will you need to save each year? To find out, simply set the present value, in B2, to `3000` leaving the other values unchanged. Because the initial investment *reduces* the total amount that you need to save to $6,350.04 (why?), your annual saving requirement is reduced to $1,172.39.

Solving for the Number of Periods in an Annuity

Solving for the present value, future value, and payment for annuities are fairly simple problems. That is, the formulas are straightforward and easy to apply. Solving for the number of periods, *N*, is not as obvious mathematically. To do so requires knowledge of logarithms. If you know the present value of the annuity, then solving Equation (7-5) for *N* we get:

$$N = \frac{\ln\left(\frac{-iPV_A}{Pmt} + 1\right)}{-\ln(1+i)} \tag{7-8}$$

where ln(·) is the natural logarithm operator. If you know the future value, then solving equation (7-7) for *N* results in:

$$N = \frac{\ln\left(\frac{iFV_A}{Pmt} + 1\right)}{\ln(1+i)} \tag{7-9}$$

Excel offers the built-in **NPER** function to solve problems of this type. This function is defined as:

NPER(*RATE*, *PMT*, *PV*, *FV*,*TYPE*)

where all of the parameters are as previously defined. To use this function, you must know the payment, per period interest rate, and either the present value or future value or both.

Return now to our example of saving for the down payment for a house. Recall that it was determined that by saving $1,846.27 per year you could afford the down payment after five years, assuming no initial investment. Set up the worksheet in Exhibit 7-6.

EXHIBIT 7-6
NUMBER OF ANNUITY PAYMENTS WHEN PV OR FV IS KNOWN

	A	B
1	**Solving for *N* in an Annuity**	
2	Present Value	$0
3	Future Value	$10,000
4	Annual Payment	$1,846
5	Annual Rate	4.00%
6	Number of Years	

Since we want to solve for the number of periods, insert the **NPER** function into B6: `=NPER(B5,-B4,-B2,B3,0)`. Notice that both the ***PV*** and ***PMT*** parameters are made negative in this function. Again, this is because of the cash flow sign convention. In this case, we wish to be able to withdraw the future value (a cash inflow and therefore positive) and deposit the ***PV*** and ***PMT***s (cash outflows, therefore negative). The result is five years, exactly as we would expect. If you include the $3,000 inheritance, you will have the downpayment in only 3.39 years.

Solving for the Interest Rate in an Annuity

Unlike the present value, future value, payment, and number of periods, there is no closed-form solution for the rate of interest of an annuity. The only way to solve this problem is to use a trial and error approach, perhaps an intelligent one such as the Newton-Raphson technique or the bisection method.[3]

Excel, however, offers a built-in function that will solve for the interest rate, though it requires a little more setup than the functions we've used so far. The function, **RATE**, is defined as:

RATE(*NPER*, *PMT*, *PV*, *FV*,*TYPE*,*GUESS*)

3. These are powerful techniques for solving these types of problems. The bisection method, briefly, involves choosing two initial guesses at the answer that are sure to bracket the true answer. Each successive guess is halfway between the two previous guesses that bracket the solution. The Newton-Raphson technique requires calculus and is beyond the scope of this book. For more information, consult any numerical methods textbook.

where the parameters are as defined earlier, and *GUESS* is your optional first guess at the correct answer. Ordinarily, the *GUESS* can be omitted.

> Suppose that you are approached with an offer to purchase an investment that will provide cash flows of $1,500 per year for 10 years. The cost of purchasing this investment is $10,500. If you have an alternative investment opportunity, of equal risk, which will yield 8% per year, which should you accept?

There are actually several ways that a problem such as this could be solved. One method is to realize that 8% is your opportunity cost of funds, and should therefore be used as your discount rate. Using the worksheet created in Exhibit 7-3 we find that the present value (i.e., current worth to you) of the investment is only $10,065.12. Since the price ($10,500) is greater than the value, you should reject the investment and accept your alternative.[4]

Another method of solving this dilemma is to compare the yields (i.e., compound annual return) offered by the investments. All other things being equal, the investment with the highest yield should be accepted. We already know that your alternative investment offers an 8% yield, but what is the yield of your new opportunity? We will use the worksheet in Exhibit 7-7 to find out.

Into B6 place the function: `=RATE(B5,B4,B2,B3,0,0.1)`. The result is 7.07% per year, so you should reject the new investment in favor of your alternative, which offers 8% per year. This is the same result we obtained with the present value methodology, as we would hope. Later, we will see that this will always be the case when comparing mutually exclusive investment opportunities.[5]

---

4. Note that we are simply comparing the cost of the investment to its perceived benefit (present value). If the cost is greater than the benefit, the investment should be rejected. We will expand on this method in future chapters.

5. Mutually exclusive investment opportunities are those in which you may choose one investment or the other, but not both. That is, the choice of one precludes your also choosing the other.

EXHIBIT 7-7
YIELD ON AN ANNUITY

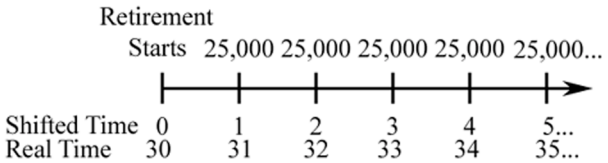
	A	B
1	**Solving for *i* in an Annuity**	
2	Present Value	(10,500)
3	Future Value	0
4	Annual Payment	$1,500
5	Number of Years	10.00
6	Annual Rate	

Deferred Annuities

Not all annuities begin their payments during the year following the analysis period. For example, if you are planning your retirement, you will probably start with the amount of income that you will need each year during retirement. But, chances are if you are a student, you will probably not retire for many years. Your retirement income, then, is an annuity which won't begin until you retire. In other words it is a *deferred annuity.* How do we determine the value of a deferred annuity?

Assume that you own a time machine (made of a super-strong futuristic metal that can withstand the gravitational forces of a black hole in space). This machine can transport you to any time period that you choose. If we use this time machine to transport you to the year just prior to retirement, then valuing the stream of retirement income becomes a simple matter. Just use Excel's **PV** function. The year before retirement is now considered to be year 0, the first year of retirement is year 1, and so on. Figure 7-3 demonstrates this time-shifting technique.

FIGURE 7-3
TIME-SHIFTING AS A FIRST STEP IN SOLVING DEFERRED ANNUITY PROBLEMS



In constructing Figure 7-3, we have assumed that you will retire 30 years from now, and will require income of $25,000 per year during retirement. If we further assume that you will need your retirement income for 35 years (you come from very long-lived stock) and expect to earn 6% per year, you will need $362,456 at retirement (year 30) to provide this income. In other words, $362,456 is the present value, at year 30, of $25,000 per year for 35 years at 6%. You can use the worksheet created for Exhibit 7-3 to verify these numbers.

The problem in Figure 7-3 is that knowing the amount that we will need 30 years from now tells us nothing about how much we need to save today. The present value function in Excel, or the PV_A equation (7-5), must be thought of as a transformation function. That is, it transforms a series of payments into a lump sum. That lump sum ($362,456 in our example) is then placed *one period before the first payment occurs*. In our earlier examples, the annuities began payment at the end of period 1, so the present value was at time period 0 (one period earlier than period 1). In the current example, the present value is at time period 30, also one period before the first payment.

In order to determine the amount that we need to invest today, we must treat the required savings at retirement as a future value. This sum must then be discounted back to period 0. For example, if we assume that we can earn 8% per year before retirement, we would need to invest $36,019.93 today in order to meet our retirement goals.

Exhibit 7-8 presents a simple worksheet to determine the investment required today in order to provide a particular income during retirement. Open a new worksheet and enter the data and labels from Exhibit 7-8.

EXHIBIT 7-8
PLANNING FOR RETIREMENT

	A	B
1	**Retirement Worksheet**	
2	Annual Retirement Income Need	25,000
3	Years until Retirement	30
4	Years in Retirement	35
5	Rate of Return before Retirement	8%
6	Rate of Return during Retirement	6%
7	Savings Required at Retirement	
8	Investment Required Today	
9	Annual Investment Required	

To complete our retirement worksheet, we need to enter functions into cells B7:B9. Recall that the first step in our retirement income problem was to determine the present value of your retirement income at period 30. To do this in our worksheet, enter the **PV** function into B7: `=PV(B6,B4,-B2,0,0)`. The result, $362,456, tells us that you will need to have saved this amount in order to provide the income indicated in B2 for the number of years indicated in B4. To determine the amount that you would need to invest today (a lump sum), you need to determine the present value, at time period 0, of the amount in B7. To do this, in B8 enter the formula: `=PV(B5,B3,0,-B7,0)`. As before, the amount required today is $36,019.93.

Another feature of the retirement planning worksheet is that it will calculate the annual savings required to reach your goal. To make Excel do this calculation, we need to use the **PMT** function. In B9 enter: `=PMT(B5,B3,0,-B7,0)`. The result is $3,199.56, which means that if you can save this amount each year for the next 30 years, and earn an average of 8% interest each year, you will reach your goal.

We have ignored the effect of inflation and taxes on your retirement planning for this worksheet. But if we assume that you save the amount in B9 in a tax-deferred account, the results are a bit more realistic. Experiment with this worksheet. You may be surprised at the difficulty of saving for a comfortable retirement!

Uneven Cash Flow Streams

Annuities are very neat from a cash flow point of view, but most investments don't have cash flows that are the same in each period. When the cash flows are different in each period we refer to them as *uneven cash flow streams*. Investments of this type are not as easy to deal with, though conceptually they are the same.

Recall our discussion of the principle of value additivity. This principle says that as long as cash flows occur in the same period, we can add them together to determine their combined value. The principle applies to any time period, not just to time period 0. So, to determine the present value of an uneven stream of cash flows, one option is to determine the present value of each cash flow separately, and then add them together. The same technique applies to the future value of an uneven stream. Simply find the future value of each cash flow separately, and then add them together.

Excel's **PV** and **FV** functions cannot be used for uneven cash flow streams because they assume equal (annuity) payments or a lump sum. Set up the worksheet in Exhibit 7-9 and we'll see what needs to be done.

EXHIBIT 7-9
PV AND FV FOR UNEVEN CASH FLOWS

	A	B
1	**Uneven Cash Flow Streams**	
2	Year	Cash Flow
3	1	1000
4	2	2000
5	3	3000
6	4	4000
7	5	5000
8	Interest Rate	11.00%
9	Present Value	
10	Future Value	

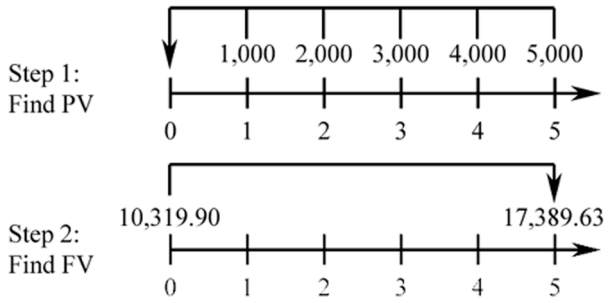
First, we want to solve for the present value of the cash flows in B3:B7. To do this, we need to use the net present value, **NPV**, function. This function will be especially valuable in capital budgeting in Chapter 10. The **NPV** function is defined as:

NPV(*RATE*,*VALUE1*,*VALUE2*, . . .)

where ***RATE*** is the per period rate of return (i.e., the discount rate), and ***VALUE1*** is the first cash flow (or range of cash flows), *VALUE2* is the second cash flow, and so on. Excel will accept up to 29 cash flows in the list. To find the present value of the cash flows, enter: `=NPV(B8,B3:B7)` into B9.[6] Note that we have entered the cash flows as a range, rather than as individual values. Excel will accept the parameters either way, though a range is generally easier to enter. The result is $10,319.90. To verify this result, you can find the present value of each cash flow at 11% and add them.

Finding the future value of an uneven stream is a bit more difficult because Excel has no built-in function to perform this calculation. Recall, however, the principle of value additivity. If we can get all of the cash flows into the same period, we can add them together and then move the result to the desired period. Figure 7-4 shows this solution.

FIGURE 7-4
FINDING THE FUTURE VALUE OF AN UNEVEN STREAM IN EXCEL



First, we find the present value of the uneven stream of cash flows, perhaps using the **NPV** function, and then we find the future value of the present value of the cash

6. If you are familiar with the definition of Net Present Value (NPV), you should know that Excel's NPV function does not calculate the NPV as it is normally defined. Instead, it merely calculates the present value of the cash flows. This is covered in more depth in Chapter 10.

flows. The easiest way to implement this method in Excel is to use the **NPV** function *nested* within the **FV** function. A nested function is one which is used as an input to another function. In B10 enter: `=FV(B8,A7,0,-NPV(B8,B3:B7),0)`. The future value is found to be $17,389.63. Notice that we have used the **NPV** function inside the **FV** function. As an alternative, we could have put –B9 in for the present value parameter, but the result would be the same. Using nested functions can often simplify a worksheet by making use of fewer cells, though the formulas tend to be more complex.

Solving for the Yield in an Uneven Cash Flow Stream

Often in financial analysis, it is necessary to determine the yield of an investment given its price and cash flows. For example, we have already seen that one way to choose between alternative investments is to compare their yields, and we will see more examples in Chapter 10. This was easy when dealing with annuities and lump-sum investments. But, what about the case of uneven cash flow investments? We will use the worksheet in Exhibit 7-10 to find out.

To solve for the yield in problems such as this, we need to make use of the internal rate of return (**IRR**) function. The IRR is defined as the rate of return which equates the present value of future cash flows with the cost of the investment ($10,319.90 in this problem). In Excel, the **IRR** function is defined as:

IRR(*VALUES*,*GUESS*)

EXHIBIT 7-10
YIELD ON AN UNEVEN CASH FLOW STREAM

	A	B
1	**Uneven Cash Flow Streams**	
2	Year	Cash Flow
3	0	(10,319.90)
4	1	1000
5	2	2000
6	3	3000
7	4	4000
8	5	5000
9	Yield	

where ***VALUES*** is a range of cash flows (including the cost), and *GUESS* is the optional first guess at the correct interest rate. We will study this function in depth in Chapter 10, but for now we will just make use of it.

Before we find the solution, notice a couple of things about the worksheet. The cash flows are listed separately, so we cannot use the **IRR** function like we did the **FV**, **PV**, and **PMT** functions. Also, we must include the cost of the investment as one of the cash flows. To find the yield on this investment, insert into B9: `=IRR(B3:B8,0.10)`. The result is 11%, which means that if you purchase this investment you will earn a compound annual rate of 11%.

We have used one form of the **IRR** function in B9. Another option is to omit the *GUESS* (0.10 in our example). In this case, either form will work. Sometimes, however, Excel will not be able to converge on a solution without a *GUESS* being specified. Remember that this is essentially a trial and error process, and sometimes Excel needs a little help to go in the right direction.

A few situations may cause an error when using the **IRR** function. One that we've already discussed is that Excel may not converge to a solution. In this case, you can usually find the answer by supplying Excel with a different *GUESS*. Another occurs if you have no negative cash flows. As an example, change the purchase price to a positive `10,500`. Excel will return the #NUM! error message indicating that there is a problem. In this case the problem is that your return is infinite (why?). A third problem can result from more than one negative cash flow in the stream. In general, there will be one solution to the problem for each sign change in the cash flow stream. In our original example, there is only one sign change (from negative to positive after the initial purchase.)

Non-Annual Compounding Periods

There is no reason why we should restrict our analyses to investments which pay cash flows annually. Some investments make payments (e.g., interest) semiannually, monthly, daily, or even more frequently. Everything that we have learned to this point still applies, with only a minor change.

Recall our basic time value of money formula (7-2):

$$FV_N = PV(1+i)^N$$

Originally, we defined *i* as the annual rate of interest, and *N* as the number of years. Actually, *i* is the periodic rate of interest and *N* is the total number of periods. As an example, *i* might be the weekly interest rate and *N* the number of weeks for which we will hold the investment.[7] Since rates are usually quoted in terms of simple (i.e., not compounded) annual rates, we can restate our basic formula as:

$$FV_N = PV\left(1 + \frac{i}{m}\right)^{Nm} \quad \textbf{(7-10)}$$

where *i* is the annual rate, *N* is the number of years, and *m* is the number of periods per year.

Excel can handle non-annual compounding just as easily as annual compounding. Just enter the rate and number of periods adjusted for the length of the compounding period. Let's look at an example.

> Assume that you are shopping for a new bank to set up a savings account (a lousy investment, but play along anyway). As you start shopping, you notice that all of the banks offer the same stated interest rate, but different compounding periods. To help make your decision, you set up the worksheet in Exhibit 7-11.

(Hint: the easiest way to set up this worksheet is to enter the data for the First National Bank and then make two copies. Next, edit the bank names and adjust the column widths to accommodate the labels.)

7. Since there are 52 weeks in a year, we would normally calculate the weekly rate as the annual rate divided by 52. Similarly, the number of weeks would be calculated by multiplying the number of years (perhaps a fractional number of years) by 52.

EXHIBIT 7-11
NON-ANNUAL COMPOUNDING PERIODS

	A	B
1	**Non-Annual Compounding Worksheet**	
2	**First National Bank**	
3	Investment	1000
4	Simple Rate	10.00%
5	Periods per Year	1
6	Term of Investment (Years)	1
7	Future Value	
8	**Second National Bank**	
9	Investment	1000
10	Simple Rate	10.00%
11	Periods per Year	2
12	Term of Investment (Years)	1
13	Future Value	
14	**Third National Bank**	
15	Investment	1000
16	Simple Rate	10.00%
17	Periods per Year	12
18	Term of Investment (Years)	1
19	Future Value	

Notice that all of the banks are advertising a 10% annual rate. The only difference is how often they credit the interest to your account (i.e., the frequency of compounding). Being an economically rational thinker, you will choose the bank that will provide the highest balance at the end of the year. To determine the end of year balances, enter the **Fv** formula in B7: `=FV(B4/B5,B6*B5,0,-B3,1)`. Copy the formula from B7 to both B13 and B19. Note that we have again made use of nested functions. In this case, the rate is defined as the annual rate *divided* by the number of periods in a year, and the number of periods is the number of years *times* the number of periods in a year.

The choice is clear. You should choose the Third National Bank since it offers the highest end of year balance. All other things being equal, the more frequent the compounding, the higher your future value will be. To see this more clearly, set up the worksheet in Exhibit 7-12.

EXHIBIT 7-12
COMPARING VARIOUS NON-ANNUAL COMPOUNDING PERIODS

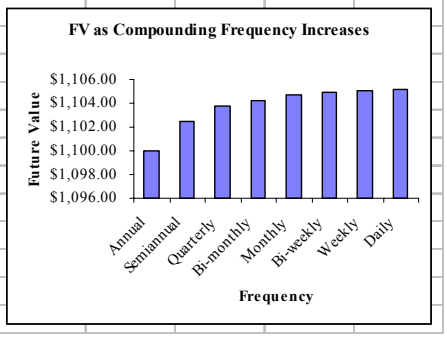
	A	B	C
1	**Non-Annual Compounding Periods**		
2	Present Value	1000	
3	Annual Rate	10.00%	
4	**Frequency**	**Periods/Year**	**FV**
5	Annual	1	
6	Semiannual	2	
7	Quarterly	4	
8	Bi-monthly	6	
9	Monthly	12	
10	Bi-weekly	26	
11	Weekly	52	
12	Daily	365	

To complete the worksheet, enter the **FV** formula in C5: `=FV(B$3/B5,B5,0,-B$2,1)` and copy it down to the other cells. It is important that you insert the dollar signs as indicated so that the references to the present value and interest rate remain fixed when copying.

Notice that, as before, the more frequent the compounding, the higher the future value. Furthermore, the future value increases at a decreasing rate as the number of compounding periods increases. This can be seen more easily if we create a graph of the future values. To accomplish this, select the labels in A5:A13 and the numbers in C5:C13 (remember, you can select non-contiguous ranges by holding down the Ctrl key while dragging the mouse). Note that you are selecting one extra row because we will use this worksheet again later to add one more data point. Now, click on the Chart Wizard icon and follow the prompts. You should end up with a worksheet that resembles the one in Exhibit 7-13.

EXHIBIT 7-13
NON-ANNUAL COMPOUNDING RESULTS

	A	B	C	D	E	F	G	H
1	**Non-Annual Compounding Periods**							
2	Present Value	1000						
3	Annual Rate	10.00%						
4	**Frequency**	**Periods/Year**	**FV**					
5	Annual	1	$1,100.00					
6	Semiannual	2	$1,102.50					
7	Quarterly	4	$1,103.81					
8	Bi-monthly	6	$1,104.26					
9	Monthly	12	$1,104.71					
10	Bi-weekly	26	$1,104.96					
11	Weekly	52	$1,105.06					
12	Daily	365	$1,105.16					



Continuous Compounding

We have seen that more frequent compounding leads to higher future values. However, our examples extended this idea only as far as daily compounding. There is no reason that we can't also compound every half-day, every hour, or even every minute. In fact, this concept can be extended to the smallest imaginable time period: the instant. This type of compounding is referred to as *continuous compounding*.

Continuous compounding is an extension of what we have seen already. To recap, recall that we changed the basic future value function:

$$FV_N = PV\left(1 + \frac{i}{m}\right)^{Nm}$$

The more frequently we compound, the larger m is going to be. For example, with semiannual compounding $m = 2$, but with daily compounding $m = 365$. What if we set m equal to infinity? Actually, we can't do that because i/∞ is effectively equal to zero. What we can do is to take the limit as m approaches infinity. When we do this, we get:

$$\lim_{m \to \infty} FV_N = PVe^{iN} \qquad \textbf{(7-11)}$$

where *e* is the base of the natural logarithm, and is approximately equal to 2.718…

Excel does not offer functions to solve for the present or future value when compounding is continuous. However, we can easily create the formulas. To do so requires that you know about the **EXP** function which raises *e* to a specified power.[8] This function is defined as:

EXP(*NUMBER*)

Using the worksheet in Exhibit 7-13, we can add, in cell C13: `=B$2*exp(B$3)`. Since we have assumed a one year period in this example, the power to which *e* is raised is simply the interest rate. Add the label: `Continuous` in A13 and the worksheet is complete. Note that continuous compounding doesn't offer much of an increase over daily compounding. The advantage does get larger as the amount invested grows, but it would take huge sums to make a significant difference. To see this, change the present value, B2, to `10,000,000`.

We can also calculate the present value of a continuously compounded sum. All that needs to be done is to solve equation (7-11) for *PV*:[9]

$$\lim_{m \to \infty} PV = FV_N e^{-iN} . \qquad \textbf{(7-12)}$$

Summary

In this chapter we have discussed the concept of the time value of money. Present value represents the amount of money that needs to be invested today in order to purchase a future cash flow or stream of cash flows. Future value represents the amount of money that will be accumulated if we invest known cash flows at known

8. *e* is the base of the natural logarithm, so exp(·) is the inverse of ln(·). In other words, $\exp(\ln(x)) = x$.

9. Many students find that the continuous compounding equations are easier to recall if we change the notation slightly. Specifically, let *P* be the present value, *F* be the future value, *r* is the annual rate of interest, and *T* is the number of years (which can be fractional). With this notation, equation (7-11) becomes: $F = Pe^{rT}$, and equation (7-12) becomes: $P = Fe^{-rT}$. This is easier because the formulas can be pronounced. For example, (7-11) is pronounced "Pert."

interest rates. Further, we discussed various types of cash flows. Annuities are equal cash flows, equally spaced through time. Uneven cash flows are those in which the periodic cash flows are not equal.

Before continuing with future chapters you should be comfortable with these concepts. Practice by changing the worksheets presented in this chapter until you develop a sense for the type of results that you will obtain.

TABLE 7-1
FINANCIAL FUNCTIONS USED IN THIS CHAPTER

Purpose	Function	Page
Find the future value	**FV**(***RATE***, ***NPER***, ***PMT***, ***PV***,*TYPE*)	185
Find the present value	**PV**(***RATE***, ***NPER***, ***PMT***, ***FV***,*TYPE*)	187
Payment of an annuity	**PMT**(***RATE***, ***NPER***, ***PV***, ***FV***,*TYPE*)	194
Number of periods	**NPER**(***RATE***, ***PMT***, ***PV***, ***FV***,*TYPE*)	195
Yield of an annuity	**RATE**(***NPER***, ***PMT***, ***PV***, ***FV***,*TYPE*,*GUESS*)	196
Present value of unequal cash flows	**NPV**(***RATE***,***VALUE1***,*VALUE2*,…)	202
Find the yield of unequal cash flows	**IRR**(***VALUES***,*GUESS*)	203
Raise *e* to a power	**EXP**(***NUMBER***)	209

Problems

1. Upon starting your new job after college, you've been confronted with selecting the investments for your 401k retirement plan. You have four choices for investing your money:
   - A money market fund which has historically returned about 5% per year.
   - A long-term bond fund which has earned an average annual rate of return of 8%.
   - A conservative common-stock fund which has earned 10% per year.

- An aggressive common-stock fund which has historically earned 14% per year.

a. If you were to contribute $3,600 per year for the next 35 years, how much would you accumulate in each of the above funds?

b. Now, change your worksheet so that it allows for non-annual investments (monthly, bi-weekly, etc.). Set up a scenario analysis that shows your accumulated value in each fund if you were to invest quarterly, monthly, bi-weekly, and weekly. Create a scenario summary of your results.

c. What relationship do you notice between the frequency of investment and the future value?

2. Given the following set of cash flows:

Period	Cash Flow
1	12,000
2	10,000
3	8,000
4	6,000
5	4,000

a. If your required rate of return is 12% per year, what is the present value of the above cash flows? Future value?

b. Now, suppose that you are offered another investment that is identical, except that the cash flows are reversed (i.e., cash flow 1 is 4,000, cash flow 2 is 6,000, etc.). Is this investment worth more, or less, than the original? Why?

c. If you paid $25,000 for the original investment, what average annual rate of return would you earn?

3. Your five-year-old daughter has just announced that she would like to attend college. Your best guess is that it will cost approximately $25,000 per year (for four years) in tuition, books,

rent, etc. for her to attend State College 13 years from now. You believe that you can earn a rate of 9% on investments to meet this goal.

a. If you were to invest a lump sum today in hopes of covering your daughter's college costs, how much would you have to invest?

b. If you now decided to invest annually instead, how much would you have to invest each year?

c. You just learned of a $10,000 inheritance and plan to invest it in your daughter's college fund. Given this new source of funds, how much will you now have to invest each year?

8 *Valuation and Rates of Return*

After studying this chapter, you should be able to:

1. *Differentiate among the definitions of "value" and explain the importance of intrinsic value in making financial decisions.*
2. *Explain how intrinsic value is calculated by considering the size, timing, and perceived riskiness of the cash flows.*
3. *Explain the concept of "required rate of return" and calculate this rate using the Capital Asset Pricing Model (CAPM).*
4. *Show how any security (common or preferred stocks, bonds, etc.) can be valued in Excel or by hand.*
5. *Calculate the various bond return measures in Excel.*

Determining the value of financial assets is important to both investors and corporate financial managers. The obvious reason is that nobody wants to pay more than an asset is worth, since such behavior would lead to lower returns. Less obvious, but equally important, is that we can draw some valuable conclusions from the observed prices of assets. We will examine one of these conclusions in detail in the next chapter when we use the value of corporate securities to determine the required rate of return on investments.

What Is Value?

The term "value" has many different meanings depending on the context in which it is used. For our purposes, there are four important types of value.

Generally, value can be defined as the amount that a willing and able buyer agrees to pay for an asset to a willing and able seller. In order to establish the value of an asset, it is important that both the buyer and seller be willing and able. Otherwise, no legitimate transaction can take place, and value cannot be determined without an exchange. Notice that we did not say that the value of an asset is always the same as its price. Price and value are distinct, though related, concepts. The price of an asset can be greater than its value (in which case we say that the asset is over-valued or over-priced), less than its value (under-valued), or equal to its value (fairly-valued).

Book value is the price of an asset minus its accumulated depreciation. Depreciation is a systematic method of accounting for the reduction in the value of an asset over its useful life. Because of the systematic nature of depreciation (i.e., it is determined in advance according to some well-defined formula), book value does not necessarily fairly represent the actual market value of the asset. Because of this, and other distortions of value, a school of investors (known as value investors) has arisen. These investors seek out the stocks of companies that they believe to be under-valued, in hopes that the market will eventually recognize the true value of the company.

Intrinsic value is the value of an asset to a particular investor. Intrinsic value can be determined by taking the present value of the future cash flows *at that investor's required rate of return*. Because we use the investor's required rate of return in the calculation, and because each investor has different preferences and perceptions, intrinsic value is unique to each individual. Without these differences in intrinsic values markets could not function.

Market value is the price of an asset as determined in a competitive marketplace. The market price is the price that the marginal investor is willing to pay, and will fluctuate (sometimes wildly) throughout the trading day. Investors will purchase assets with market values below their intrinsic values (under-valued assets), and sell assets with market values above their intrinsic values (over-valued assets). It is easy to determine the market value of securities traded in the public markets, but not so easy for many other types of assets. Houses, for example, trade only rarely so it is difficult to determine their true market value. In these cases, we must rely on estimates of market value made by experts (e.g., appraisers).

Unless otherwise modified, or obvious from the context, all references to the term "value" from this point forward will refer to the individual's intrinsic value.

Fundamentals of Valuation

As noted above, the intrinsic value of an asset is the present value of the expected future cash flows provided by the asset. Mathematically, intrinsic value is given by:

$$V = \sum_{t=1}^{N} \frac{Cf_t}{(1+i)^t} \qquad \textbf{(8-1)}$$

where Cf_t is the expected cash flow in period t, and i is the required rate of return for the investor performing the calculation.[1]

The most important components of value are likely to be the size and timing of the expected cash flows. The larger the expected cash flows are, and the more quickly they are to be received, the higher the value will be. In other words, there is a positive relationship between the size of the cash flows and value, and a negative relationship between the time until the cash flows are received and value.

The other component of value is the investor's required rate of return. The required return is affected by the rates of return offered by competing investment vehicles and the riskiness of the investment. For example, if bonds are offering higher returns than stocks, we would expect that the prices of stocks would drop (and the prices of bonds would rise) as investors moved their money out of stocks and into bonds. This would occur because investors would recognize that bonds are less risky than are stocks, and they would raise their required returns for stocks. Since an increase in the required return will decrease value, investors would sell stocks, thereby driving down the prices. This process would continue until the prices of stocks had fallen enough, and bond prices risen enough, so that the expected returns reverted to the equilibrium relationship.

To determine the value of a security, then, we must first determine three things:

1. At this point we will assume that all future cash flows are known with certainty. In Chapter 11 we will examine what happens when future cash flows are uncertain.

1. What are the expected cash flows?
2. When will the cash flows occur?
3. What is the required rate of return for this particular stream of cash flows?

As we discuss the methods of valuing securities, keep these ideas in mind as they are the fundamentals of all security valuation.

Determining the Required Rate of Return

As mentioned above, one of the determinants of the required return for any stream of cash flows is the perceived riskiness of those cash flows. We will leave an in-depth discussion of risk for Chapter 11, but for now we will assume that the risk of a security is known.

In general, each investor can be classified by risk preference into one of three basic categories:

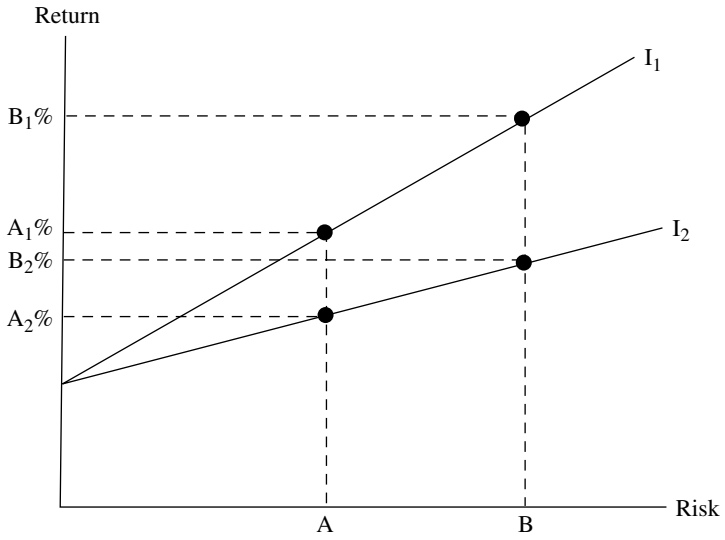
1. **Risk Averse** — The risk averse investor prefers less risk for a given rate of return. The risk averter can be encouraged to accept nearly any level of risk, but only if the rate of return is expected to compensate him fairly. In other words, he must be paid in order to accept risk.
2. **Risk Neutral** — The risk neutral investor is indifferent to the level of risk. His required rate of return will not change, regardless of the risk involved.
3. **Risk Lover** — The risk loving investor will actually lower his required rate of return as the risk increases. In other words, he is willing to pay to take on extra risk.

Under ordinary circumstances we assume that all investors are risk averse, and must receive a higher rate of return in order to accept a higher risk. Realize, however, that even investors in the same category can have different risk preferences, so two risk averse investors will likely have different required returns for the same asset.

Figure 8-1 illustrates the *ex-ante* (expected) risk-return trade-off for two risk averse investors. We know they are risk averse because the lines have a positive slope. In

this case security B is riskier than A and therefore has the higher expected return for both investors. Investor I_1 can be seen to be more risk averse than I_2 because the slope of the risk-return line is steeper. In other words, the risk premium grows at a faster rate for I_1 than it does for I_2.

FIGURE 8-1
THEORETICAL RISK-RETURN TRADE-OFF FOR TWO RISK AVERSE INVESTORS



A Simple Risk Premium Model

An easy method of determining the rate of return for a security can be derived by assuming that the relationship pictured in Figure 8-1 is constant. If this is the case, then we can define the expected rate of return for an asset as a base rate (Y-axis intercept) plus a premium which is based on the riskiness of the security. In equation form:

$$E(R_i) = \text{Base Rate} + \text{Risk Premium}$$

where $E(R_i)$ is the expected rate of return for security i, the base rate is the rate of return on some benchmark security, and the risk premium is subjectively determined.

The problem with this model is that it is entirely subjective. Both the security chosen to provide the base rate and the risk premium are defined by the individual using the model. For example, one individual might choose as the base rate the rate of return on bonds issued by his company, while another might choose the average rate paid on AAA-rated corporate bonds. Furthermore, because of individual differences in risk preferences, each individual is likely to assign a different value to the risk premium. Obviously, what is needed is a more objective approach.

CAPM: A More Scientific Model

The Capital Asset Pricing Model (CAPM) provides us with a more objective version of the simple risk premium model for determining expected returns. For our purposes, we can consider the CAPM to be a version of the simple risk premium model with its inputs more rigorously defined. The CAPM is given by:

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] \quad \textbf{(8-2)}$$

where R_f is the risk-free rate of interest, β_i is a measure of the riskiness of security i relative to the riskiness of the market portfolio, and $E(R_m)$ is the expected rate of return on the market portfolio.

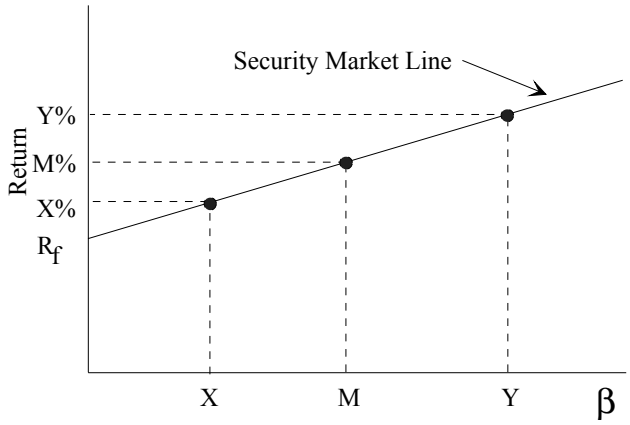
In the CAPM, R_f serves as the base rate of interest. It is defined as the rate of return on a security with zero risk. Sometimes R_f is referred to as the "pure time value of money," or, in other words, the rate of return that is earned for delaying consumption but not accepting any risk. Because it is risk-free, we know R_f with certainty in advance. Ordinarily, R_f is assumed to be the rate of return on a U.S. Treasury security with time to maturity equal to the expected holding period of the security in question. Treasury securities are chosen because they are free of default risk, and are therefore the closest of all securities to being truly risk-free.

The second term in the CAPM is the risk premium and is more difficult to understand. The market portfolio is a portfolio of all risky assets, usually proxied by a stock index such as the S&P 500, which serves as a sort of benchmark against which other portfolios are measured. Subtracting the risk-free rate of return from the expected market return gives the expected market risk premium. Beta (β) is an

index of systematic risk.[2] It measures the risk of a particular security relative to the market portfolio. If a stock has a beta of 2, then we could say that the stock is twice as risky as the market portfolio. If it is twice as risky, then common sense (and the CAPM) tells us that the risk premium for this stock should be twice that of the market. Likewise, a stock with a beta of 0.5 should carry half of the risk premium of the market.

So the CAPM is no more than a sophisticated version of the simple risk premium model. With this in mind, we can redraw the risk-return trade-off graph (known as the security market line) in Figure 8-2.

FIGURE 8-2
THE SECURITY MARKET LINE



To see the CAPM in action, consider the following example:

> As a security analyst for Dewey, Cheatham, and Howe Securities you are preparing a report detailing your firm's expectations regarding two stocks for the year to come. Your report is to include the expected returns for these stocks and a graph illustrating the expected risk-return trade-off. Other analysts at

2. In the world of CAPM there are two types of risk: systematic and unsystematic. Systematic risk is the market-related risk that affects all assets. An example would be unexpected changes in interest rates. Unsystematic risk is the company-specific risk such as the risk of a strike or of losing a major contract. As we will see in Chapter 11, through proper diversification, unsystematic risk can often be eliminated from a portfolio.

DCH have informed you that the firm expects the S&P 500 to earn a return of 11% in the year ahead while the risk-free rate is 5%. According to *Value Line*, the betas for stocks X and Y are 0.5 and 1.5, respectively. What are the expected returns for X and Y?

To work this example, open a new workbook and enter the data so that it resembles the worksheet in Exhibit 8-1.

EXHIBIT 8-1
CALCULATING EXPECTED RETURNS WITH THE CAPM

	A	B	C	D	E
1	**The Security Market Line**				
2		Risk-free	X	Market	Y
3	Beta	0.00	0.50	1.00	1.50
4	Expected Return	5.00%		11.00%	

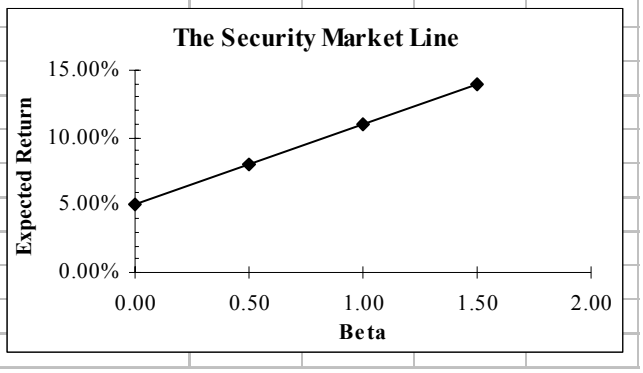
Before continuing, it is important to understand some of these inputs. The example problem did not mention the betas of the risk-free asset or of the market portfolio. How did we know that the beta of the risk-free asset is 0? Recall that beta measures the riskiness of the asset *relative to the market*. Since the risk-free asset has no risk, by definition, any measure of risk must be equal to zero. Similarly, by definition the market has a beta of 1.00 (why?).

To complete this example, we need to enter the formula for the CAPM, equation (8-2), into C4 and E4. In C4 enter: `=$B$4+C3*($D$4-$B$4)` and then copy this cell to E4. You should see that security X has an expected return of 8% and Y has an expected return of 14%. Notice that the expect return of X is not one-half that of the market, nor is the expected return of Y 50% greater than that of the market. Instead, it is the risk premium of these securities that is one-half (for X) or one and one-half (for Y) the risk premium of the market. The portion of the expected return that comes from delaying consumption (the risk-free rate) is the same for both securities.

Finally, we can create a graph of the SML with these data points. Select B3:E4 and use the Chart Wizard to create an XY scatter graph being sure that you make the first row the category (X-axis) labels. You can experiment with the SML by changing the expected return for the market or the risk-free rate. You will notice that the slope of the SML changes as you change the market risk premium. At this point your worksheet should match the one in Exhibit 8-2.

EXHIBIT 8-2
EXPECTED RETURNS AND THE SECURITY MARKET LINE

	A	B	C	D	E
1	The Security Market Line				
2		Risk-free	X	Market	Y
3	Beta	0.00	0.50	1.00	1.50
4	Expected Return	5.00%	8.00%	11.00%	14.00%



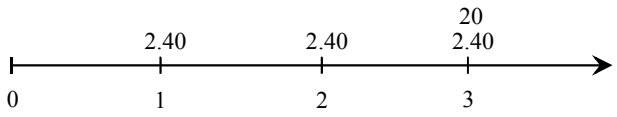
Valuing Common Stocks

The first question to ask when attempting to value any security is, "What are the expected cash flows?" In the case of common stocks there are two types of cash flows: dividends and the amount received at the time of the sale. Consider the following problem:

> Suppose that you are interested in purchasing shares of the common stock of the XYZ Corporation. XYZ recently paid a dividend of $2.40, and you expect that this dividend will continue to be paid into the foreseeable future. Furthermore, you believe (for reasons that will become clear) that you will be able to sell this stock in three years for $20 per share. If your required return is 12% per year, what is the maximum amount that you should be willing to pay for a share of XYZ common stock?

To clarify the problem, it helps to examine it in terms of a timeline. Figure 8-3 presents the timeline.

FIGURE 8-3
TIMELINE FOR XYZ COMMON STOCK



Calculating the value of this stock is a simple matter of calculating the present value of its cash flows (equation (8-1)). Given that your required return is 12%, the intrinsic value must be:

$$V = \frac{2.40}{1.12} + \frac{2.40}{(1.12)^2} + \frac{2.40 + 20}{(1.12)^3} = 20$$

If the stock is currently selling for $24 (the market value), would you purchase any shares? Obviously not, because the market value exceeds your intrinsic value by $4. If you did purchase the shares, and your cash flow expectations were realized, your average annual rate of return would be less than your required return.

Of course, the XYZ example problem is somewhat contrived, because there is no way to know, for sure, what the dividends and selling price are going to be in the future. With dividends this is not so much of a problem, because firms tend to have a somewhat stable dividend policy. The advanced knowledge of the selling price is a different matter. It is impossible to know exactly what the market price will be tomorrow, and even more difficult to know the price three years hence.

The Constant-Growth Dividend Discount Model

To eliminate these problems, we can make a couple of assumptions. The first assumption is that dividends will change at a constant rate.[3] With this assumption, knowing the most recent dividend is equivalent to knowing all future dividends. Also assume that we have an infinite holding period. In other words, we will never

3. Note that this is not an assumption that the dividend stream will always get larger. The growth rate could be negative, in which case the dividends would be shrinking over time. Furthermore, the growth rate could be zero, which means that the dividends are constant.

sell the stock, so we don't have to worry about forecasting the selling price. While this second assumption may sound ludicrous, we will see that it is little more than a mathematical trick which allows us to develop a model.

These assumptions lead to a model for the valuation of common stock which is known as the constant-growth dividend discount model (DDM), or the *Gordon Model*. Recall that we have defined the value of a common stock as the present value of future dividends plus the present value of the selling price. Since the stock will never be sold, because of the infinite holding period, the model becomes:

$$V_{CS} = \frac{D_1}{(1+k_{CS})} + \frac{D_2}{(1+k_{CS})^2} + \frac{D_3}{(1+k_{CS})^3} + \ldots + \frac{D_\infty}{(1+k_{CS})^\infty}$$

where V_{CS} is the value of the common stock, the D's are the dividends in a particular period, and k_{CS} is the required return.[4] Because the dividends are growing at a constant rate, they can be expressed as a function of the most recently paid dividend (D_0):

$$V_{CS} = \frac{D_0(1+g)}{(1+k_{CS})} + \frac{D_0(1+g)^2}{(1+k_{CS})^2} + \frac{D_0(1+g)^3}{(1+k_{CS})^3} + \ldots + \frac{D_0(1+g)^\infty}{(1+k_{CS})^\infty}$$

This equation can be restated in closed-form as:

$$V_{CS} = \frac{D_0(1+g)}{k_{CS}-g} = \frac{D_1}{k_{CS}-g} \qquad \textbf{(8-3)}$$

Returning to the example, realize that XYZ's dividend growth rate is 0% (i.e., the dividend stream is not growing). Therefore, the value of a share is:

$$V_{CS} = \frac{2.40(1+0)}{0.12-0} = 20$$

which is exactly the same value as was found when assuming that you knew the value of the stock three years hence.

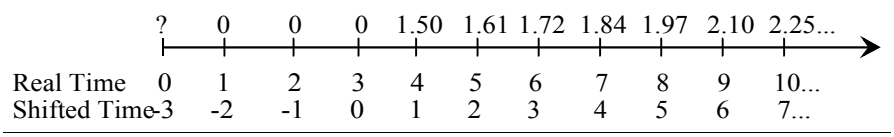
---

4. k_{CS} is the same as i, but is the more common notation for this model. As we will see later, this notation also helps to distinguish between the investor's required return for the different securities issued by the firm.

To see how you knew that the value of the stock would be $20 in three years, we can again use the time-shifting technique. Let's look at another example.

> Suppose that you are interested in purchasing a share of the common stock of the ABC Corporation. ABC has not recently paid any dividends, nor is it expected to for the next three years. However, ABC is expected to begin paying a dividend of $1.50 per share four years from now. In the future, that dividend is expected to grow at a rate of 7% per year. If your required return is 15% per year, what is the maximum amount that you should be willing to pay for a share of ABC common stock?

FIGURE 8-4
VALUING ABC COMMON STOCK WITH TIME-SHIFTING



In order to determine the value of ABC common stock as of today (period 0), we must first find the value as of some future time period. The constant growth dividend discount model can be used at any time period, and will always provide the value of the stock at the time period that is one period before the dividend which is used in the numerator. For this particular problem, the future time period we choose is somewhat arbitrary as long as it is period 3 or later (but period 3 is the easiest). In this case, let's find the value as of period 3 (using the period 4 dividend):

$$V_3 = \frac{D_4}{k_{CS} - g} = \frac{1.50}{0.15 - 0.07} = 18.75$$

So we know that the stock will be worth $18.75 per share three years from today. Remembering that the value of a stock is the present value of its cash flows, and that the only relevant cash flow in this case is the value at year three (which encapsulates the value of all future dividends), the value as of today must be:

$$V_0 = \frac{18.75}{1.15^3} = 12.33$$

We could also begin the valuation process at period 5 (or any other period). In this case, the value at period 5 (using the period 6 dividend) is:

$$V_5 = \frac{1.72}{0.15 - 0.07} = 21.50$$

The next step is to take the present value of all future cash flows (in this case: D_4, D_5, and V_5):

$$V_0 = \frac{1.50}{1.15^4} + \frac{1.61 + 21.50}{1.15^5} = 12.35$$

The $0.02 difference in values is due to rounding. Incidentally, note that had we only discounted back to period 3, the value at that time would have been $18.75.

Earlier we said that the assumption of an infinite holding period was not as ludicrous as it sounds. Let's examine this assumption in more detail with a worksheet. Open a new worksheet and enter the labels as shown so that it matches the fragment of a worksheet in Exhibit 8-3.

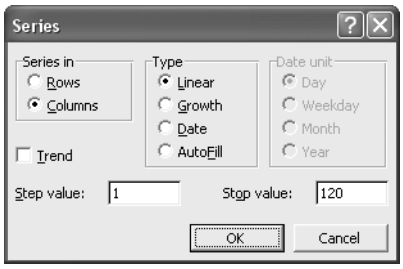
EXHIBIT 8-3
WORKSHEET TO TEST THE INFINITE HOLDING PERIOD ASSUMPTION

	A	B	C	D	E
1	**Infinite Holding Period Assumption**				
2	Period	Dividends	Present Value	Growth Rate	7%
3	1	0.00		Req. Return	15%
4	2	0.00			
5	3	0.00			
6	4	1.50			
7	5	1.61			
8	6	1.72			
9	7	1.84			
10	8	1.97			
11	9	2.10			
12	10	2.25			

Note that the series of numbers representing the periods extends from 1 to 120 in cells A3:A122. To easily input these numbers, enter a `1` in A3 and then highlight the cells in the range A3:A122. Use the **E**dit F**i**ll **S**eries command to fill in the numbers. In the Series dialog box, set the **S**tep value to `1` and the St**o**p value to

120. Also be sure to set the series Type to **L**inear and Series in to **C**olumns. The dialog box should look like the one in Figure 8-5.

FIGURE 8-5
THE SERIES DIALOG BOX



In this worksheet we want to calculate the value of the stock with various numbers of dividends included. From the example problem, we know that ABC will first pay a dividend of $1.50 in period 4 and that the dividend will grow at a 7% (cell E2) rate each year. Before continuing, enter the dividends into the worksheet as follows: First, enter a `0` for each of the first three dividends. For period 4, enter: `1.50` in B6. In B7 we want to calculate the period 5 dividend, so enter: `=B6*(1+E$2)`. Now copy this formula to each cell in the range B8:B122. To make sure that the copy was successful, note that the value in B122 should be 3842.46 (the power of compounding!).

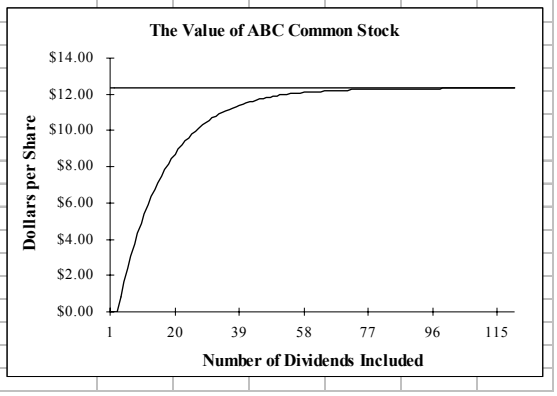
Now, we want to find the present values of dividends in cells C3:C122. We will use the NPV function to calculate the present values of the dividends. In C3 enter: `=NPV(E$3,B$3:B3)`. The dollar sign will effectively freeze the first cell reference, so if we copy this formula down the range will expand. Copy the formula over the range C4:C122. Column C gives the value of the stock if we include only the dividends through the selected period. For example, the value in C20 ($8.15) is the value of the stock if we consider only the first 18 dividends. Similarly, the value in C50 ($11.85) is the value of the stock if we consider only the first 48 dividends.

Notice how the present value of the dividends converges to the value of the stock ($12.33) as we include more and more dividends in the calculation. It is not necessary to include more than about 120 dividends because the present value of all dividends beyond that point is effectively zero. This is easier to see if we create a graph of the values versus the number of dividends. Highlight the range C3:C122. Now select the Chart Wizard icon and follow the prompts to create the line graph.

Be sure to choose a line graph without symbols and on the Series tab set the range for the X-axis labels to A3:A122. Your worksheet should now resemble the one in Exhibit 8-4, except that we have added a line to represent the known value of the stock ($12.33).

EXHIBIT 8-4
THE INFINITE HOLDING PERIOD IS JUST FOR SIMPLICITY

	A	B	C	D	E	F	G	H	I	J
1	Infinite Holding Period Assumption									
2	Period	Dividends	Present Value	Growth Rate	7%					
3	1	0.00	$0.00	Req. Return	15%					
4	2	0.00	$0.00							
5	3	0.00	$0.00							
6	4	1.50	$0.86							
7	5	1.61	$1.66							
8	6	1.72	$2.40							
9	7	1.84	$3.09							
10	8	1.97	$3.73							
11	9	2.10	$4.33							
12	10	2.25	$4.89							
13	11	2.41	$5.40							
14	12	2.58	$5.89							
15	13	2.76	$6.33							
16	14	2.95	$6.75							
17	15	3.16	$7.14							
18	16	3.38	$7.50							
19	17	3.61	$7.84							
20	18	3.87	$8.15							



The Two-Stage Growth Model

Assuming that the dividends will grow at a constant rate forever is convenient from a mathematical perspective, but it isn't very realistic. Other valuation models have been developed that are more realistic. For example, there is a two-stage growth model that allows for a period of supra-normal growth followed by constant growth. In addition, a three-stage model modifies the two-stage model to allow for a gradual decline into the constant-growth stage. Both of these models are more complex than the constant-growth model, but keep in mind that they are still present value calculations. The only thing that has changed is the pattern of the future cash flows.

The two-stage valuation model allows for the dividend to grow at one rate for several periods, and then to grow at a (usually, but not necessarily) slower rate from that point on. This is a much more realistic model because a firm's dividends may be growing at a fast rate now, but that rate of growth is unlikely to be continued

forever. All companies will eventually mature and find that their earnings growth slows so their dividend growth rate must slow as well. The two-stage model assumes that the change in the dividend growth rate will happen instantaneously at some point.

Let g_1 represent the dividend growth rate from period 1 to n, and g_2 be the dividend growth rate for the remainder of time. Assuming that $D_0 \neq 0$, $g_1 \neq k_{CS}$ and $g_2 < k_{CS}$, the model is:

$$V_{CS} = \frac{D_0(1+g_1)}{k_{CS}-g_1}\left[1-\left(\frac{1+g_1}{1+k_{CS}}\right)^n\right] + \frac{\dfrac{D_0(1+g_1)^n(1+g_2)}{k_{CS}-g_2}}{(1+k_{CS})^n} \quad \textbf{(8-4)}$$

Note that the first term in equation (8-4) is simply the present value of the first n dividends growing at a rate of g_1. The second term is the present value of all of the remaining dividends growing at a constant rate of g_2. This is exactly the same procedure we used earlier to value ABC's common stock, except that ABC not only had two growth rates (0% and 7%), but also was not originally paying a dividend.[5] Note that if $g_1 = g_2$ then equation (8-4) simplifies to equation (8-3).

To demonstrate the use of this model, let's use an example.

> Oviedo Paper, Inc. is a major producer of paper products. Due to its immensely popular new stationery product, analysts expect that the firm's earnings and dividends will grow at a rate of 15% per year for the next five years. After that, analysts expect that the firm's growth rate will decline to its historical value of 8% per year as competitors launch similar products. If Oviedo Paper recently paid a dividend (D_0) of \$0.35 and your required return is 12%, what is the value of the stock today?

To find the value, use equation (8-4):

5. Note that we cannot use equation (8-4) in that case because D_0 was equal to \$0.00. Plugging in \$0.00 for D_0 would give a value of \$0.00 for the stock.

$$V_{CS} = \frac{0.35(1.15)}{0.12 - 0.15}\left[1 - \left(\frac{1.15}{1.12}\right)^5\right] + \frac{\dfrac{0.35(1.15)^5(1.08)}{0.12 - 0.08}}{(1.12)^5} = 12.68$$

Since this equation is quite tedious, and Excel has no built-in function for this model, we have written a macro to do the calculations. Make sure that you have the file FAMEFNCS.XLS opened so that you have access to the macro. Now, return to your original workbook and open a new worksheet. The macro we will use is called FAME_TwoStageValue and is defined as:

FAME_TwoStageValue(*DIV1*, *REQRATE*, *GROWTHRATE1*, *GROWTHRATE2*, *G1PERIODS*)

where ***DIV1*** is the dividend to be paid at the end of period 1, ***REQRATE*** is the required return, ***GROWTHRATE1*** and ***GROWTHRATE2*** are the two growth rates, and ***G1PERIODS*** is the length of the first growth period.

Set up your new worksheet to look like the one in Exhibit 8-5. To get the value in B7, use the Insert Function dialog box. Choose the User Defined category, and then select FAME_TwoStageValue from the list. After entering the appropriate cell addresses, your function in B7 should be: `=famefncs.xls! FAME_TwoStageValue(B1*(1+B2),B5,B2,B3, B4)`. Note that to get the dividend at period 1 (***DIV1***), we need to multiply the period 0 dividend by 1 + B2, which is the first growth rate. Your answer in B7 should confirm the calculations we made using equation (8-4).

EXHIBIT 8-5
THE TWO-STAGE GROWTH MODEL

	A	B
1	Dividend 0	0.35
2	Growth Rate 1	15%
3	Growth Rate 2	8%
4	Period 1 Length	5
5	Required Return	12%
6		
7	Two-Stage Value of Stock	$ 12.68

The Three-Stage Growth Model

The three-stage growth model is very similar in concept to the two-stage model. The difference is that the two-stage model assumes that the change in the growth rate occurs instantaneously, whereas the three-stage model assumes a linear decline in the growth rate over some period. In other words, the three-stage model allows the growth rate to decline more slowly to a constant rate. This is a more realistic assumption.

Mathematically, the three-stage model is given by:

$$V_{CS} = \frac{D_0}{k_{CS} - g_2}\left[(1 + g_2) + \frac{n_1 + n_2}{2}(g_1 - g_2)\right] \quad \textbf{(8-5)}$$

Note that equation (8-5) looks quite similar to equation (8-3). The difference is that rather than using a single growth rate, the term in brackets in the three-stage model represents a factor by which the constant growth model must be multiplied to account for the higher initial growth rates. Also, note that all of the variables in (8-5) are as previously defined, except that n_2 is the number of years until the growth rate becomes constant.

It should be obvious that the average growth rate in the three-stage model will be higher than the average growth rate in the two-stage model. For this reason, the three-stage model will always give a somewhat higher valuation than the two-stage model. How much higher depends on the length of the transition period.

Let's return to our example using Oviedo Paper, Inc. In addition to the previous information, assume that the growth rate will transition from 15% to 8% over a three-year period. That makes the time in the first stage 5 years (n_1), and the time until constant growth of 8 years (n_2). Using equation (8-5), we find that the value of the stock has increased to:

$$V_{CS} = \frac{0.35}{0.12 - 0.08}\left[1.08 + \frac{5 + 8}{2}(0.15 - 0.08)\right] = 13.43$$

As with the two-stage model, we have written a function macro to make the calculations for the three-stage model. This function is defined as:

FAME_ThreeStageValue(*DIV1*, *REQRATE*, *GROWTHRATE1*, *GROWTHRATE2*, *G1PERIODS*,*TRANSPERIODS*).

All of the function's inputs are the same as before, except that ***TRANSPERIODS*** is the length of the transition period between growth rates.

To use this function, you will need to modify your worksheet from Exhibit 8-5 slightly. Select row 5 and insert a row. In cell A5 enter the label: `Transition Period Length`, and in B5 enter `3`. In A9 enter: `3-stage Value of Stock`. In B9, use the Insert Function dialog box to enter the function. It is: `=famefncs.xls!FAME_ThreeStageValue(B1*(1+B2),B6,B2,B3,B4,B5)`. As you can see in Exhibit 8-6, the three-year transition period adds $0.75 to the value of the stock as compared to the two-stage model.

EXHIBIT 8-6
THE THREE-STAGE GROWTH MODEL

	A	B
1	Dividend 0	0.35
2	Growth Rate 1	15%
3	Growth Rate 2	8%
4	Period 1 Length	5
5	Transition Period Length	3
6	Required Return	12%
7		
8	Two-Stage Value of Stock	$ 12.68
9	Three-Stage Value of Stock	$ 13.43

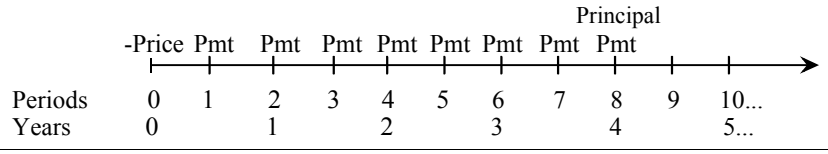
Ultimately, its important to remember that all three of the common stock valuation models are nothing more than present value functions. Each uses a differing assumption about the growth pattern of the dividends, but they are still present value calculations. When faced with a problem that doesn't fit the assumptions of any of these models, simply forecast the dividends in the future using whatever growth assumptions are appropriate. Then, calculate the present value of the future dividends. This is the method that was used to find the value of ABC common stock in the example problem on page 224.

Bond Valuation

A bond is an interest-bearing, or discounted, security which obligates the issuer to pay the bondholder periodic interest payments and to repay the principal at maturity. Bonds are valued in the same manner as most other securities. That is, the value of a bond is the present value of its future cash flows.

For a bond the cash flows consist of periodic (usually semiannual) interest payments and the return of the principal at maturity. The cash flow at maturity will therefore consist of both the last interest payment and the principal (often $1,000). For a four-year semiannual payment bond the timeline is pictured in Figure 8-6.

FIGURE 8-6
TIMELINE FOR A FOUR-YEAR BOND WITH SEMIANNUAL INTEREST PAYMENTS



As Figure 8-6 makes clear, a bond consists of two types of cash flows: an annuity (the interest payments) and a lump sum (the principal). Recalling the principal of value additivity from Chapter 7, we know that this stream of cash flows can be valued by adding the present values of its components. For a bond, the value is given by:

$$V_B = Pmt\left[\frac{1-\frac{1}{(1+k_B)^N}}{k_B}\right] + \frac{FV}{(1+k_B)^N} \qquad \textbf{(8-6)}$$

where Pmt is the periodic interest payment, k_B is the periodic required rate of return for the bond, N is the number of periods, and FV is the face value. Recognize that this formula is valid only on a payment date.

Consider the example problem:

> Wrent-a-Wreck, Inc., has issued bonds with 20 years to maturity, an 8% coupon rate, and $1,000 face value. If your required rate of return is 9% and the bonds pay interest semiannually, what is the value of these bonds?

Before solving this problem, some definitions are required. Until fairly recently, bonds were printed on ornately decorated paper with small detachable coupons around the edges. These coupons were to be presented to the issuer in order to collect the periodic interest payments. Because of this practice, the interest payment has come to be known as the *coupon payment* and the rate of interest that

the issuer has promised to pay is referred to as the *coupon rate*. The annual interest payment is determined by multiplying the *face value* (principal) by the coupon rate. For bonds which pay interest more frequently than annually, the annual interest payment is divided by the number of payments per year. Most often, interest is paid twice per year so the annual interest payment must be divided by two.

For the Wrent-a-Wreck bonds, the annual interest payment is $80 (=0.08*1,000), but the semiannual payment is $40 (=80/2). Furthermore, because the bond interest is paid twice per year, we must adjust the required return and number of periods to a semiannual basis. The required return is 9% per year which is 4.5% (=9%/2) per six-month period. Since there are 20 years to maturity, there are 40 (=20*2) six-month periods to maturity. Therefore, the value of the bonds is:

$$V_B = 40\left[\frac{1-\frac{1}{1.045^{40}}}{0.045}\right] + \frac{1{,}000}{1.045^{40}} = 907.99$$

Excel has a number of built-in functions which can be used for bond valuation. Most of these functions are beyond the scope of this text, so we will examine only two. To find the value of a coupon bearing bond, Excel provides the **PRICE** function. Note that, unlike equation (8-6), the **PRICE** function works even on non-payment dates. The **PRICE** function is defined as:[6]

PRICE(*SETTLEMENT*, *MATURITY*, *RATE*, *YLD*, *REDEMPTION*, *FREQUENCY*, *BASIS*).

SETTLEMENT is the date on which money and securities change hands,[7] and ***MATURITY*** is the date on which the last coupon payment is made and the principal is returned. Excel uses the Windows date format to determine if what you have entered is a date. The Windows date format can be changed in the Control Panel if necessary, but most users will accept the default for their country. In the U.S. the default is the Month/Day/Year format so Excel will recognize, say, 2/4/2004 as February 4, 2004, and treat it as a date. You could also enter this date as Feb 4, 2001, and Excel will convert it to a date. Unrecognized date formats are treated as text strings. Dates are converted to a number which represents the number of days since

6. In order to use the **PRICE** function, and the **YIELD** function which is introduced later, you must have installed the Analysis ToolPak which is an add-in program that ships with Excel.

7. Before June 1995, the settlement date was five days after the trade. Since that time it has been reduced by the SEC to three business days after the trade. This policy is known as T+3.

January 1, 1900 (or January 1, 1904, on the Macintosh). In the 1900 date system the serial number 1 corresponds to January 1, 1900. In the 1904 date system the serial number 1 corresponds to January 2, 1904 (January 1, 1904, is 0). To see the actual serial number, you can use the General number format. The difference in date systems is important to those transferring files from PCs to Macs. Using serial numbers makes date math quite simple. For example, you can determine the number of days between two dates with simple subtraction.[8] Also, note that the date serial number is independent of the date format applied.

RATE is the annual coupon rate. ***YLD*** is the annual required rate of return. In Excel functions, percentage rates are always entered in decimal form. If the coupon rate is 10%, you must enter it as 0.10, although Excel will convert a number followed by a percent sign (%) to this format. The effect of the percent sign is to cause Excel to divide the preceding number by 100.

REDEMPTION is the amount to be received per $100 of face value when the bond is redeemed. It is important to realize that the redemption price can be different than the face value of the bond. This would be the case, for example, if the bond was called by the issuer. Calling a bond issue is very similar to refinancing a mortgage in that the issuer usually wishes to re-issue debt at a lower interest rate. There is often a premium that is paid to bondholders when bonds are called, and this premium plus the face value is the redemption price. If a bond issue has a 4% call premium, then ***REDEMPTION*** would be set to 104. For non-callable bonds this will be set to 100.

FREQUENCY is the number of coupons paid each year. Most commonly this will be 2, though other values are possible. Excel will return the #NUM! error if ***FREQUENCY*** is any value other than 1, 2, or 4 (annual, semiannual, or quarterly).

BASIS describes the assumption regarding the number of days in a month and year. Historically, different financial markets have made different assumptions regarding the number of days in a month and a year. Corporate, agency, and municipal bonds

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8. As an interesting, if pointless, demonstration of the power of serial date numbers and custom formatting, consider the following: To determine exactly how old you are, enter your birth date in a blank cell of a worksheet, say A1. In A2 enter the formula: `=TODAY()-A1`. The Today() function returns the serial number of the current date. Now, choose the Custom **C**ategory in the Number Format dialog box type the following format in the **T**ype box: `yy "years "mm" months and" dd" days"` and click on OK. Now set the width of column A to about 30 to see the display. We leave as an exercise for the reader the extension of this to display hours, minutes, and seconds.

are priced assuming that there are 30 days in a month and 360 days in a year. Treasury securities are priced assuming a 365-day year (366 days in a leap year) and the actual number of days in a month.[9] Excel allows for four possibilities [days per month/days per year (code)]: 30/360 (0 or omitted); actual/actual (1); actual/360 (2); actual/365 (3). Any number greater than 3 will result in an error. For our purposes, the basis is unlikely to make a difference in the calculated price. However, if you are trading in large numbers of bonds, the basis can make a significant difference.

To see how the **PRICE** function works, open a new worksheet and enter the data displayed in Exhibit 8-7 which is taken from the example. The settlement date should be entered by simply typing the date as it appears. As noted above, Excel will automatically recognize it as a date. Recall that the Wrent-a-Wreck bonds mature in 20 years. We have assumed that the settlement date is 2/15/2004. Your inclination is probably to enter 2/15/2024 for the maturity date, but that is actually 20 years and 5 days. To find the actual date that is exactly 20 years in the future, we have entered the formula: `=B2+20*365` in B3. This formula takes the settlement date in B2 and adds 20 years to it. We do this to be consistent with the example calculations. In actual practice, the maturity date of the bond could be found in the indenture,[10] by simply asking a broker, or by consulting a bond guide.

EXHIBIT 8-7
BOND VALUATION WORKSHEET USING THE PRICE FUNCTION

	A	B
1	**Bond Valuation**	
2	Settlement Date	2/15/2004
3	Maturity Date	2/10/2024
4	Coupon Rate	8.00%
5	Required Return	9.00%
6	Redemption Value	100
7	Frequency	2
8	Basis	0
9	Value	

9. For more information on day count conventions, see *Standard Securities Calculation Methods*, by John J. Lynch, Jr., and Jan H. Mayle, Securities Industry Association, 1986.

10. The indenture is the formal agreement which specifies all of the conditions of the bond issue.

The current value of the bond can now be found by entering the function: `=PRICE(B2,B3,B4,B5,B6,B7,B8)*10` in B9. The value is $907.99, exactly as we found by hand. Since bond prices are normally quoted as a percentage of par value we have multiplied the **PRICE** function's return value by 10. This will convert the output to an actual price. If the face value is something other than $1,000, you will have to use a different multiplier. Also notice that we have not made any adjustment to account for the fact that the bond pays interest semiannually. Excel automatically makes this adjustment for you based on the frequency.

In most textbooks, the homework problems don't provide dates for input to spreadsheet functions. There are two ways to attack these types of problems. The first method is illustrated above: simply assume the dates. The actual dates are not important, as long as the time between the dates is equal to the time specified in the problem.[11] The second method is to use other built-in time value functions. For example, we could have entered: `=-PV(B5/2,40,B4*1000/2,1000,0)` in B9. Note that, because of the way that we set up the worksheet, we must adjust the required return and the interest payment to a semiannual basis. Note also that the result is exactly the same as the other methods that we have used, $907.99.

Bond Return Measures

Most often, investors do not decide to buy a bond because the price is below their arbitrarily determined intrinsic value. Instead, they examine the alternatives and compare bonds on the basis of the returns that they offer. There are several ways to calculate the returns offered by bonds. In this section we will cover three return measures for bonds and two additional measures for discounted debt securities.

Current Yield

The current yield is defined as the annual coupon payment divided by the current price of the bond:

11. In practice the actual dates might be important. For example, assume that you need a six-month period. If you were to choose 2/15/2004 to 8/15/2004, that would be 182 days. On the other hand, 8/15/2004 to 2/15/2005 is 184 days. The difference in price can be important if you are trading a large quantity of bonds.

$$CY = \frac{Pmt}{V_B} \quad \textbf{(8-7)}$$

The current yield is considered to be a rough measure of the return earned over the next year. We say that it is rough because it ignores compounding and the change in price which may occur over the life of the bond.

Excel has no built-in function to calculate the current yield, but it is a simple matter to write the formula yourself. On your worksheet, move to A11 and type: `Current Yield`. Now, in B11 enter: `=(B4*B6*10)/B9`. We must multiply the redemption value (in B6) by 10 to convert to the annual interest payment. In our example, the current yield is 8.81% which is, in fact, the return that you would earn over the next year if you received $80 in interest on an investment of $907.99. However, if interest rates remain unchanged over the year, the value of the bond will increase to $909.75. The capital gain of $1.76 is ignored in the current yield calculation.

Yield to Maturity

The *yield to maturity* is the compound annual rate of return that can be expected if the bond is held to maturity. The yield to maturity is not without its problems as a return measure, but it is superior to the current yield because it accounts for both interest payments and capital gains. Unfortunately, it is also much more complex to calculate.

Essentially, the yield to maturity is found by taking the bond price as given and solving the valuation equation for the required return (k_B).[12] No method exists, however, to solve directly for the yield to maturity. The yield can be found by using a trial and error approach, but it is a bit tedious. Excel makes the yield calculation simple with its built-in **YIELD** function which is defined as:

YIELD(*SETTLEMENT*, *MATURITY*, *RATE*, *PR*, *REDEMPTION*, *FREQUENCY*, *BASIS*)

12. It should be noted that for most purposes the terms "required return" and "yield to maturity" can be used interchangeably, and often are. However, there is a slight, but important difference between the terms. Specifically, the required return is specified by the investor, and can be different for different investors. The yield to maturity is not under the control of the investor, instead it is merely a function of the current bond price and cash flows promised from the bond. As such, the yield to maturity will be the same regardless of who calculates it.

All of the variables are the same as previously defined with the exception of ***PR***, which is the price of the bond as a percentage of the face value.

To make the calculation, first place the label: `Yield to Maturity` in A12 and then enter: `=YIELD(B2,B3,B4,B9/10,B6,B7,B8)` in B12. Note that the only difference from the **PRICE** function is that we replaced ***YLD*** with the current price of the bond as a percentage of par. In this case, we had to convert the bond price (in B9) back to a percentage of par by dividing it by 10. The result, as should be expected, is 9%.

Note that we could also use the **RATE** function (see page 200) to find the yield to maturity if we assume that the settlement date is also an interest payment date for the bond. This technique is especially useful if you don't know the exact settlement and maturity dates for the bond, and if you are calculating the yield on a payment date. Rather than replace our **YIELD** function, we'll simply insert the **RATE** function in C12 so that we can compare the results. In C12 enter the function: `=RATE((B3-B2)/365*B7,B4*B6/2,-B9/10,B6)*2`.

In order to use this function, we've had to embed several calculations. For the number of periods, we are taking the difference between the maturity and settlement dates to find the number of days. We next convert this to the number of periods by dividing by 365 and multiplying by the number of periods in a year. The payment amount is simply the coupon rate times the face (redemption) value divided by two. Finally, we need to adjust the price of the bond by dividing by 10 to convert it to a percentage of the face value. You'll note that after annualizing the result by doubling (because it pays semiannually), the answer is the same 9% as before.

Yield to Call

One other common measure of return is the *yield to call*. As noted earlier, many issuers reserve the right to buy back the bonds that they sell if it serves their interests. In most cases, bonds will be called if interest rates drop substantially so that the firm will save money by refinancing at a lower rate. If we calculate the yield to maturity assuming that the bond will be called at the first opportunity, we will have calculated the yield to call. Since it is common to have a contractual obligation to pay a premium over par value if the bonds are called, this must be taken into account in our calculation.

In order to make this calculation we must add a couple of lines to our worksheet. First, insert a row above row 4. To do this highlight row 4, and choose **I**nsert

Rows. Now, in A4 type: `First Call Date` to indicate that this is the first date at which the firm has the option of calling the bonds. In B4 enter: `2/15/2009`. This date reflects the fact that the first call date is often five years after the issue date (which we are assuming is the same as the settlement date in this case). Next, insert a row above row 8 and label it in A8: `Call Price`. Cell B8 will be the price at which the bonds can be called, in this case 5% over par value, so enter: `105`. In A15, enter the label: `Yield to Call`.

Finally, we will calculate the yield to call in B15 with the formula: `=YIELD(B2,B4,B5,B11/10,B8,B9,B10)`. This is exactly the same formula as the yield to maturity, except that we have changed the maturity date to the call date, and the redemption value to the call price. Note that the call premium plus the earlier receipt of the face value has caused the yield to call to be 11.23%. Of course, the issuer would never call the bond under these circumstances because interest rates have risen since the bond was originally issued.

Your worksheet should now resemble the one in Exhibit 8-8.

EXHIBIT 8-8
BOND VALUATION WORKSHEET WITH YIELD TO CALL ADDED

	A	B
1	**Bond Valuation**	
2	Settlement Date	2/15/2004
3	Maturity Date	2/10/2024
4	First Call Date	2/15/2009
5	Coupon Rate	8.00%
6	Required Return	9.00%
7	Redemption Value	100
8	Call Price	105
9	Frequency	2
10	Basis	0
11	Value	$ 907.99
12	**Return Measures**	
13	Current Yield	8.81%
14	Yield to Maturity	9.00%
15	Yield to Call	11.23%

Returns on Discounted Debt Securities

Not all debt instruments are bonds of the type that we have discussed above. Money market securities are short-term, high-quality, debt instruments that are sold on a discounted basis. That is, they do not pay interest; instead, they are sold for less than their face value. Since the full face value is returned to the investor at maturity, the interest is the difference between the face value and the purchase price. Examples of this type of security would include U.S. Treasury Bills, commercial paper, banker's acceptances, and short-term municipals.

Returns on discount securities on usually quoted on a bank discount basis. The bank discount rate is calculated as follows:

$$BDR = \frac{FV - P_0}{FV} \times \frac{360}{M} \quad \textbf{(8-8)}$$

where FV is the face value of the security, P_0 is the purchase price, and M is the number of days until maturity. For example, if you purchase a six-month (182-day) T-Bill for $985, the bank discount rate is:

$$BDR = \frac{1{,}000 - 985}{1{,}000} \times \frac{360}{182} = 0.02967 = 2.967\%$$

We can calculate the bank discount rate in Excel using the **DISC** function:

DISC(*SETTLEMENT*, *MATURITY*, *PR*, *REDEMPTION*, *BASIS*)

All of the variables are as previously defined. To see how this function works, insert a new worksheet into your workbook and enter the data as shown in Exhibit 8-9.

EXHIBIT 8-9
CALCULATING THE BANK DISCOUNT RATE

	A	B
1	**Discount Securities**	
2	Settlement Date	2/15/2004
3	Maturity Date	8/15/2004
4	Redemption Value	100
5	Purchase Price	98.5
6	Days to Maturity	182
7		
8	Bank Discount Rate	

Notice that both the redemption value and purchase price are entered as a percentage of par, though we could enter the actual values. In B8 enter the **DISC** function as: `=DISC(B2,B3,B5,B4,2)`. Note that we have set the *BASIS* to 2 because we are using the actual/360 day count convention. The answer is 2.967%, exactly as we calculated in equation (8-8).

The bank discount rate is the method that is used to quote discount securities in the market. However, it does have a couple of problems: (1) It uses the face value as the basis for calculating the return, but you have only paid the purchase price, not the face value. (2) It assumes that there are only 360 days in a year, instead of 365 (366 in a leap year). We can solve these problems by calculating the bond equivalent yield:

$$BEY = BDY \times \frac{FV}{P_0} \times \frac{365}{360} = \frac{FV - P_0}{P_0} \times \frac{365}{M} \qquad \textbf{(8-9)}$$

Note that the bond equivalent yield is simply a "fixed" version of the bank discount rate: We are using the purchase price as the basis for calculating the return, and changing the day count convention to actual/actual. In this example the bond equivalent yield is:

$$BEY = 0.2967 \times \frac{1{,}000}{985} \times \frac{365}{360} = \frac{1{,}000 - 985}{985} \times \frac{365}{182} = 0.03054 = 3.054\%$$

As you might expect, Excel has a built-in function to calculate the bond equivalent yield:

YIELDDISC(*SETTLEMENT*, *MATURITY*, *PR*, *REDEMPTION*, *BASIS*)

In A9 of your worksheet enter the label: `Bond Equivalent Yield`, and in B9 enter the formula: `=YIELDDISC(B2,B3,B5,B4,3)`. Note that the *BASIS* is set to 3 in this case. Again, the answer is 3.054% as we found using the equation.

Bond Price Sensitivities

As should be clear, bond values are a function of several parameters: interest payment amount, face value, term to maturity, and the required return. Of these, only the interest payment and face value are constant over the life of the bond. Obviously, all other things being equal, the value of a bond is positively related to both. It is not so obvious how the value changes as the term to maturity or required return changes. In this section, we will examine the sensitivity of the value to changes in these variables.

Changes in the Required Return

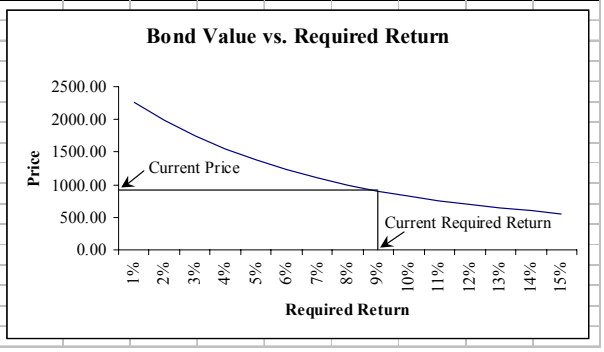
Because the value of a bond is the present value of its future cash flows, you probably expect that the value will increase as the interest rate declines and vice versa. And you would be correct. Let's examine this idea to fix it in your mind, and to point out a factor which you may not have considered.

Return to the worksheet created for our bond valuation example (Exhibit 8-8). We want to create a new section on this worksheet which will show the value of the bond at various interest rates. Move to A19 and enter: `Required Return`, and in B19 enter: `Bond Value`. Starting in A20, we want a column of interest rates ranging from 1% to 15% in steps of 1% (i.e., 0.01). Create this data series using the **E**dit F**i**ll **S**eries menu command. In B20 we need the value of the bond, using 1% as the required return. Using the **PRICE** function, this can be done with the formula: `=PRICE($B$2,$B$3,$B$5,A20,$B$7,$B$9,$B$10)*10`. This is the same formula as we used previously in B11, except that we have replaced the rate with the value in A20. Further, we have added dollar signs to fix most of the cell references so that they do not change as we copy this formula down. The interest rate is not fixed because we want it to change in each row.

If you now create a chart with the interest rate on the X-axis and the bond value on the Y-axis, your worksheet should look similar to the one in Exhibit 8-10.

EXHIBIT 8-10
BOND VALUE FOR VARIOUS REQUIRED RETURNS

	A	B
18	**Sensitivity to Required Return**	
19	Required Return	Bond Value
20	1%	2265.23
21	2%	1984.48
22	3%	1747.51
23	4%	1546.85
24	5%	1376.38
25	6%	1231.05
26	7%	1106.72
27	8%	999.98
28	9%	907.99
29	10%	828.42
30	11%	759.33
31	12%	699.10
32	13%	646.38
33	14%	600.07
34	15%	559.21



We have embellished our graph to show the current price and required rate of return.[13] As expected, the price is negatively related to the required return. However, the relationship is not linear; instead it is convex to the origin. This non-linear relationship leads to an interesting conclusion that we will now examine.

Move the chart to the right so that column C is exposed. To do this, click once on the chart with the left mouse button and drag it to the right. In C19 enter the label: `Change`. In C20:C34 we want to enter the change in the bond price from the current price. In other words, the numbers in this range will be the gain or loss that would be experienced if you purchased the bond and then interest rates changed to the value in column A. In C20 enter the formula: `=B20-B$28` which will fix the subtracted price at B28. Now copy the formula down the entire range.

13. Adding the lines is a simple matter of drawing them in. First, turn on the Drawing toolbar by choosing **V**iew **T**oolbars Drawing. Now, click on the line icon and click and drag the line on to the chart. To alter the style of the lines, click on one of them with the right mouse button and select Format Aut**o**Shape from the menu that appears. Make the changes in the dialog box and click OK. To change the other line to the same style, click on it with the left button and choose **E**dit **R**epeat Format Shape.

FIGURE 8-7
BOND VALUE VS. REQUIRED RETURN

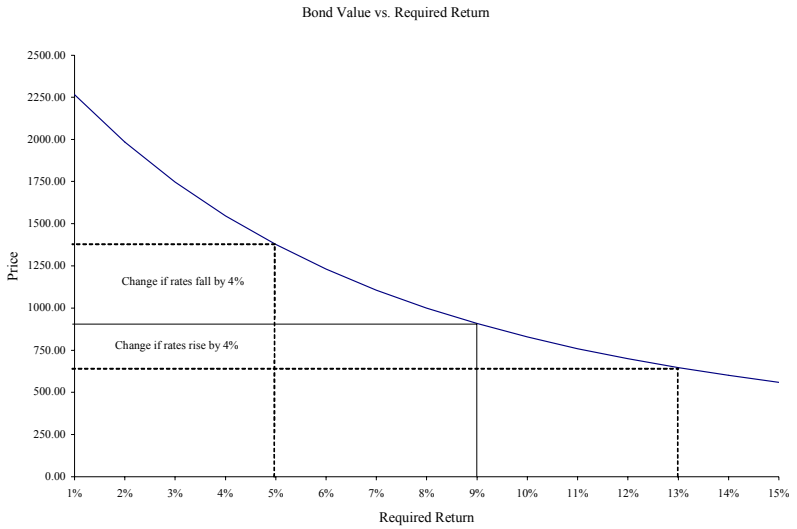
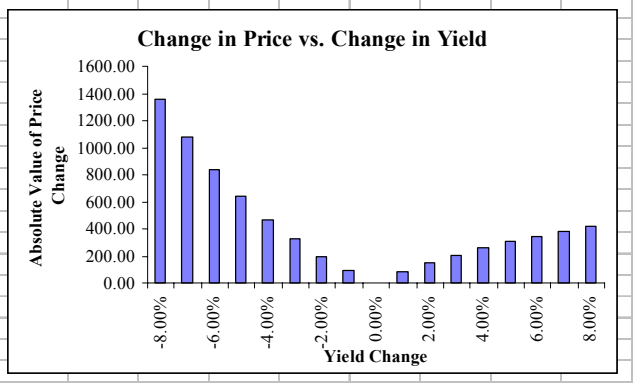


Figure 8-7 shows how your chart should appear. In your worksheet examine C20:C34 carefully. In particular, notice that the price changes are not symmetric. For example, if the interest rate falls 4% (to 5%), the price rises by $468.38. However, if the rate rises by 4% (to 13%), the price falls by only $261.61. In other words, as yields drop the price rises by more than it falls if yields rise a similar amount. Exhibit 8-11 demonstrates this asymmetry, and how it grows (in absolute value) as the change in rates grows.

EXHIBIT 8-11
ABSOLUTE VALUE OF CHANGES IN PRICE VS. CHANGES IN YIELD

	A	B
1	Yield Change	Price Change
2	-8.00%	1357.24
3	-7.00%	1076.49
4	-6.00%	839.52
5	-5.00%	638.86
6	-4.00%	468.38
7	-3.00%	323.06
8	-2.00%	198.73
9	-1.00%	91.99
10	0.00%	0.00
11	1.00%	79.57
12	2.00%	148.66
13	3.00%	208.90
14	4.00%	261.61
15	5.00%	307.93
16	6.00%	348.78
17	7.00%	384.97
18	8.00%	417.14



Changes in Term to Maturity

As a bond approaches its maturity date, the bond price must approach its face value (ignoring accrued interest). Since a bond can sell at a premium (above face value), at face value, or at a discount (below face value), the investor may realize a capital loss, no gain or loss, or a capital gain if they hold the bond to maturity.

To see how the price changes as maturity approaches, move to A37 and enter the labels so that your worksheet resembles the fragment in Exhibit 8-12. Create a series in A39:A59 from 20 down to 0. Use the **E**dit F**i**ll **S**eries command with a step value of –1. Now, change the value in A59 from 0 to `0.01`. This is because the **PRICE** function will return a #NUM! error if the maturity date is the same as the settlement date.

EXHIBIT 8-12
BOND PRICES VS. TIME TO MATURITY

	A	B	C
37	**Sensitivity to Time to Maturity**		
38	Time to Maturity	Bond 1	Bond 2
39	20	907.99	1106.72
40	19	909.75	1104.16
41	18	911.67	1101.41
42	17	913.77	1098.45
43	16	916.06	1095.29
44	15	918.56	1091.92
45	14	921.30	1088.29
46	13	924.28	1084.41
47	12	927.54	1080.24
48	11	931.09	1075.80
49	10	934.97	1071.03

Notice that we have included a column for a second bond. Make a copy of the original bond data (in B2:B11) and place it in C2:C11. The only difference between the two bonds will be the required return. For the second bond set the required return to 7%, and notice that the price of this bond is $1106.72. We are doing this to compare bonds selling at a discount and premium as they move towards maturity.[14]

In B39, we want to enter the **PRICE** function for the first bond allowing only the time to maturity to change. The formula to do this is:[15] `=PRICE(B$2,B$2+$A39*365,B$5,B$6,B$7,B$9,B$10)*10`. Since the second parameter is the maturity date, we must calculate it based on the number of years which is given in A39. We do this by taking the settlement date plus 365 times the number of years to maturity. Copy this formula to C39 to find the price of the second bond, and then copy both of these down the entire range. The numbers in your worksheet should be the same as those in Exhibit 8-12.

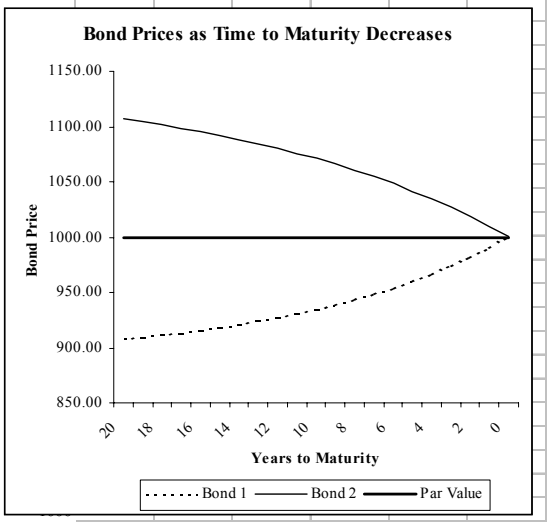
14. Note that this is a contrived situation. The "law of one price" guarantees that identical cash flows will have identical prices, and thus identical yields. If this situation actually existed, arbitrageurs would buy bond 1 (driving its price up) and short sell bond 2 (driving its price down) until the prices were the same.

15. If you have forgotten the parameters, refer to the definition of the **PRICE** function on page 233, in the chapter summary, or use the Insert Function dialog box.

Notice that the first bond slowly increases in price as the time to maturity declines. The second bond's price, however, slowly decreases in price as time to maturity declines. To see this more clearly, create a chart of this data with the Chart Wizard by selecting B38:C59. Again, make sure that A39:A59 is used for the category axis labels. Once the chart is created, you may want to adjust the scale of the Y-axis. Right-click the Y-axis and choose Format Axis, then click on the Scale tab. Now set the Minimum edit box to `850`. This will change the scale so that the origin of the Y-axis is at 850, effectively magnifying the area of the chart that we are interested in. Note that we have also added a line to indicate the par value of the bond. In cell D39 enter `1000` and copy it down to the rest of the range. Now, select D39:D59 and drag the series over the chart and drop it there. You should see that the data has been added to the chart as a new series. After adding labels to the chart, this part of your worksheet should look like Exhibit 8-13.

EXHIBIT 8-13
BOND PRICE VS. TIME TO MATURITY

	A	B	C
37	**Sensitivity to Time to Maturity**		
38	Time to Maturity	Bond 1	Bond 2
39	20	907.99	1106.72
40	19	909.75	1104.16
41	18	911.67	1101.41
42	17	913.77	1098.45
43	16	916.06	1095.29
44	15	918.56	1091.92
45	14	921.30	1088.29
46	13	924.28	1084.41
47	12	927.54	1080.24
48	11	931.09	1075.80
49	10	934.97	1071.03
50	9	939.22	1065.91
51	8	943.85	1060.43
52	7	948.90	1054.58
53	6	954.42	1048.29
54	5	960.45	1041.56
55	4	967.03	1034.35
56	3	974.21	1026.64
57	2	982.06	1018.37
58	1	990.64	1009.50
59	0.01	999.89	1000.06



We have seen how bond prices change when the required return and time to maturity change. But, when examining these changes all other variables were held constant. When all of the variables are allowed to change, bond price behavior is much more complex to predict.

Preferred Stock Valuation

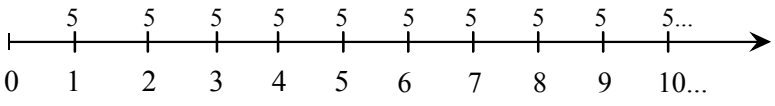
Preferred stock is a kind of hybrid security. It represents an ownership claim on the assets of the firm, like common stock, but holders of preferred stock do not benefit from increases in the firms earnings and they generally cannot vote in corporate elections, like bonds. Further, like a bond, preferred stock generally pays a fixed dividend payment each period. Also, like a common stock, there is no predefined maturity date, so the life of a share of preferred stock is effectively infinite.

With the complex nature of preferred stock, it would be natural to assume that it must be difficult to determine its value. As we will see, preferred stock is actually easier to value than either bonds or common stock. To see how we can derive the valuation formula for preferred stock, consider the following example.

> The XYZ Corporation has issued preferred stock which pays a 10% annual dividend on its $50 par value. If your required return for investments of this type is 12%, what is the maximum amount that you should be willing to pay for a share of XYZ preferred?

As usual, the first step in valuing preferred stock is to determine the cash flows. In the case of XYZ preferred, we have an infinite stream of dividends which are 10% of the par value. That is, we have a perpetual annuity, or perpetuity, of $5 per year. Figure 8-8 illustrates the expected cash flows for XYZ preferred stock.

FIGURE 8-8
TIMELINE FOR XYZ PREFERRED STOCK



One way that we can arrive at a valuation formula for preferred stock is to realize that the cash flows resemble those of common stock. Preferred stock pays a dividend and never matures, just like common stock. The only difference, as far as the cash flows are concerned, is that the dividend never changes. In other words, the growth rate is zero. Therefore, we can say that the value of preferred stock is:

$$V_P = \frac{D_0(1+g)}{k_P - g}$$

but since the growth rate is 0 we can simplify this to:

$$V_P = \frac{D}{k_P} \tag{8-10}$$

Notice that the subscript has been dropped on the dividend because all dividends are equal.

As an alternative, we can value the perpetuity as if it were a bond with an infinite life. In this case, we have:

$$V_P = D\left[\frac{1 - \frac{1}{(1+k_P)^{\infty}}}{k_P}\right] + \frac{FV}{(1+k_P)^{\infty}}$$

Realizing that any number greater than 1 raised to an infinite power is equal to infinity, we can rewrite this expression as:

$$V_P = D\left[\frac{1 - \frac{1}{\infty}}{k_P}\right] + \frac{FV}{\infty}$$

But any number divided by infinity is effectively equal to 0, so this equation reduces to:[16]

$$V_P = \frac{D}{k_P}$$

which is exactly the same as equation (8-10). So, for valuation purposes, regardless of whether we treat preferred stock like common stock or bonds, we arrive at exactly the same valuation formula. To find the value of a share of preferred stock, we need to merely divide its dividend payment by our required rate of return. Therefore, the value of XYZ's preferred stock must be:

16. Actually, we can't divide by infinity. Instead, we should take the limit as N approaches infinity.

$$V_P = \frac{5}{0.12} = 41.66$$

You can prove this to yourself by recreating Exhibit 8-4 (page 227) with all of the dividends set to 5.

Summary

The valuation process is important to both financial managers and investors. As we will see in future chapters, understanding the valuation process is crucial to making sound financial decisions.

In this chapter we found that the value of a security depends on several factors:

- The size of the expected cash flows.
- The timing of the expected cash flows.
- And the perceived riskiness of the expected cash flows.

Once the cash flows and required rate of return have been determined, we can value the security by finding the present value of its future cash flows.

The actual equations are different for different cash flow patterns, but they all reduce to the present value of future cash flows. The formulas are:

Valuation Model	Formula	Page
Constant growth common stock	$V_{CS} = \frac{D_0(1+g)}{k_{CS}-g} = \frac{D_1}{k_{CS}-g}$	223
Two-stage growth common stock	$V_{CS} = \frac{D_0(1+g_1)}{k_{CS}-g_1}\left[1-\left(\frac{1+g_1}{1+k_{CS}}\right)^n\right] + \frac{\frac{D_0(1+g_1)^n(1+g_2)}{k_{CS}-g_2}}{(1+k_{CS})^n}$	228

Valuation Model	Formula	Page
Three-stage growth common stock	$V_{CS} = \frac{D_0}{K_{CS} - g_2}\left[(1+g_2) + \frac{n_1+n_2}{2}(g_1 - g_2)\right]$	230
Bonds	$V_B = Pmt\left[\frac{1 - \frac{1}{(1+k_B)^N}}{k_B}\right] + \frac{FV}{(1+k_B)^N}$	232
Preferred stock	$V_P = \frac{D}{k_P}$	249

TABLE 8-1
FUNCTIONS INTRODUCED IN THIS CHAPTER

Purpose	Function	Page
Two-stage growth model	**FAME_TwoStageValue(*DIV1*, *REQRATE*, *GROWTHRATE1*,*GROWTHRATE2*,*G1PERIODS*)**	229
Three-stage growth model	**FAME_ThreeStageValue(*DIV1*, *REQRATE*,*GROWTHRATE1*,*GROWTHRATE2*, *G1PERIODS*,*TRANSPERIODS*)**	231
Value of a bond	**PRICE**(*SETTLEMENT*, *MATURITY*,*YLD*, *REDEMPTION*, *FREQUENCY*, *BASIS*)	233
Yield to maturity of a bond	**YIELD**(*SETTLEMENT*, *MATURITY*, *RATE*,*PR*, *REDEMPTION*, *FREQUENCY*, *BASIS*)	237
Bank Discount Rate	**DISC**(*SETTLEMENT*, *MATURITY*, *PR*, *REDEMPTION*, *BASIS*)	240
Bond Equivalent Yield	**YIELDDISC**(*SETTLEMENT*, *MATURITY*, *PR*, *REDEMPTION*, *BASIS*)	242

Problems

1. As an analyst at Churnem & Burnem Securities, you are responsible for making recommendations to your firm's clients regarding common stocks. After gathering data on Denver Semiconductors, you have found that their dividends have been growing at a rate of 10% per year to the current (D_0) rate of \$0.60 per share. The stock is currently selling for \$12 per share, and you believe that an appropriate rate of return for this stock is 15% per year.

    a. If you expect that the dividend will continue to grow at a 10% rate into the foreseeable future, what is the highest price at which you would recommend purchasing this stock to your clients?

    b. Suppose now that you determine that the company's new product line will cause much higher growth in the near future. Your revised estimate is for a three-year period of 20% annual growth which will be followed by a return to the historical 10% growth rate. Under these new assumptions, what is the current value of the stock using the two-stage dividend growth model?

    c. After considering your assumptions from Part b, you realize that it is likely that the growth will gradually transition from 20% down to 10% rather than instantaneously. If you believe that this transition will take five years, what is the value that you place on the stock today? Use the three-stage dividend growth model.

2. As an investor, you are considering an investment in the bonds of the Conifer Coal Company. The bonds, which pay interest semiannually, will mature in eight years, and have a coupon rate of 9.5% on a face value of \$1,000. Currently, the bonds are selling for \$872.

    a. If your required return is 11% for bonds in this risk class, what is the highest price you would be willing to pay? (Note: use the **PV** function.)

b. What is the yield to maturity on these bonds if you purchase them at the current price? (Note: use the **RATE** function.)

c. If the bonds can be called in three years with a call premium of 4% of the face value, what is the yield to call on these bonds? (Note: use the **RATE** function.)

d. Now assume that the settlement date for your purchase would be 7/30/2004, the maturity date is 7/28/2012, and the first call date is 7/29/2007. Using the **PRICE** and **YIELD** functions recalculate your answers to Parts a, b, and c.

e. If market interest rates remain unchanged, do you think it is likely that the bond will be called in three years? Why or why not?

f. Create a chart that shows the relationship of the bond's price to your required return. Use a range of 0% to 15% in calculating the prices.

Internet Exercises

1. Using the Yahoo! Finance Web site (http://finance.yahoo.com) get the current price and five-year dividend history for Albertsons, Inc. To gather this data, enter the ticker symbol (ABS), choose Chart from the drop-down list of quote types, and click the Get Quotes button. At the bottom of the chart, click on the "historical quotes" link. To get a table of previous dividends, select Dividends at the top of the table, set the Start Date to five years before today's date and click the Get Historical Data button. Click the Download Spreadsheet Format link at the bottom of the table to download a file with this data. Open the .CSV file in Excel. You may find that the dates and dividends are sharing a cell. In this case, select all of the data choose **D**ata T**e**xt to Columns from Excel's menu. On the second dialog box, select Space as the delimiter and then click the OK button. You should now have the dividend data in a usable form.

a. Since ABS pays dividends quarterly, calculate the quarterly percentage change in the dividends. Now, calculate the compound quarterly growth rate of the dividends using the **GEOMEAN** function.

b. Now, annualize the quarterly dividend growth rate.

c. Calculate the intrinsic value of the stock using a 10% required rate of return and the calculated annual growth rate. Use the sum of the most recent four dividends as D_0.

d. How does the calculated intrinsic value compare to the actual market price of the stock? Would you purchase the stock at its current price?

2. Using the Bond Screener at the Yahoo! Finance Web site (http://bonds.yahoo.com/search.html), find a AAA rated corporate bond with at least 12 years to maturity. Click the link to get more detailed information on your chosen bond, and then set up a worksheet to answer the following questions. Note that since we are using corporate bonds, the basis should be set to 0 (30/360).

a. Using the coupon rate, settlement date, maturity date, and the given yield to maturity, calculate the value of the bond using the **PRICE** function.

b. Using the coupon rate, settlement date, maturity date, and the given price of the bond, calculate the current yield.

c. Using the coupon rate, settlement date, maturity date, and the given price of the bond, calculate the yield to maturity using the **YIELD** function.

9 *The Cost of Capital*

After studying this chapter, you should be able to:

1. *Define "hurdle rate" and show how it relates to the firm's Weighted Average Cost of Capital (WACC).*
2. *Calculate the WACC using both book- and market-value weights.*
3. *Calculate component costs of capital with flotation costs and taxes.*
4. *Explain how and why a firm's WACC changes as total capital requirements change.*
5. *Use Excel to calculate the "break-points" in a firm's marginal WACC curve, and graph this curve in Excel.*

Knowledge of a firm's cost of capital is vital if managers are to make appropriate decisions regarding the use of the firm's funds. Without this knowledge, poor investments may be made that actually reduce shareholder wealth. In this chapter we will examine what the cost of capital is and how to calculate it.

The Appropriate "Hurdle" Rate

A firm's required rate of return on investments is often referred to as its *hurdle rate* because all projects must earn a rate of return high enough to clear this rate. Otherwise, a project will not cover its cost of financing, thereby reducing shareholder wealth. But what is the appropriate rate to use? Let's look at an example.

> The managers of the Rocky Mountain Motors (RMM) are considering the purchase of a new tract of land which will be held for one year. The purchase price of the land is $10,000. RMM's capital structure is currently made up of 40% debt, 10% preferred stock, and 50% common equity. Because this capital structure is considered to be optimal, any new financing will be raised in the same proportions. RMM must raise the new funds as indicated in Table 9-1.

TABLE 9-1
FUNDING FOR RMM'S LAND PURCHASE

Source of Funds	Amount	Dollar Cost	After-Tax Cost
Debt	$ 4,000	$ 280	7%
Preferred Stock	1,000	100	10%
Common Stock	5,000	600	12%
Total	10,000	980	9.8%

> Before making the decision, RMM's managers must determine what required rate of return will simultaneously satisfy all of their capital providers. What minimum rate of return will accomplish this goal?

Obviously, the land must generate at least $980 in excess of its cost in order to cover the financing costs. This represents a minimum required return of 9.8% on

the investment of $10,000. Table 9-2 shows what would happen under three alternative rate of return scenarios.

TABLE 9-2
ALTERNATIVE SCENARIOS FOR RMM

Rate of Return	8%	9.8%	11%
Total Funds Available	$ 10,800	$ 10,980	$ 11,100
Less: Debt Costs	4,280	4,280	4,280
Less: Preferred Costs	1,100	1,100	1,100
Available to Common Shareholders	5,420	5,600	5,720

Recall that the common shareholders' required rate of return is 12% on the $5,000 that they provided. If RMM earns only 8%, the common shareholders will receive only $5,420 which is $180 less than required. Presumably, the common shareholders have alternative investment opportunities (with equal risk) which would return 12%. Therefore, if the project can return only 8%, the best decision that the managers could make would be to allow the common shareholders to hold on to their money. In other words, the project should be rejected.

On the other hand, if the project is expected to return 9.8% the common shareholders will receive exactly the amount that they require. If the project returns 11%, they will be more than satisfied. Under these latter two scenarios the project should be accepted because shareholder wealth will either be increased by the amount required ($600) or increased by more than required ($720).[1]

The Weighted Average Cost of Capital

It still remains to determine, in a general way, what required rate of return will simultaneously satisfy all of the firm's stakeholders. Recall that 40% of RMM's funds were provided by the debt holders. Therefore, 40% of this minimum required rate of return must go to satisfy the debt holders. For the same reason, 10% of this minimum required rate of return must go to satisfy the preferred stockholders, and

1. Note that the difference between the amount that is available to the common shareholders and the amount required is known as the net present value (*NPV*). This concept will be explored in Chapter 10.

50% will be required for the common stockholders. In general, the minimum required rate of return must be a weighted average of the individual required rates of return on each form of capital provided.

Therefore, we refer to this minimum required rate of return as the *weighted average cost of capital* (*WACC*). The weighted average cost of capital can be found as follows:

$$WACC = w_d k_d + w_P k_P + w_{cs} k_{cs} \quad \textbf{(9-1)}$$

where the *w*'s are the weights of each source of capital, and the *k*'s are the costs (required returns) for each source of capital. In the case of RMM, the *WACC* is:

$$WACC = 0.40(0.07) + 0.10(0.10) + 0.50(0.12) = 0.098 = 9.80\%$$

which is exactly the required return that we found above.

Determining the Weights

The weights that one uses in the calculation of the *WACC* will obviously affect the result. Therefore, an important question is, "where do the weights come from?" Actually, there are two possible answers to this question. Perhaps the most obvious answer is to find the weights on the balance sheet.

The balance sheet weights (usually referred to as the *book-value* weights) can be obtained by the following procedure. Find the total long-term debt, total preferred equity, and the total common equity. Add together each of these to arrive at the grand total of the long-term sources of capital. Finally, divide each component by the grand total to determine the percentage that each source is of total capital. Table 9-3 summarizes these calculations for RMM.

TABLE 9-3
CALCULATION OF BOOK-VALUE WEIGHTS FOR RMM

Source of Capital	Total Book Value	Percentage of Total
Long-term Debt	$400,000	40%
Preferred Equity	100,000	10%
Common Stock	500,000	50%
Grand Total	1,000,000	100%

The problem with book-value weights is that they represent the weights as they were when the securities were originally sold. That is, the book-value weights represent historical weights. The calculated *WACC* would better represent current reality if we used the present weights. Since the market constantly re-values the firm's securities, we can find the weights by using the current market values of the securities.

The procedure for determining the market-value weights is similar to that used to find the book-value weights. First, determine the total market value of each type of security. Total the results, and divide the market value of each source of capital by the total to determine the weights.

TABLE 9-4
CALCULATION OF MARKET-VALUE WEIGHTS FOR RMM

Source	Price Per Unit	Units	Total Market Value	Percentage of Total
Debt	$ 904.53	400	$ 361,812	31.14%
Preferred	100.00	1,000	100,000	8.61%
Common	70.00	10,000	700,000	60.25%
Totals			1,161,812	100.00%

Table 9-4 shows RMM's current capital structure in market-value terms. Note that, in market value terms, the percentage of common equity has risen considerably, while the percentages of debt and preferred equity have fallen. Using these weights we can see that their *WACC* is:

$$WACC = 0.3114(0.07) + 0.0861(0.10) + 0.6025(0.12) = 0.1027 = 10.27\%$$

In this example, the book-value *WACC* and the market-value *WACC* are quite close together. This is not always the case. Whenever possible, use the market values of the firm's securities to determine the *WACC*.

WACC Calculations in Excel

We can easily set up a worksheet to do the calculations for the *WACC* as in Table 9-4. To do this, first copy the data from Table 9-4 into a new worksheet, starting with the headings in A1.

In column D, we want to calculate the total market value of the securities which is the price times the number of units outstanding. So, in D2 enter: `=B2*C2` and copy the formula down to D3 and D4. Cell D5 should have the total market value of the securities, so enter: `=Sum(D2:D4)`. In Column E we need the percentage that each security represents of the total market value. These are the weights that we will use to calculate the *WACC*. In E2 enter: `=D2/D$5` and copy down to E3 and E4. As a check, calculate the total in E5.

Next, we want a column for the after-tax costs of each source of capital, and the weighted-average cost of capital. In F1 enter the label: `After-tax Cost`. Now, in F2:F4 enter the after-tax cost of each component from Table 9-1. We could calculate the *WACC* in F5 with the formula: `=E2*F2+E3*F3+E4*F4`. Even easier would be to use the array formula: `=SUM(E2:E4*F2:F4)`, just remember to press Ctrl+Shift+Enter when entering this formula. The completed worksheet appears in Exhibit 9-1. Note that the *WACC* is exactly as we calculated earlier.[2] You are encouraged to experiment by changing the market prices of the securities to see how the weights, and the *WACC*, change.[3]

EXHIBIT 9-1
WORKSHEET TO CALCULATE RMM'S *WACC*

	A	B	C	D	E	F
1	**Source**	**Price**	**Units**	**Total Market Value**	**Percentage of Total**	**After-tax Cost**
2	Debt	$ 904.53	400	$ 361,812	31.14%	7.00%
3	Preferred	$ 100.00	1,000	$ 100,000	8.61%	10.00%
4	Common	$ 70.00	10,000	$ 700,000	60.25%	12.00%
5	Totals			$ 1,161,812	100.00%	10.27%

2. Note that this is a simplified example. In reality, most companies will have multiple debt issues outstanding, and many have more than one class of common and preferred stock outstanding as well. The calculations will work in exactly the same way, regardless of the number of issues outstanding. However, you will first have to calculate a weighted-average cost for each source of capital (e.g., a weighted-average after-tax cost of debt).

3. It would be a fairly simple exercise to completely automate the calculation of the *WACC* for a firm. Using either a Web Query or a database query (both available on the **D**ata Import External **D**ata menu), an Excel programmer could get "live" prices from the Internet or a database and update the prices in the worksheet. The *WACC* could then be recalculated continuously without further human intervention.

Calculating the Component Costs

Up to this point, we have taken the component costs of capital as a given. In reality, these costs are anything but given, and, in fact, change continuously. How we calculate these costs is the subject of this section.

To begin, note that the obvious way of determining the required rates of return is to simply ask each capital provider what her required rate of return is for the particular security that she owns. For all but the most closely held of firms, this would be exceedingly impractical and you would likely get some outlandish responses. However, there is a way by which we can accomplish the same end result.

Recall from Chapter 8 that the market value of a security is equal to the intrinsic value of the marginal investor. Further, if shareholders are rational, they will buy (sell) securities as the expected return rises above (falls below) their required return. Therefore, we can say that the investors in the firm "vote with their dollars" on the issue of the firm's cost of capital. This force operates in all markets.[4] So at any given moment, the price of a security will reflect the overall required rate of return for that security. All we need, then, is a method of converting the observed market prices of securities into required rates of return.

Since we have already discussed the valuation of securities (common stock, preferred stock, and bonds) you should recall that a major input was the investor's required rate of return. As we will see, we can simply invert the valuation equations to solve for the required rate of return.

The Cost of Common Equity

Because of complexities in the real world, finding a company's cost of common equity is not always straightforward. In this section we will look at two approaches to this problem, both of which we have seen previously in other guises.

Using the Dividend Discount Model

Recall that a share of common stock is a perpetual security which, we often assume, will periodically pay a cash flow which grows over time. We have previously

4. Anybody who isn't convinced should check the history of bond and stock prices for companies such as Enron and WorldCom. They were falling dramatically long before those firms filed for bankruptcy.

demonstrated that the present value of such a stream of cash flows is given by equation (8-3):

$$V_{CS} = \frac{D_0(1+g)}{k_{CS}-g} = \frac{D_1}{k_{CS}-g}$$

assuming an infinite holding period and a constant rate of growth for the cash flows.

If we know the current market price of the stock, we can use this knowledge to solve for the common shareholder's required rate of return. Simple algebraic manipulation will reveal that this rate of return is given by:

$$k_{CS} = \frac{D_0(1+g)}{V_{CS}} + g = \frac{D_1}{V_{CS}} + g \qquad \textbf{(9-2)}$$

Note that this equation says that the required rate of return on common equity is equal to the sum of the dividend yield and the growth rate of the dividend stream.

Using the *CAPM*

Not all common stocks will meet the assumptions of the Dividend Discount Model. In particular, many companies do not pay dividends. An alternative approach to determining the cost of equity is to use the *Capital Asset Pricing Model* (*CAPM*).

The *CAPM* gives the expected rate of return for a security if we know the risk-free rate of interest, the market risk premium, and the riskiness of the security relative to the market portfolio (i.e., the security's beta). The *CAPM*, you will recall, is the equation for the security market line:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f)$$

Assuming that the stockholders are all price-takers, their expected return is the same as the firm's required rate of return.[5] Therefore, we can use the *CAPM* to determine the required rate of return on equity.

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5. A price-taker cannot materially affect the price of an asset through individual buying or selling. This situation generally exists in the stock market because most investors are small when compared to the market value of the firm's common stock. In an earlier footnote, we distinguished between the expected and required rates of return for an *individual* investor. Note that we have not altered this distinction here. We are merely pointing out that the *investors'* expected return is the same as the *firm's* required return.

The Cost of Preferred Equity

Preferred stock, for valuation purposes, can be viewed as a special case of the common stock with the growth rate of dividends equal to zero. We can carry this idea to the process of solving for the preferred stockholders' required rate of return. First, recall that the value of a share of preferred stock was given by equation (8-10):

$$V_P = \frac{D}{k_P}$$

As with common stock, we can algebraically manipulate this equation to solve for the required return if the market price is known:

$$k_P = \frac{D}{V_p} \tag{9-3}$$

The Cost of Debt

Finding the cost of debt is more difficult than finding the cost of either preferred or common equity. The process is similar: determine the market price of the security, and then find the discount rate which makes the present value of the expected future cash flows equal to this price. However, we cannot directly solve for this discount rate. Instead, we must use an iterative trial and error process.

Recall that the value of a bond is given by equation (8-6):

$$V_B = Pmt\left[\frac{1-\frac{1}{(1+k_d)^N}}{k_d}\right] + \frac{FV}{(1+k_d)^N}$$

The problem is to find k_d such that the equality holds between the left and right sides of the equation. Suppose that, as in Exhibit 9-1, the current price of RMM's bonds is \$904.53, the coupon rate is 10%, the face value of the bonds is \$1,000, and the bonds will mature in 10 years. If the bonds pay interest annually, our equation looks as follows:

$$904.53 = 100\left[\frac{1-\frac{1}{(1+k_d)^{10}}}{k_d}\right] + \frac{1{,}000}{(1+k_d)^{10}}$$

We must make an initial, but intelligent, guess as to the value of k_d. Since the bond is selling at a discount to its face value, we know that the yield to maturity (k_d) must be greater than the coupon rate. Therefore, our first guess should be something greater than 10%. If we choose 12% we will find that the price would be $886.99 which is lower than the actual price. Our first guess was incorrect, but we now know that the answer must lie between 10% and 12%. The next logical guess is 11%, which is the halfway point. Inserting this for k_d we get a price of $941.11 which is too high, but not by much. Further, we have narrowed the range of possible answers to those between 11% and 12%. Again, we choose the halfway point, 11.5%, as our next guess. This results in an answer of $913.48. Continuing this process we will eventually find the correct answer to be 11.67%.[6]

Making an Adjustment for Taxes

Notice that the answer that we found for the cost of debt, 11.67%, is not the same as that listed in Exhibit 9-1. Because interest is a tax-deductible expense, interest payments actually cost less than the full amount of the payment. In this case, if RMM were to make an interest payment of $116.70, and the marginal tax rate is 40%, it would only cost them $70.02 ($= 116.70 \times (1 - 0.40)$). Notice that $70.02 / 1{,}000 \approx 0.07$, or 7%, which is the after-tax cost of debt listed in Exhibit 9-1.

In general, we need to adjust the cost of debt to account for the deductibility of the interest expense by multiplying the before-tax cost of debt (i.e., the yield to maturity) by 1 - t, where t is the marginal tax rate. Note that we do not make the same adjustment for the cost of common or preferred equity because dividends are not tax deductible.[7]

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6. The method presented here is known as the bisection method. Briefly, the idea is to quickly bracket the solution and to then choose as the next approximation the answer that is exactly halfway between the previous possibilities. This method can lead to very rapid convergence on the solution if a good beginning guess is used.

7. This is just a close approximation, but close enough for most purposes since the cost of capital is just an estimate anyway. It would be more accurate to use the after-tax cash flows in the equation. This will result in the after-tax cost of debt with no additional adjustment required, and will differ slightly from that given above.

Using Excel to Calculate the Component Costs

A general principle that we have relied on in constructing our worksheet models is that we should make Excel do the calculations whenever possible. We will now make changes to our worksheet in Exhibit 9-1 to allow Excel to calculate the component costs of capital.

The After-Tax Cost of Debt

We cannot calculate any of the component costs on our worksheet without adding some additional information. We will first add information which will be used to calculate the after-tax cost of debt. Beginning in A7 with the label: `Additional Bond Data`, add the information from Table 9-5 into your worksheet.

TABLE 9-5
ADDITIONAL DATA FOR CALCULATING THE COST OF DEBT FOR RMM

Additional Bond Data	
Tax Rate	40%
Coupon Rate	10%
Face Value	$1,000
Maturity	10

With this information entered, we now need a function to find the cost of debt. Excel provides two built-in functions that will do the job: **RATE** and **YIELD**. We have already seen both of these functions. Since **YIELD** (defined on page 237) requires more information than we have supplied, we will use **RATE**. Recall that **RATE** will solve for the yield for an annuity-type stream of cash flows and allows for a different present value and future value. Specifically, **RATE** is defined as:

RATE(*NPER*, *PMT*, *PV*, *FV*,*TYPE*,*GUESS*)

The only unusual aspect of our usage of this function is that we will be supplying both a ***PV*** and an ***FV***. Specifically, ***PV*** will be the negative of the current bond price and ***FV*** is the face value of the bond. In F2 enter the **RATE** function as: `=RATE(B11,B9*B10,-B2,B10)`. The result is 11.67%, which we found to be the pre-tax cost of debt. Remember that we must also make an adjustment for taxes, so we need to multiply by 1 – t. The final form of the formula in F2 then is: `=RATE(B11,B9*B10,-B2,B10)*(1-B8)`, and the result is 7.00%.

With the new bond information, your worksheet should resemble Exhibit 9-2.

EXHIBIT 9-2
RMM WORKSHEET WITH BOND DATA

	A	B	C	D	E	F
1	**Source**	**Price**	**Units**	**Total Market Value**	**Percentage of Total**	**After-tax Cost**
2	Debt	$ 904.53	400	$ 361,812	31.14%	7.00%
3	Preferred	$ 100.00	1,000	$ 100,000	8.61%	10.00%
4	Common	$ 70.00	10,000	$ 700,000	60.25%	12.00%
5	Totals			$ 1,161,812	100.00%	10.27%
6						
7	**Additional Bond Data**					
8	Tax Rate	40%				
9	Coupon Rate	10%				
10	Face Value	$ 1,000				
11	Maturity	10				

The Cost of Preferred Stock

Compared to calculating the after-tax cost of debt, finding the cost of preferred stock is easy. We need only add one piece of information: the preferred dividend. In C7 type: `Additional Preferred Data`. In C8 type: `Dividend` and in D8 enter: `10`.

We know from equation (9-3) that we need to divide the preferred dividend by the current price of the stock. Therefore, the equation in F3 is: `=D8/B3`.

The Cost of Common Stock

To calculate the cost of common stock, we need to know the most recent dividend and the dividend growth rate in addition to the current market price of the stock. In E7 type: `Additional Common Data`. In E8 type: `Dividend 0` and in F8 enter: `3.96`. In E9 enter the label: `Growth Rate` and in F9 enter: `6%`.

Finally, we will use equation (9-2) to calculate the cost of common stock in F4. Since we know the most recent dividend (D_0) we need to multiply that by 1 + g. The formula in F4 is: `=(F8*(1+F9))/B4+F9`, and the result is 12% as we found earlier.

As you will see, we have not yet completed the calculation of the component costs for RMM. We have left out one crucial piece which we will discuss in the next section. At this point, your worksheet should resemble that in Exhibit 9-3.

EXHIBIT 9-3
RMM COST OF CAPITAL WORKSHEET

	A	B	C	D	E	F
1	**Source**	**Price**	**Units**	**Total Market Value**	**Percentage of Total**	**After-tax Cost**
2	Debt	$ 904.53	400	$ 361,812	31.14%	7.00%
3	Preferred	$ 100.00	1,000	$ 100,000	8.61%	10.00%
4	Common	$ 70.00	10,000	$ 700,000	60.25%	12.00%
5	Totals			$ 1,161,812	100.00%	10.27%
6						
7	**Additional Bond Data**		**Additional Preferred Data**		**Additional Common Data**	
8	Tax Rate	40%	Dividend	$ 10.00	Dividend 0	$ 3.96
9	Coupon Rate	10%			Growth Rate	6%
10	Face Value	$ 1,000				
11	Maturity	10				

The Role of Flotation Costs

Any action that a corporation takes has costs associated with it. Up to this point we have implicitly assumed that securities can be issued without cost, but this is not the case. Selling securities directly to the public is a complicated procedure, generally requiring a lot of management time as well as the services of an *investment banker*. An investment banker is a firm which serves as an intermediary between the issuing firm and the public. In addition to forming the underwriting syndicate to sell the securities, the investment banker also functions as a consultant to the firm. As a consultant, the investment banker usually advises the firm on the pricing of the issue and is responsible for preparing the registration statement for the Securities and Exchange Commission (SEC).

The cost of the investment banker's services, and other costs of issuance, are referred to as *flotation costs*. (The term derives from the fact that the process of selling a new issue is generally referred to as floating a new issue.) These flotation costs add to the total cost of the new securities to the firm, and we must increase the component cost of capital to account for them.

There are two methods for accounting for flotation costs.[8] The most popular method is the cost of capital adjustment. Under this method the market price of new securities is *decreased* by the per unit flotation costs. This results in the net amount that the company receives from the sale of the securities. The component costs are then calculated in the usual way except that the net amount, not the market price, is used in the equation.

The second, less common, method is the investment cost adjustment. Under this methodology we increase the initial outlay for the project under consideration to account for the total flotation costs. Component costs are then calculated as we did above. The primary disadvantage of this technique is that, because it assigns all flotation costs to one project, it implicitly assumes that the securities used to finance a project will be retired when the project is completed.

Because it is more common, and its assumptions are more realistic, we will use the cost of capital adjustment technique. When flotation costs are included in the analysis, the equations for the component costs are given in Table 9-6.

TABLE 9-6
COST OF CAPITAL EQUATIONS WITH FLOTATION COST ADJUSTMENT

Component	Equation*
Cost of new common equity	$k_{CS} = \frac{D_0(1+g)}{V_{CS}-f} + g = \frac{D_1}{V_{CS}-f} + g$
Cost of preferred equity	$k_P = \frac{D}{V_p - f}$
Pre-tax cost of debt (solve for k_d)	$V_B - f = Pmt\left[\frac{1-\frac{1}{(1+k_d)^N}}{k_d}\right] + \frac{FV}{(1+k_d)^N}$

* In these equations the flotation costs (f) are a dollar amount per unit. It is also common for flotation costs to be stated as a percentage of the unit price.

8. For more information on both methods, see Brigham and Gapenski, "Flotation Cost Adjustments," *Financial Practice and Education* (Fall/Winter 1991): 29–34.

Adding Flotation Costs to Our Worksheet

We can easily incorporate the adjustment for flotation costs into our worksheet. All we need to do is change the references to the current price in each of our formulas to the current price minus the per unit flotation costs. These costs are given in Table 9-7.

TABLE 9-7
FLOTATION COSTS AS A PERCENTAGE OF SELLING PRICE FOR RMM

Security	Flotation Cost
Bonds	1%
Preferred Stock	2%
Common Stock	5%

Enter the information from Table 9-7 into your worksheet. For each security, we have added the information at the end of the "Additional information" section. For example, in A12 enter: `Flotation` and in B12 enter: `1%`, which is the flotation cost for bonds.

To account for flotation costs, change your formulas to the following:

F2 `=RATE(B11,B9*B10,-B2*(1-B12),B10)*(1-B8)`

F3 `=D8/(B3*(1-D9))`

F4 `=(F8*(1+F9))/(B4*(1-F10))+F9`

Once these changes have been made, you will notice that the cost of each component has risen. Your worksheet should now resemble the one pictured in Exhibit 9-4.

EXHIBIT 9-4
COST OF CAPITAL WORKSHEET WITH FLOTATION COSTS

	A	B	C	D	E	F
1	**Source**	**Price**	**Units**	**Total Market Value**	**Percentage of Total**	**After-tax Cost**
2	Debt	$904.53	400	$ 361,812	31.14%	7.10%
3	Preferred	$100.00	1,000	$ 100,000	8.61%	10.20%
4	Common	$ 70.00	10,000	$ 700,000	60.25%	12.31%
5	Totals			$ 1,161,812	100.00%	10.51%
6						
7	**Additional Bond Data**		**Additional Preferred Data**		**Additional Common Data**	
8	Tax Rate	40%	Dividend	$ 10.00	Dividend 0	$ 3.96
9	Coupon Rate	10%	Flotation	2%	Growth Rate	6%
10	Face Value	$ 1,000			Flotation	5%
11	Maturity	10				
12	Flotation	1%				

The Cost of Retained Earnings

We have shown how to calculate the required returns for purchasers of new common equity, preferred stock, and bonds, but firms also have another source of long-term capital: retained earnings. Is there a cost to such internally generated funds, or are they free? Consider that managers generally have two options as to what they do with the firm's internally generated funds. They can either reinvest them in profitable projects or return them to the shareholders in the form of dividends. Since these funds belong to the common shareholders alone, the definition of a "profitable project" is one that earns at least the common shareholder's required rate of return. If these funds will not be invested to earn at least this return, they should be returned to the common shareholders (in the form of extra dividends, share buybacks, etc.). So there is a cost (an opportunity cost) to internally generated funds: the cost of common equity.

Note that the only difference between retained earnings (internally generated common equity) and new common equity is that the firm must pay flotation costs on the sale of new common equity. Since no flotation costs are paid for retained earnings, we can find the cost of retained earnings in the same way we did before learning about flotation costs. In other words,

$$k_{RE} = \frac{D_0(1+g)}{V_{CS}} + g = \frac{D_1}{V_{CS}} + g \qquad \textbf{(9-4)}$$

This notion of an opportunity cost for retained earnings is important for a couple of reasons. Most importantly, managers should be disabused of the notion that the funds on hand are "free." As you now know, there is a cost to these funds and it should be accounted for when making decisions. In addition, there may be times when a project that otherwise appears to be profitable is really unprofitable when the cost of retained earnings is correctly accounted for. Accepting such a project is contrary to the principle of shareholder wealth maximization, and will result in the firm's stock price falling.

The Marginal WACC Curve

A firm's weighted average cost of capital is not constant. Changes can occur in the *WACC* for a number of reasons. As a firm raises more and more new capital its *WACC* will likely increase due to an increase in supply relative to demand for the firm's securities. Furthermore, total flotation costs may increase as more capital is raised. Additionally, no firm has an unlimited supply of projects that will return more than the cost of capital, so the risk that new funds will be invested unprofitably increases.

We will see in the next chapter that these increases in the *WACC* play an important role in determining the firm's optimal capital budget. For the remainder of this chapter we will concentrate on determining the *WACC* at varying levels of total capital.

Finding the Break-Points

We can model a firm's marginal *WACC* curve with a *step function*. This type of function resembles a staircase when plotted. They are commonly used as a linear (though discontinuous) approximation to non-linear functions. The accuracy of the approximation improves as the number of steps increases.

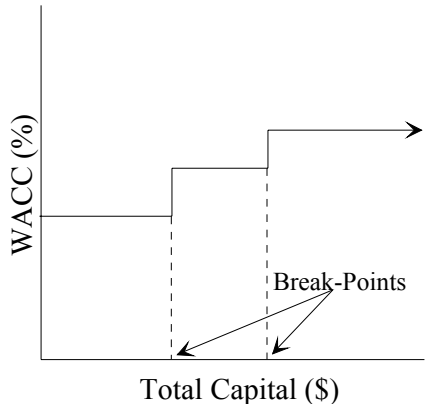
Estimating the marginal *WACC* (MCC) curve is a two step process:

1. Determine the levels of total capital at which the marginal *WACC* is expected to increase. These points are referred to as *break-points*.
2. Determine the marginal *WACC* at each break-point.

Figure 9-1 illustrates what a marginal *WACC* curve might look like for Rocky Mountain Motors. Notice that the break-points are measured in terms of dollars of

total capital. In this section we will estimate where these break-points are likely to occur and the *WACC* at the break-points.

FIGURE 9-1
THE MARGINAL *WACC* (MCC) CURVE AS A STEP FUNCTION



After consulting with their investment bankers, the managers of RMM have determined that they can raise new money at the costs indicated in Table 9-8. Open a new worksheet and enter the data from Table 9-8 beginning in cell A1. The percentages in the "% of Total" column should be referenced from the worksheet that was created for Exhibit 9-4.

TABLE 9-8
ROCKY MOUNTAIN MOTORS INFORMATION

Source	% of Total	Amounts Which Can Be Sold	Marginal After-Tax Cost
Common	60.25%	Up to 100,000	12.31%
		100,001 to 500,000	15.00%
		More than 500,000	17.00%
Preferred	8.61%	Up to 50,000	10.20%
		More than 50,000	13.00%
Debt	31.14%	Up to 250,000	7.10%
		More than 250,000	8.00%

Note that you should enter just the numbers from the "Amounts Which Can Be Sold" column. You can define custom formats, if desired, so the numbers are displayed with the text. This allows us to have the text, and still use the numbers for the calculations that follow. For example, you can format the first cell as `"Up to "#,##0` which will cause the number to be displayed as shown in the table. The second number (500,000) can be formatted with `"100,001 to "#,##0` so that it will display as shown.

RMM feels that its current capital structure is optimal, so any new money will be raised in the same percentages. For example, if the firm decides to raise $200,000 in total capital, then $120,500 (60.25% of $200,000) will come from common equity, $62,280 (31.14%) will be debt, and $17,220 (8.61%) will be preferred equity.

Using the information in Table 9-8, we can determine the break-points in RMM's marginal *WACC* curve. To do this, first realize that a break will occur wherever the cost of an individual source of capital changes (why?). There will be a break-point associated with the issuance of $100,000 in common stock, for example. But recall that break-points are measured in dollars of total capital. So the question is, "How do we convert this $100,000 in common stock into the amount of total capital?"

Since all of the capital will be raised in constant proportion, we can use the following equation:

$$\$ \text{ Total Capital} = \frac{\$ \text{ Common Stock}}{\% \text{ Common Stock}} \qquad \textbf{(9-5)}$$

In this case, we can see that if RMM raised $100,000 in new common stock, then they must have raised $165,973 in total capital. Using equation (9-5):

$$\$165{,}973 \approx \frac{\$100{,}000}{0.6025}$$

We can use this information to see that if RMM issued $100,000 in new common stock, then they must also have raised $51,684 ($= \$165{,}973 \times 0.3114$) in new debt, and $14,290 ($= \$165{,}973 \times 0.0861$) in new preferred.

To locate all of the break-points, all we need to do is find the points at which the cost of each source changes, and then convert those into dollars of total capital.

Table 9-9, using the information from Table 9-8, shows how to find these break-points.

TABLE 9-9
FINDING THE BREAK-POINTS IN RMM'S MARGINAL *WACC* CURVE

Source	Calculation	Break-Point
Common Stock	100,000/ 0.6025	$ 165,973
Common Stock	500,000/ 0.6025	$ 829,866
Preferred Stock	50,000/ 0.0861	$ 580,906
Debt	250,000/ 0.3114	$ 802,773

In your worksheet enter `Break-points` in cell E1. The first break-point is associated with the $100,000 level of new common stock. In E2, enter the formula `=C2/B$2`. The result is $165,973, exactly as we found in Table 9-9. Copy this formula to E3. In E5 the formula is: `=C5/B$5`. In E7 your formula will be: `=C7/$B$7`.

The next step is to determine the *WACC* at each of the break-points. To find the *WACC* we must convert each break-point into its components, and then determine the cost of each component. There are a number of ways we might approach this problem in the worksheet. Because we would ultimately like to generate a chart of the marginal *WACC*, we will set up a table which shows the amount of total capital, the cost of each component, and the *WACC* at that level of total capital.

Begin by entering the labels in A10:E10. In A10 enter: `Total Capital`. In B10: `Cost of Equity`. In C10: `Cost of Preferred`. In D10: `Cost of Debt`. In E10: `WACC`. Now, in A11:A36, enter a series from 0 to 2,500,000 in steps of 100,000. Use **E**dit F**i**ll **S**eries . . . from the menus, or AutoFill, to enter the series.

Next, we will determine the cost of each source for each level of total capital. In B11, we need to find the cost of equity at $0 of total capital. To facilitate later copying, we will set up a nested **IF** statement. In this case, the formula is: `=IF(A11*$B$2<=$C$2,$D$2,IF(A11*$B$2<=$C$3,$D$3,$D$4))`. In words, this formula says: "If the amount of total capital (in A11) times the percentage of common stock (B2) is less than or equal to $100,000 (C2) then the cost is 12.31% (D2). Otherwise, if the amount is less than or equal to $500,000 then the cost is 15% (D3). Otherwise, the cost is 17% (D4)."

We use similar, but less complicated, formulas to determine the cost of preferred stock and debt at each level of total capital. For preferred stock, enter the formula: `=IF(A11*$B$5<=$C$5,$D$5,$D$6)` into C11. In D11 enter the formula: `=IF(A11*$B$7<=$C$7,$D$7,$D$8)` to determine the appropriate cost of debt.

Finally, we can calculate the marginal weighted average cost of capital (in E11), with the formula: `=$B$2*B11+$B$5*C11+$B$7*D11`. This formula calculates a weighted average of the costs which were calculated in B11:D11. Make sure that you have entered the formulas exactly as given, and then copy them down through each row to row 36.

We can create the chart of the marginal *WACC* by selecting A10:A36 and E10:E36 and then using the Chart Wizard to create an XY scatter chart.[9] Your worksheet should appear like that in Exhibit 9-5.

Note that in Exhibit 9-5 we have placed the chart on top of the data to save space. Also, the chart does not depict a perfect step function, as shown in Figure 9-1. With a little trick, we can easily change this chart into a perfect step function.

First, realize that we want the line to be perfectly vertical at each break-point. In order to do that, we must have two Y-values (*WACC*) corresponding to that particular X-value (amount of total capital). In addition, we must have the exact breakpoints in our charted data series. The first break-point is that caused by the increase in the cost of new common equity at a total capital level of $165,973. To enter this data point into the chart, select rows 13 and 14 and then choose **I**nsert **R**ows. Now, in A13 enter `=E2`, and in A14 enter `=E2+0.01`.[10] Now copy B12:E12 to B13:E14. We now have two entries for the break-point, and the chart looks exactly right up to the first break-point. Repeat these steps with the other three break-points, and then your chart should look like the one in Exhibit 9-6.

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9. The most common error in making this type of chart correctly is choosing the wrong type of XY scatter chart. Choose the type illustrated in the lower-right corner of the samples on the Chart Wizard's Chart Type dialog box. If you choose an XY chart with smoothed lines, the result will be anything but smooth. Also note that you will not get a good step function using a line chart.

10. This very slight (0.01) increase in the break-point is required to cause the cost of capital to change to the next higher level. The increase is slight enough that the line will appear to be vertical.

EXHIBIT 9-5
MARGINAL *WACC* WORKSHEET FOR RMM

	A	B	C	D	E
1	**Source**	**% of Total**	**Max Level**	**After-tax Cost**	**Break-points**
2	Common	60.25%	100,000	12.31%	165,973
3			500,000	15.00%	829,866
4			500,000	17.00%	
5	Preferred	8.61%	50,000	10.20%	580,906
6			50,000	13.00%	
7	Debt	31.14%	250,000	7.10%	802,773
8			250,000	8.00%	
9					
10	**Total Capital**	**Cost of Equity**	**Cost of Preferred**	**Cost of Debt**	**WACC**
11	0	12.31%	10.20%	7.10%	10.51%
12	100,000	12.31%	10.20%	7.10%	10.51%
13	200,000	15.00%	10.20%	7.10%	12.13%
14	300,000	15.00%	10.20%	7.10%	12.13%
15					
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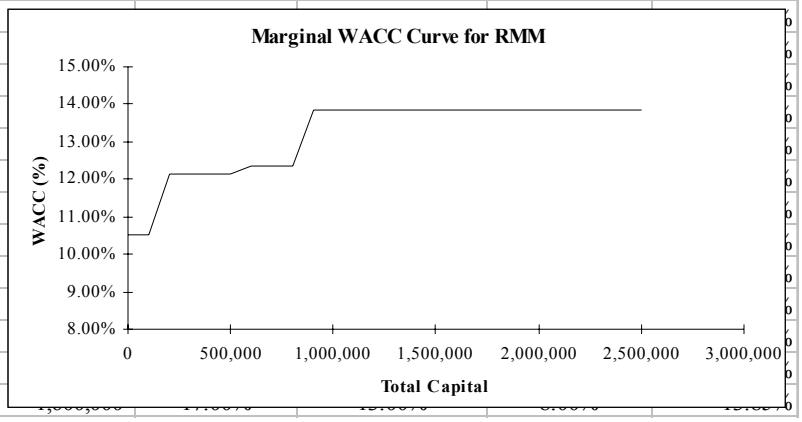
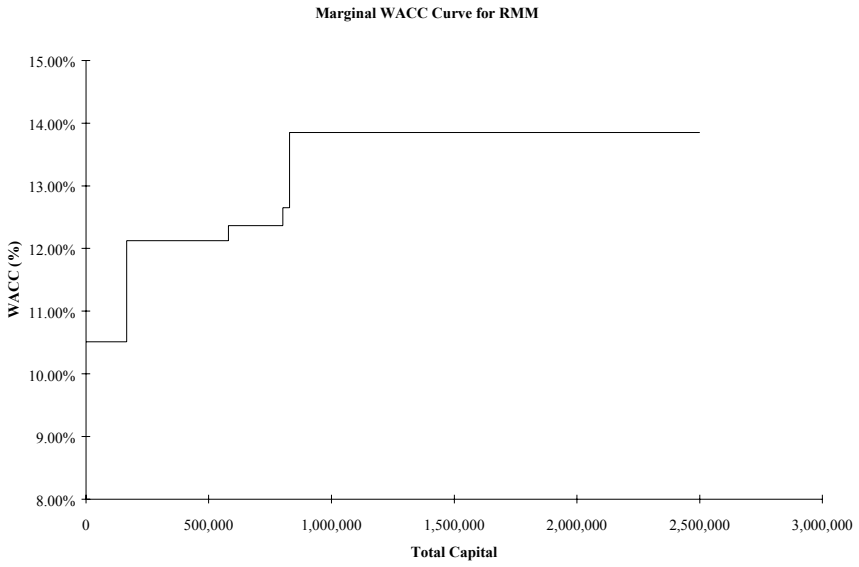


EXHIBIT 9-6
THE MCC AS A PERFECT STEP FUNCTION



Summary

We began this chapter with a discussion of the appropriate required rate of return to use in the evaluation of a company's scarce capital resources. We demonstrated that a weighted average of the cost of each source of capital would be sufficient to simultaneously satisfy the providers of capital. In addition, we showed that the costs of the sources of capital can be found by simply inverting the valuation equations from Chapter 8 and including flotation costs. Finally, we saw that the firm's marginal weighted average cost of capital changes as the amount of total capital changes. We showed how to determine the location of the break-points and how to plot the marginal *WACC* curve.

TABLE 9-10
FUNCTIONS INTRODUCED IN THIS CHAPTER

Purpose	Function	Page
Determine the yield to maturity for an annuity or bond	**RATE(*NPER*, *PMT*, *PV*, *FV*, *TYPE*, *GUESS*)**	265

Problems

1. TRM Consulting Services currently has the following capital structure:

Source	Book Value	Quantity
Common Stock	$4,200,000	240,000
Preferred Stock	$250,000	2,500
Debt	$3,100,000	3,100

Debt is represented by 15 year original maturity bonds, issued 5 years ago with a coupon rate of 9%, which are currently selling for $945. The bonds pay interest semiannually. The preferred stock pays an $11 dividend annually, and is currently valued at $125 per share. Flotation costs on debt and preferred equity are negligible and can be ignored, but they will be 8% of the selling price for common stock. The common stock, which can be bought for $41.50, has experienced a 7% annual growth rate in dividends and is expected to pay a $1.25 dividend next year. In addition, the firm expects to have $200,000 of retained earnings. Assume that TRM's marginal tax rate is 35%.

   a. Set up a worksheet with all of the data from the problem in a well-organized input area.

   b. Calculate the book-value weights for each source of capital.

   c. Calculate the market value weights for each source of capital.

d. Calculate the component costs of capital (i.e., debt, preferred equity, retained earnings, and new common equity).

e. Calculate the weighted average costs of capital using both the market value and book value weights.

2. Suppose that TRM Consulting Services has discussed its need for capital with its investment bankers. The bankers have estimated that TRM can raise new funds in the capital markets under the following conditions:

Source	Range	After-Tax Cost
Retained Earnings	Up to 200,000	10.01%
Common Equity	Up to 1,000,000	10.27%
	1,000,001 to 3,000,000	10.75%
	More than 3,000,000	11.25%
Preferred Equity	Up to 200,000	8.80%
	More than 200,000	9.10%
Debt	Up to 1,000,000	6.43%
	1,000,001 to 2,000,000	6.75%
	More than 2,000,000	7.00%

a. Using the information developed in the previous problem, calculate each of the break-points. Don't forget to include the break-point due to retained earnings.

b. Create a chart of TRM's marginal weighted average cost of capital curve using the market value weights. Make sure that it is a perfect step function.

Internet Exercise

1. Using the Yahoo! Finance Web site (http://quote.yahoo.com) get the current price and five-year dividend history for PPG Industries, Inc. (NYSE: PPG). Use the same procedure as in the

Internet Exercise of Chapter 8 to gather this data. In addition, get the beta for PPG from its profile page on Yahoo! Finance, and the five-year U.S. Treasury yield (ticker: ^FVX). Note that you will need to divide the index value by 10 to get the yield.

a. Calculate the annualized dividend growth rate from the five-year dividend history using the same procedure as in Chapter 8.

b. Using the stock's current price, dividend, and growth rate calculate the cost of retained earnings for PPG.

c. Assuming that the average market return over the next five years will be 12%, calculate the cost of retained earnings using the *CAPM*. Use the actual beta and five-year Treasury yield (risk-free rate) in the model.

d. To get your final estimate of the cost of retained earnings, simply average the results from parts b and c.

10 *Capital Budgeting*

After studying this chapter, you should be able to:

1. *Identify the relevant cash flows in capital budgeting.*
2. *Demonstrate the use of Excel in calculating the after-tax cash flows used as inputs to the various decision making techniques.*
3. *Compare and contrast the six major capital budgeting decision techniques (payback period, discounted payback, NPV, PI, IRR, and MIRR).*
4. *Explain scenario analysis, and show how it can be done in Excel.*
5. *Use Excel's Solver to determine the firm's optimal capital budget under capital rationing.*

Capital budgeting is the term used to describe the process of determining how a firm should allocate scarce capital resources to available long-term investment opportunities. Some of these opportunities are expected to be profitable, while others are not. Inasmuch as the goal of the firm is to maximize shareholder's wealth, the financial manager is responsible for selecting only those investments that are expected to increase shareholder wealth.

The techniques that you will learn in this chapter have wide applicability beyond corporate asset management. Lease analysis, bond refunding decisions, mergers

and acquisition analysis, corporate restructuring, and new product decisions are all examples of where these techniques are used. On a more personal level, decisions regarding mortgage refinancing, renting versus buying, and choosing a credit card are but a few examples of where these techniques are useful.

On the surface, capital budgeting decisions are simple. If the benefits exceed the costs the project should be accepted, otherwise it should be rejected. Unfortunately, quantifying costs and benefits is not always straightforward. We will examine this process in this chapter and extend it to decision making under conditions of uncertainty in the next.

Estimating the Cash Flows

Before we can determine whether an investment will increase shareholder wealth or not, we need to estimate the cash flows that it will generate. While this is usually easier said than done, there are some general guidelines to keep in mind. There are two important conditions that a cash flow must meet in order to be included in our analysis.

The cash flows must be:

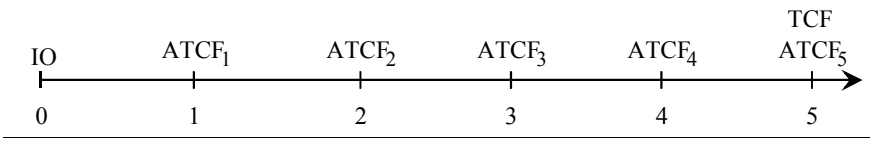
1. ***Incremental*** – The cash flows must be in addition to those that the firm already has. For example, a firm may be considering an addition to an existing product line. But the new product may cause some current customers to switch from another of the firm's products. We must in this case consider both the cash flow increase from the new product and the cash flow decrease from the existing product. In other words, only the net new cash flows are considered.
2. ***After-tax*** – The cash flows must be considered on an after-tax basis. The shareholders are not concerned with before-tax cash flows because they can't be reinvested or paid out as dividends until the taxes have been paid.

But we should disregard cash flows which are:

1. ***Sunk costs*** – These are cash flows which have occurred in the past and cannot be recovered. Since value is defined as the present value of the expected *future* cash flows, we are only concerned with the future cash flows. Therefore, sunk costs are irrelevant for capital budgeting purposes.
2. ***Financing costs*** – The cost of financing is obviously important in the analysis, but it will be implicitly included in the discount rate used to evaluate the profitability of the project. Explicitly including the dollar amount of financing costs (e.g., extra interest expense) would amount to double counting. For example, suppose that you discovered an investment which promised a sure 15% return. If you could borrow money at 10% to finance the purchase of this investment, it obviously makes sense because you will earn 5% over your cost. Notice that the dollar interest cost is implicitly included, because you must earn at least 10% to cover your financing costs.

With these points in mind we can move on to discuss the estimation of the relevant cash flows. We will classify all cash flows as a part of one of the three groups illustrated in Figure 10-1.

FIGURE 10-1
TIMELINE ILLUSTRATING PROJECT CASH FLOWS



The Initial Outlay

The *initial outlay* (abbreviated IO in Figure 10-1) represents the net cost of the project. Though we will presume that the initial outlay occurs at time period 0 (today), there are many cases, perhaps most, in which the cost of a project is spread out over several periods. For example, the contractor in large construction projects is usually paid some percentage up-front, with additional monies being paid as the project reaches various stages of completion. Furthermore, there is usually some delay between the analysis phase of a project and its implementation. So to be technically correct, the initial outlay actually occurs over some near-term future time period.

The initial outlay is comprised of several cash flows. It is impossible to enumerate all of the components for all possible projects, but we will provide some basic principles. The most obvious is the cash outlay required to purchase the project. The price of a piece of machinery or of a building are obvious examples. There are other components however. Any shipping expenses, labor costs to install machinery, or employee training costs should be included. Together, the costs to get a project up and running are referred to as the *depreciable base* for the project because this is the amount which we will depreciate over the life of the project.

There may also be cash flows which serve to reduce the initial outlay. For example, in a replacement decision (e.g., replacing an existing machine with a newer model) there is often some salvage value for the old machine. This amount will be deducted from the initial outlay. However, there may be taxes associated with the sale. Whenever an asset is sold for an amount that differs from its book value there are tax consequences. If an asset is sold for more than its book value tax is owed on the difference. If it is sold for less than book value, the difference is used to offset the firm's taxable income thus resulting in a tax savings. These extra taxes (tax savings) will increase (decrease) the initial outlay.

Finally, there may be costs which are not at all obvious. For example, suppose that a company is considering an investment in a new machine which is substantially faster than the older model currently being used. Because of the extra speed, the company may find that it needs to increase its investment in raw materials. The cost of these extra raw materials should be included as an increase in the initial outlay because they would not be purchased unless the project is undertaken. This cost is referred to as the increase in net working capital.

The calculation of the initial outlay can be summarized by the following equation:

IO = Price of Project + Shipping + Installation + Training – (Salvage Value – Additional Taxes) + Change in Net Working Capital

The Annual After-Tax Cash Flows

Calculating the initial outlay, as complicated as it may appear, is relatively easy compared with accurately calculating the annual after-tax cash flows. The reason is that we really can't be sure of the cash flows in the future. For the time being, we will assume that we do know exactly what the future cash flows will be, and in the next chapter we will consider the complications of uncertainty.

Generally, the annual after-tax cash flows are made up of four components, but not necessarily all four:

1. ***Additional Revenue*** – New products, and sometimes production processes, can lead to net new revenue. Remember that we must consider only the incremental revenues.
2. ***Cost savings*** – There may be some savings which will accompany the acceptance of a project. For example, the firm may decide to replace a manually operated machine with a fully automated version. Part of the savings would be the salary and benefits of the operators of the old machine. Other savings might come from lower maintenance costs, lower power consumption, or fewer defects.
3. ***Additional expenses*** – Instead of purchasing a fully automated machine, the firm might opt for a process which is more labor intensive. This would allow the company more flexibility to adjust to changes in the market, but the extra labor costs must be considered when determining the cash flows.
4. ***Additional depreciation benefits*** – Whenever the asset mix of the firm changes, there is likely to be a change in the amount of depreciation expense. Since depreciation expense is a non-cash expense that serves to reduce taxes, we need to consider the tax savings, or extra taxes, due to depreciation.

We must be careful to remember that the only relevant cash flows are those that are after-tax and incremental. Keeping this in mind, we can summarize the calculation of the after-tax cash flows as follows:

$$\begin{aligned}\text{ATCF} = &(\Delta\text{Revenues} + \text{Savings} - \text{Expenses}) \times (1 - \text{marginal tax rate}) + \\ &(\Delta\ \text{Depreciation} \times \text{marginal tax rate})\end{aligned}$$

The Terminal Cash Flow

The terminal cash flow consists of those non-operating cash flow events which occur only in the final time period of the project. Normally, there will also be operating cash flows that occur during this period, but we have categorized those as the final period after-tax cash flows. The terminal cash flow will consist of things such as the expected salvage value of the new machine, any tax effects associated with the sale of the machine, recovery of any investment in net working capital, and perhaps some shut-down costs.

TCF = Recovery of NWC – (Shut-down Expenses × (1 – marginal tax rate)) + Salvage Value – ((Salvage Value – Book Value) × marginal tax rate)

Estimating the Cash Flows: An Example

Throughout this chapter we will demonstrate the concepts with the following example.

> The Supreme Shoe Company is considering the purchase of a new, fully automated machine to replace a manually operated one. The machine being replaced, now five years old, originally had an expected life of ten years, is being depreciated using the straight line method from $40,000 down to $0, and can now be sold for $22,000. It takes one person to operate the machine and he earns $29,000 per year in salary and benefits. The annual costs of maintenance and defects on the old machine are $6,000 and $4,000, respectively. The replacement machine being considered has a purchase price of $75,000 and an expected salvage value of $15,000 at the end of its five year life. There will also be shipping and installation expenses of $6,000. Because the new machine would work faster, investment in raw materials would increase by a total of $3,000. The company expects that annual maintenance costs on the new machine will be $5,000 while defects will cost $2,000. Before considering this project the company undertook an engineering analysis of current facilities to determine if other changes would be necessitated by the purchase of this machine. The study cost the company $5,000 and determined that existing facilities could support this new machine with no other changes. In order to purchase the new machine, the company would have to take on new debt of $30,000 at 10% interest, resulting in increased interest expense of $3,000 per year. The required rate of return for this project is 15% and the company's marginal tax rate is 34%. Furthermore, management has determined that the maximum allowable time to recover its investment is three years. Is this project acceptable?

For this type of problem, it is generally easiest to separate the important data from the text. This is true regardless of whether you are doing problems by hand or with a spreadsheet program. Of course, a spreadsheet offers many advantages that we

will examine later. For now, open a new worksheet and enter the data displayed in Exhibit 10-1.

Notice that in creating Exhibit 10-1 we have simply listed all of the relevant data from the Supreme Shoe problem. There are also some minor calculations entered. Remember, it is important that you set up your worksheets so that Excel does all of the possible calculations for you. This will allow us to more easily experiment with different values (i.e., perform a "what-if" analysis) later.

EXHIBIT 10-1
RELEVANT CASH FLOWS FOR SUPREME SHOE

	A	B	C	D
1	**The Supreme Shoe Company**			
2	**Replacement Analysis**			
3		*Old Machine*	*New Machine*	*Difference*
4	Price	40,000	75,000	
5	Shipping and Install	0	6,000	
6	Original Life	10	5	
7	Current Life	5	5	
8	Original Salvage Value	0	15,000	
9	Current Salvage Value	22,000	0	
10	Book Value	20,000	81,000	
11	Increase in Raw Materials	0	3,000	
12	Depreciation	4,000	13,200	(9,200)
13	Salaries	29,000		29,000
14	Maintenance	6,000	5,000	1,000
15	Defects	4,000	2,000	2,000
16	Marginal Tax Rate	34.00%		
17	Required Return	15.00%		

We have left the cost of the engineering study out of our model. Because the $5,000 was spent before our analysis it is considered to be a sunk cost. That is, there is no way to recover that money, especially if we reject the project, so it is irrelevant to any future decisions. Adding this to the cost of the project would unnecessarily penalize the project. Furthermore, we haven't considered the $3,000 in extra interest expense that will be incurred each year. The money spent to finance a project must be ignored because we will account for it in the required return. In addition, Supreme Shoe has decided to take on the debt for 10 years which is longer than the expected life of the new machine. Therefore it wouldn't be correct to apply all of the interest expense to this one project.

With this in mind, the first calculation is depreciation. Supreme Shoe uses the straight-line method for analysis purposes. Straight-line depreciation applies depreciation equally throughout the expected useful life of the project, and is calculated as follows:[1]

$$\frac{\text{Depreciable Base} - \text{Salvage Value}}{\text{Useful Life}}$$

Excel has built-in functions for calculating depreciation in five different ways: straight-line (**SLN**), double-declining balance (**DDB**), fixed-declining balance (**DB**), sum of the years' digits (**SYD**), and variably-declining balance (**VDB**). The **VDB** function is interesting because it allows you to specify the rate at which the asset value declines, and whether to switch to straight-line when that method leads to higher depreciation. Since Supreme Shoe uses the straight-line method, we will use the **SLN** function which is defined as:

SLN(*COST*, *SALVAGE*, *LIFE*)

where ***COST*** is the depreciable base of the asset, ***SALVAGE*** is the estimated salvage value, and ***LIFE*** is the number of years over which the asset is to be depreciated.

Recall that the depreciable base includes the price of the asset plus the shipping and installation costs. For the old machine, then, in cell B12 insert: `=SLN(B4+B5, B8,B6)`. Because the annual depreciation will be calculated the same way for the new machine, simply copy the formula in B12 to C12.

We calculate the book value of the current machine in B10 because the book value and the salvage value together will determine the tax liability from the sale of this machine. Book value is calculated as the difference between the depreciable base and the accumulated depreciation. In this instance, the depreciable base is found by adding B4 and B5. The accumulated depreciation is the annual depreciation expense times the number of years of the original life that have passed. In our worksheet this is B12*(B6–B7). So the formula in B10 is: `=B4+B5-B12*(B6-B7)`. Just for informational purposes copy the formula to C10.

The difference column presents the savings that the new machine will provide. The formulas are simply the difference between the expenses of the current machine and those of the proposed machine. In D12 place the formula: `=B12-C12` and

1. Some finance textbooks use a form of straight-line depreciation referred to as "simplified straight-line" which assumes that the salvage value is always zero.

then copy it to cells D13:D15. To avoid confusion, we only calculate differences for the relevant cells. Your worksheet should now resemble Exhibit 10-1 (page 287).

Now that the data are more clearly presented we can calculate the relevant cash flows. The initial outlay consists of the price of the new machine, the shipping and installation costs, and the salvage value of the old machine and any taxes that might be due from that sale. We will calculate the initial outlay in B19 as: `=-(C4+C5-B9+(B9-B10)*B16+C11)`. The formula is less complex than it looks. The first three terms simply represent the total cost of the new machine minus the salvage value of the old machine. The next part of the formula calculates the tax that is due on the sale of the old machine. Notice that if the book value were less than the salvage value this formula will add a negative value thus reducing the initial outlay. Again, it is important that you construct the worksheet formulas so that any changes are automatically reflected in the calculated values. Finally, we add the increased investment in raw materials because this investment would not be necessary unless the new machine were purchased.

Next we need to calculate the annual after-tax cash flows for this project. We will separate the calculation of the depreciation tax benefit from the other cash flows because it is informative to see the savings generated by the increased depreciation (also because, as we will see in the next chapter, the depreciation tax benefit is a less risky cash flow than the others). In B20 we calculate the annual after-tax savings as: `=SUM(D13:D15)*(1-B16)`. We have used the **SUM** function because it is more compact than simply adding the three cell addresses individually. Also, if we later discover any other savings (or extra costs) we can insert them into the range and the formula will automatically reflect the change. Note that this project will not have any impact on overall revenues.

The depreciation tax benefit represents the savings in taxes that we will have because of the extra depreciation expense. Remember that depreciation is a non-cash expense so that the only result of increasing depreciation is to reduce taxes and thereby increase cash flow. To calculate the depreciation tax benefit in cell B21 enter the formula: `=-D12*B16`. We make the depreciation amount negative because the change in depreciation in D12 is negative (indicating extra expense). In B22 we total the annual after-tax savings and the depreciation tax benefit with the formula: `=SUM(B20:B21)`.

Finally, the terminal cash flow consists of any non-operating cash flows which occur only in the final period. For the Supreme Shoe project, the additional cash flows are the after-tax salvage value and the recovery of the investment in raw

materials. In this case, there is no tax consequence of salvaging the machine for $15,000 because that is the same as the book value. The formula in B23 is: `=C11+C8`. Don't forget that the terminal cash flow is only a part of the total cash flow in year 5. We will have to add on the annual after-tax cash flow (operating cash flows) in year 5 before analyzing the profitability of the project.

At this point, your worksheet should resemble the one pictured in Exhibit 10-2.

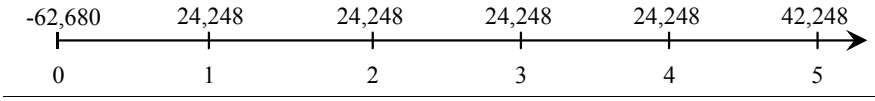
EXHIBIT 10-2
CASH FLOWS FOR SUPREME SHOE

	A	B	C	D
1	**The Supreme Shoe Company**			
2	**Replacement Analysis**			
3		*Old Machine*	*New Machine*	*Difference*
4	Price	40,000	75,000	
5	Shipping and Install	0	6,000	
6	Original Life	10	5	
7	Current Life	5	5	
8	Original Salvage Value	0	15,000	
9	Current Salvage Value	22,000	0	
10	Book Value	20,000	81,000	
11	Increase in Raw Materials	0	3,000	
12	Depreciation	4,000	13,200	(9,200)
13	Salaries	29,000		29,000
14	Maintenance	6,000	5,000	1,000
15	Defects	4,000	2,000	2,000
16	Marginal Tax Rate	34.00%		
17	Required Return	15.00%		
18	**Cash Flows**			
19	Initial Outlay	(62,680)		
20	Annual After-Tax Savings	21,120		
21	Depreciation Tax Benefit	3,128		
22	Total ATCF	24,248		
23	Terminal Cash Flow	18,000		

Making the Decision

We are now ready to make a decision as to the profitability of this project. Financial managers have a number of tools at their disposal to evaluate profitability. We will examine six of these. Before beginning the analysis, examine the time line presented in Figure 10-2 which summarizes the cash flows for the Supreme Shoe replacement decision.

FIGURE 10-2
TIME LINE FOR THE SUPREME SHOE REPLACEMENT DECISION



The Payback Method

The payback method answers the question, "How long will it take to recoup our initial investment?" If the answer is less than or equal to the maximum allowable period, the project is considered to be acceptable. If the payback period is longer than acceptable, then the project is rejected. Note that the payback period serves as a kind of break-even period, and thus provides some information regarding the liquidity of the project under analysis.

There are two ways to calculate the payback period. The easiest method, which we can use for the Supreme Shoe problem, is used when the cash flows are an annuity. To calculate the payback for these types of cash flows, simply divide the initial outlay by the annuity payment:

$$\text{Payback Period} = \frac{\text{Initial Outlay}}{\text{Annuity Payment}}$$

For Supreme Shoe, the cash flows are not strictly an annuity, except for the first four years. If the payback period is less than four years then we can use this method. For this project the payback period is calculated as:

$$\text{Payback Period} = \frac{62{,}680}{24{,}248} = 2.58 \text{ years}$$

Because Supreme Shoe requires that projects have a maximum payback period of three years, the replacement machine is acceptable by this criteria. In A25, enter

the label: `Payback Period` and in B25 enter the formula: `=-B19/B22`. Your result should be 2.58 years.

An alternative way to calculate the payback period subtracts the cash flows from the initial outlay until the outlay is recovered. This method is much easier to demonstrate than to describe. So let's look at the Supreme Shoe problem using this method. Table 10-1 illustrates this procedure.

TABLE 10-1
CALCULATING THE PAYBACK PERIOD

	Calculation	Comments	Cumulative Payback
	62,680	Initial outlay	
–	24,248	minus first cash flow	1 year
=	38,432	left to be recovered	
–	24,248	minus second cash flow	2 years
=	14,184	left to be recovered	2 years < payback < 3 years

At this point we know that the payback period must be between two and three years, and that the remainder will be recovered during the third year. Assuming that the cash flow in year 3 is evenly spread out through the year, we can simply divide the amount yet to be recovered by the cash flow in year 3 to arrive at the fraction of the year required to recover this amount. In this case, it will take 0.58 years (= 14,184 ÷ 24,248) to recover the remainder. Add this to the two years that we have already counted, and we arrive at 2.58 years, exactly as before. Note that when the project's cash flows are not an annuity, this is the method that must be used to calculate the payback period.

While the payback period makes a great deal of sense intuitively, it is not without its problems. Specifically, the principal problem is that the payback method ignores the time value of money. You know, from the discussion of time value in Chapter 7, that we cannot simply add cash flows which occur in different time periods. Furthermore, it should be obvious that most investments become increasingly more (less) attractive as the firm's *WACC* falls (rises). However, the payback period doesn't change when the *WACC* changes. We will address this problem shortly.

A second difficulty with the payback period is that it does not take all of the cash flows into account. Because it ignores all cash flows beyond the payback period, it

can lead to less than optimal decisions. Suppose, for example, that the year 5 cash flow for the Supreme Shoe project was $–100,000 instead of $42,248. The payback period is still 2.58 years which suggests that it should be accepted, but anybody taking even a cursory look at the cash flows would reject the project immediately. This second problem will be remedied when we look at the *NPV*, *PI*, *IRR*, and *MIRR* techniques.

The Discounted Payback Period

We can remedy the time value problem with the discounted payback period. This method is identical to the regular payback period, except that we use the present value of the cash flows instead of the nominal values. Because present values are always less than nominal values, the discounted payback period will always be longer than the regular payback period.

For Supreme Shoe, the discounted payback period is 3.53 years. Calculating this number is slightly more difficult than calculating the regular payback period because the present values of the cash flows are different in each period. For this reason we must use the second method to calculate the discounted payback period.[2] Since Excel does not have a payback function we have included one in the workbook named FameFncs.xls. Writing macros is beyond the scope of this text, so we will not discuss the macro in detail. Before continuing with this example make sure that the FameFncs.xls workbook is open.[3] This workbook contains a function macro called **FAME_PAYBACK** which can be used exactly like any other built-in function, as long as the workbook is open. The function is defined as:

FAMEFNCS.XLS!FAME_PAYBACK(*CASHFLOWS*, *RATE*)

where ***CASHFLOWS*** is a contiguous range of cash flows, and *RATE* is the optional discount rate to be used to calculate the present values of the cash flows. If *RATE* is left out, the default discount rate is 0% so this function will calculate the regular

2. In the case where all of the nominal cash flows are equal (an annuity) we could use the **NPER** function. This function calculates the number of periods that an annuity must pay to have the present value of the cash flows be equal to the price. We can also use this function to calculate the regular payback period for an annuity if we set the discount rate to zero.
3. To open the workbook just choose **F**ile **O**pen and select the file from wherever you last saved it or the product support Web site, http://mayes.swlearning.com. This workbook is just like any other workbook, except that it has some macros programmed into it. Excel macros are available for use on any worksheet as long as the workbook containing them is opened.

payback period. Be aware that the initial outlay (i.e., the first cash flow in the list) must be negative, or else you will get unpredictable results. All other cash flows may be either positive or negative.

Before using the **FAME_PAYBACK** macro, and the other functions that we will be using later, we need to set up a table of cash flows. In cells C18:D24 set up the following table:

EXHIBIT 10-3
CASH FLOWS FOR CALCULATING THE DISCOUNTED PAYBACK PERIOD

	C	D
18	Period	Cash Flows
19	0	(62,680)
20	1	24,248
21	2	24,248
22	3	24,248
23	4	24,248
24	5	42,248

In order to set up the table in Exhibit 10-3 very little data input is required since most of the data already exists or can be calculated. Start by typing the column labels in cells C18 and D18. To enter the period numbers, in cell C19 type a zero and then select the range C19:C24. From the **E**dit menu select F**i**ll **S**eries and click on OK when the dialog box appears (the default options should work fine). This command will enter a series of numbers starting with the first number in the selected range. It can be very helpful in situations where you need a list of consecutive numbers or dates.

The cash flows are most easily entered by using references to the cells where the original calculations exist. Entering the numbers in this way, rather than retyping them, will later allow us to experiment with various scenarios. In cell D19 enter: `=B19` to capture the initial outlay. In cell D20 we need the first cash flow, so enter: `=B$22`. Note that the dollar sign will freeze the cell reference so that it will remain at row 22 when we copy it. Copy the formula from D20 to the range D21:D23, and note that the value is the same in each cell as it was in D20. Finally, to get the last year's cash flow in D24 enter: `=B22+B23`.

Now that the table of cash flows is set up, calculating the discounted payback period is a simple matter. In cell B26 enter the formula: `=FameFncs.xls!Fame_Payback(D19:D24,B17)`.[4] The discounted payback period is 3.53 years which is longer than the maximum acceptable payback. You should verify this result by hand.

Using the three-year benchmark in this case would be incorrect, since it was presumably determined under the assumptions of the regular payback period. Some allowance must be made for the fact that the discounted payback period will always be greater than the regular payback period. Suppose then that management decides that the discounted payback must be 3.75 years or less to be acceptable. With the new criteria, the project is acceptable under both payback methods.

However, the benefit of the discounted payback period technique is that the acceptability of a project will change as required returns change. If the required return should rise to 18%, the discounted payback period will rise to 3.80 years and the project would be rejected. Since the regular payback period ignores the time value of money it would still suggest that the project is acceptable, regardless of the required return. Try changing the required return in B17 to verify this for yourself.

Note that the discounted payback period still ignores cash flows beyond the period where payback is achieved. All of the remaining techniques that we will introduce are considered to be superior because they recognize the time value of money and all of the cash flows are considered in the analysis.

Net Present Value

Neither the regular payback period nor the discounted payback period are economically correct decision criteria. Even with the discounted payback method we are ignoring cash flows beyond the payback period. How then can the financial analyst make the correct decision? In this section we will cover the net present value technique.

Most people would agree that purchasing an asset for less than its value is a good deal. Further, purchasing an asset for exactly its value isn't bad. What most people try to avoid is purchasing an asset for more than its value.[5] If we define value as

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4. You can also enter this function, just like any built-in function, using the Insert Function dialog box. Select the User Defined category and you'll see it in the list.
5. Theoretically, nobody would ever purchase an asset for more than it is worth to them at the time the decision is made. Purchasing an asset proves, *ipso facto*, that the cost is, at most, equal to the value to that individual at that moment.

the present value of future cash flows (see Chapter 8), then net present value (*NPV*) represents the excess value captured by purchasing an asset. More specifically:

$$NPV = PVCF - IO = Value - Cost$$

or more mathematically:

$$NPV = \sum_{t=1}^{N} \frac{ATCF_t}{(1+i)^t} - IO \qquad \textbf{(10-1)}$$

There are a couple of important things to note about the *NPV*. Most importantly, since value can be greater than, equal to, or less than cost, the *NPV* can be greater than, equal to, or less than zero. If the value is less than the cost, the *NPV* will be less than zero, and the project will be rejected. Otherwise, the project will be accepted because the value is greater than (or equal to) the cost. In the latter case, the wealth of the shareholders will be increased (or at least unchanged) by the acceptance of the project. So *NPV* really represents the change in shareholder wealth that accompanies the acceptance of an investment. Since the goal of management is to maximize shareholder wealth, they must accept all projects where the *NPV* is greater than or equal to zero.

Why does *NPV* represent a change in shareholder wealth? To see this important point, remember that any cash flows in excess of expenses accrue to the common stockholders of the firm. Therefore, any project which generates cash flows sufficient to cover its costs will result in an increase in shareholder wealth.[6] Consider the following example:

> Huey and Louie are considering the purchase of a lemonade stand which will operate during the summer months. It will cost them $100 to build and operate the stand. Since they only have $50 of their own (common equity) they will need to raise the additional capital elsewhere. Huey's father agrees to loan the pair $30 (debt), with the understanding that they will repay him a total of $33 at the end of the summer. The other $20 can be

6. It is important to note that we are talking about the economic costs, not just the accounting costs. In particular, economists consider the cost of the equity and any other opportunity costs. Accounting costs ignore the cost of equity and other opportunity costs. Therefore, *NPV* is the same thing as the *economic profit* generated by the project.

raised in a preferred stock offering to several of the other kids in the neighborhood. The preferred stock is sold with the promise to pay a five dollar dividend, if possible, at the end of the summer. Huey and Louie would have to earn at least $10 in order to compensate them for their time, effort, and money invested. Assuming that the stand will be demolished at the end of the summer, should they undertake this project?

The answer to this question depends on the cash flows that Huey and Louie expect the lemonade stand to generate. The three scenarios in Table 10-2 will demonstrate the possibilities:

TABLE 10-2
POSSIBLE SCENARIOS FOR THE LEMONADE STAND

	Scenario 1	Scenario 2	Scenario 3
Total cash inflow after operating expenses	$118	$130	$110
Less cost of debt	(33)	(33)	(33)
Less cost of preferred stock	(25)	(25)	(25)
Less cost of common equity	(60)	(60)	(60)
Remainder to common stockholders (*NPV*)	0	12	-8

For this example, we have purposely ignored taxes to concentrate on the definition of net present value. Notice that the required returns of each of the stakeholders is unchanged in each scenario. The only variable is the cash inflow after operating expenses. In the first scenario all of the stakeholders are exactly satisfied, even Huey and Louie get the $10 return that they have demanded. Therefore, the project is acceptable, and it has a net present value of zero (as indicated by the remainder). Under the second scenario, everybody is satisfied and there is an extra $12 which goes directly to Huey and Louie (the shareholders). This is an example of a positive *NPV*. Finally, under scenario 3, the debtholder and the preferred stockholders are satisfied, but there is a shortfall of $8 which will reduce Huey and Louie's return to only $2. Notice that in the last case, the return to the common stockholders is positive (i.e., they do make money), but less than required. This is an example of a negative *NPV* and will cause Huey and Louie to reject the project.

Returning now to our Supreme Shoe example, the *NPV* of this project can be determined by taking the present value of the after-tax cash flows and subtracting

the initial outlay. In this case, performing the calculations by hand poses no great difficulty. However, Excel can calculate the *NPV* just as easily and allow us to experiment. You have already made use of the built-in **NPV** function in Chapter 7. At that point, we did not make clear the misleading nature of this function. It does not really calculate the NPV as we defined it. Instead, it simply calculates the sum of present values of the cash flows as of one period before the first cash flow. It is vitally important that you understand this point before using this function.

To use the **NPV** function for this problem, insert: `=NPV(B17,D20:D24)+B19` into B27. Note that we do *not* include the initial outlay in the range used in the **NPV** function. Instead, we use the **NPV** function to determine the present value of the cash flows and then add the (negative) initial outlay to this result. The net present value is shown to be $27,552.24, so the project is acceptable. An alternative method is to include the initial outlay and then adjust the result. In this case, the present value would be as of time period –1, so multiplying by $(1 + i)$ will bring it to time period 0. The alternative, then, is to place the formula: `=NPV(B17,D19:D24)*(1+B17)` into B27. This will give exactly the same result.

The Profitability Index

The beauty of the net present value is that it reports the dollar increase in shareholder wealth that would result from acceptance of a project. Most of the time this is desirable, but there is one problem. Comparing projects of differing size can be misleading when a firm is operating with a fixed amount of investment capital. Assuming that both projects are acceptable and mutually exclusive, the larger project will likely have a higher *NPV*. The profitability index (*PI*) provides a measure of the dollar benefit per dollar of cost ("bang for the buck"). *PI* is calculated by:

$$PI = \frac{\text{\$ Benefit}}{\text{\$ Cost}} = \frac{\sum_{t=1}^{N} \frac{ATCF_t}{(1+i)^t}}{IO} = \frac{PVCF}{IO} \qquad \textbf{(10-2)}$$

As indicated in the equation, the benefit is calculated as the present value of the after-tax cash flows and the cost is the initial outlay. Obviously, then, if the *PI* is greater than or equal to 1, the project is acceptable because the benefits exceed or at least equals the costs. Otherwise, the benefits are less than the costs and the project would be rejected.

There are two ways that we can calculate the *PI* in Excel. The most apparent is to use the **NPV** function and to divide that result by the initial outlay. In other words, in B28 type: `=NPV(B17,D20:D24)/(-B19)`. This will give 1.4396 as the result, indicating that the project is acceptable. The alternative is to make use of the following relationship:

$$NPV = PVCF - IO$$

or, by rearranging we get:

$$PVCF = NPV + IO$$

Therefore, since we have already calculated the *NPV* in B27, we can calculate the PI with: `=(B27-B19)/(-B19)`. This method will be slightly faster because Excel doesn't have to recalculate the present values. In all but the largest problems, the increase in speed probably won't be noticeable on a PC, but the technique is especially helpful when doing problems by hand.

The Internal Rate of Return

The internal rate of return (*IRR*) provides a measure of the average annual rate of return that a project will provide. If the *IRR* exceeds the required return for a project, the project will be accepted. Because it is a measure of the percentage return, many analysts prefer it to the other methods that we have discussed, but, as we will see, there are many problems with the *IRR*.

The *IRR* is the discount rate which makes the net present value equal to zero. An alternative, but equivalent, definition is that the *IRR* is the discount rate which equates the present value of the cash flows to the initial outlay. In other words, the *IRR* is the discount rate which makes the following equality true:

$$IO = \sum_{t=1}^{N} \frac{ATCF_t}{(1 + IRR)^t} \qquad \textbf{(10-3)}$$

Unfortunately, in most cases there is no closed-form method for solving for the *IRR*. The primary method of solving this equation is an iterative trial-and-error approach. While this may sound tedious, generally a solution can be found within three or four iterations if some intelligence is used. However, there is little need for this procedure since Excel has a built-in function that performs this operation.

The built-in **RATE** function in Excel will find the *IRR* for an annuity-type of cash flow stream, but it cannot accept an uneven series of cash flows. To deal with uneven cash flows, Excel provides the **IRR** function which is defined as:

IRR(*VALUES*, *GUESS*)

where ***VALUES*** is the contiguous range of cash flows and *GUESS* is the (optional) initial guess at the true *IRR*. Note that your cash flow stream must include at least one negative cash flow (payment) or else the *IRR* would be infinite (why?). Since solving for the *IRR* is an iterative process, it is possible that Excel will not converge to a solution. Excel will indicate this situation by displaying #NUM! in the cell rather than an answer. If this error occurs, one possible solution is to change your *GUESS* until Excel can converge to a solution.

To calculate the *IRR* for the Supreme Shoe example, enter: `=IRR(D19:D24)` into cell B29. The result is 30.95% which is greater than the required return of 15%. So the project is acceptable. At this point, let's try an experiment to prove our definition of the *IRR*. Recall that the *IRR* was defined as the discount rate which makes the *NPV* equal zero. To prove this, temporarily change the value in B17 to: `=B29`. Notice that the net present value in B27 changes to $0.00 which proves the point. Note also that the profitability index changes to 1.0000 (why?). Before continuing, change the required return back to its original value of 15%.

Problems with the IRR

The internal rate of return is a popular profitability measure because, as a percentage, it is easy to understand and easy to compare to the required return. However, the *IRR* suffers from several problems that could potentially lead to less-than-optimal decisions. In this section we will discuss these difficulties, and solutions where they exist.

Earlier, we mentioned that the *NPV* will almost always lead you to the economically correct decision. Unfortunately, the *IRR* and *NPV* will not always lead to the same decision when projects are mutually exclusive. *Mutually exclusive* projects are those for which the selection of one project precludes the acceptance of another. When projects that are being compared are mutually exclusive, a ranking conflict may arise between the *NPV* and *IRR*.[7] In other words, the *NPV* method

7. This is not a problem with independent projects because all independent projects with a positive *NPV* (*IRR* > required rate) will be accepted. In other words, ranking is not required.

may suggest that Project A be accepted while the *IRR* may suggest Project B. If you can't select both, which profitability measure do you believe?

There are two causes of this type of problem: (1) the projects are of greatly different sizes; or (2) the timing of the cash flows are different. To see the size problem more clearly, consider the following question. "Would you rather earn a 100% return on a $10 investment (Project A), or a 10% return on a $1,000 investment (Project B)?" Obviously, most of us would be more concerned with the dollar amounts and would choose the 10% return because that would provide $100 versus only $10 in the other case. The solution to this problem is actually quite simple. If you can raise $1,000 for the Project B, then the correct comparison is not between A and B, but between B and A plus whatever you could do with the other $990 (call it Project C) that is available if you choose Project A. If Project C would return 10%, then you could earn $109 by investing in both A and C, which is preferable to investing in B.

The timing problem is more difficult to deal with. Suppose that you are given the task of evaluating the two mutually exclusive projects in Table 10-3, with a 10% required return.

TABLE 10-3
THE TIMING OF CASH FLOWS CAN LEAD TO A CONFLICT

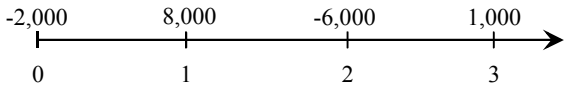
Period	Project A	Project B	Project C (= A – B)
0	(1000)	(1000)	0
1	0	400	(400)
2	200	400	(200)
3	300	300	0
4	500	300	200
5	900	200	700
NPV	$291.02	$248.70	$42.32
IRR	17.32%	20.49%	12.48%

Which would you choose? Obviously there is a conflict because Project A would be selected under the *NPV* criteria, but Project B would be selected by the *IRR* criteria. We can use logic similar to that used for the size problem to see that *NPV* is the correct criteria. If Project B is accepted, we must reject Project A and the

differential cash flows (Project C). If the differential cash flows provide a positive *NPV*, then they should not be rejected. In effect, what we are arguing is that Project A is equivalent to Project B plus the differential cash flows. So choosing between these projects is effectively deciding whether the differential cash flows are profitable or not. Conveniently, all that we really need to do is to accept the project with the highest *NPV*.

Yet another problem with the *IRR* is that there may be more than one *IRR*. Specifically, because the general equation for the *IRR* is an *N*th degree polynomial, it will have *N* solutions. In the usual case, where there is one cash outflow followed by several inflows, there will be only one real number solution; the others are imaginary numbers. However, when there are net cash outflows in the outlying periods, we may be able to find more than one real solution. In particular, there can be, at most, one real solution per sign change in the cash flow stream.[8]

FIGURE 10-3
CASH FLOWS FOR MULTIPLE *IRR*S



Consider, as an example, the cash flows depicted in Figure 10-3. Solving for the *IRR* in this example will lead to three solutions: 207.82%, –31.54%, and –76.27%. The answer that you get from Excel will depend on the initial *GUESS* that you supply. If you don't provide Excel with a *GUESS*, it will give –31.54% as the answer. Any *GUESS* of 21.7% or greater will get an answer of 207.82%, and a guess of –71.11% will get an answer of –76.27%. It is impossible to say which of these answers is correct since all will result in an *NPV* of zero if used as the discount rate (try it!).

The Modified Internal Rate of Return

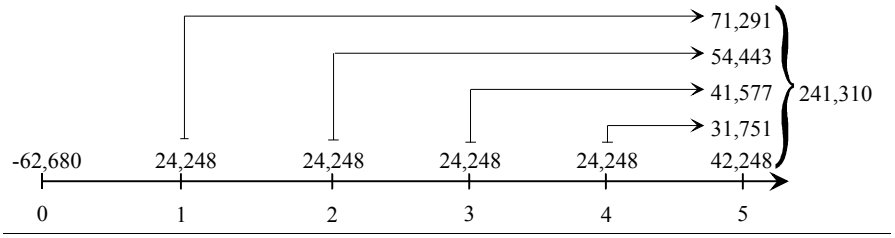
An easy solution to the problems of the *IRR* as a profitability measure is to simply use the *NPV* instead. This is not likely to please everyone, however. Despite its problems, executives continue to prefer the *IRR* to the *NPV* because, as a

8. The interested reader is advised to study Descartes' Rule of Signs to understand this point in more depth.

percentage, it is easy to compare to the firm's cost of capital. To understand how we can use an *IRR*-type calculation and still arrive at correct answers requires that you understand the root cause of the problems with the *IRR*.

Implicit in the calculation of the *IRR* is the assumption that the cash flows are reinvested at the *IRR*. In other words, the *IRR* method assumes that as each cash flow is received, it is reinvested for the remaining life of the project at a rate which is the same as the *IRR*.[9] For projects with a very high, or very low, *IRR* this assumption is likely to be violated. If the cash flows are reinvested at some other rate, the actual average annual rate of return will be different than the *IRR*. To see this assumption at work, consider again our Supreme Shoe project. The timeline is pictured in Figure 10-4 with the explicit reinvestment of the cash flows at the *IRR* of 30.945%.

FIGURE 10-4
SUPREME SHOE CASH FLOWS WITH EXPLICIT REINVESTMENT AT THE *IRR*



Assuming that the cash flows are reinvested at 30.945% per year, at the end of year 5 Supreme Shoe will have accumulated $241,310 from their original investment of $62,680. The compound average annual return, then, must be:

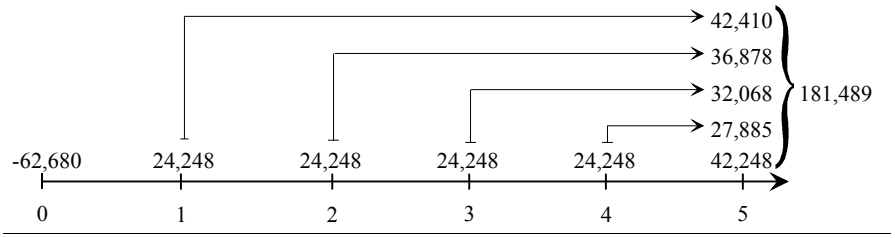
$$\sqrt[5]{\frac{241{,}310}{62{,}680}} - 1 \approx \ 30.945\%$$

which is exactly the same as the *IRR*. Note that we have used the geometric mean, equation (1-1) from Chapter 1, in this example.

9. This also explains why we cannot solve directly for the *IRR*: We must know the *IRR* to know the reinvestment rate, and without knowing the reinvestment rate we can't solve for the *IRR*.

It seems unlikely that Supreme Shoe can earn a rate this high over a five-year period. If we change the reinvestment rate to a more reasonable 15% (the *WACC*), then we have the timeline in Figure 10-5.

FIGURE 10-5
SUPREME SHOE CASH FLOWS WITH EXPLICIT REINVESTMENT AT 15%



In this case, Supreme Shoe will have accumulated only $181,489 by the end of the fifth year. Their average annual rate of return with a 15% reinvestment rate will be:

$$\sqrt[5]{\frac{181,489}{62,680}} - 1 \approx 23.69\%$$

which is substantially lower than the 30.95% *IRR*. When we calculate the average annual return with a reinvestment rate that is different than the *IRR* we refer to it as the *modified internal rate of return*, or *MIRR*. For Supreme Shoe, the *MIRR* is 23.69% which is greater than the required return of 15%, so the project should be accepted.

Excel has a built-in function to calculate the *MIRR*. The function is defined as:

MIRR(*VALUES*, *FINANCE_RATE*, *REINVEST_RATE*)

where ***VALUES*** is the range of cash flows, ***FINANCE_RATE*** is the required rate of return, and ***REINVEST_RATE*** is the rate at which the cash flows are to be reinvested. To calculate the *MIRR* in your Supreme Shoe worksheet, enter: `=MIRR(D19:D24,B17,B17)` into B30. Exactly as we calculated above, the answer is 23.69%. In this example we have used the same rate for the required return and the reinvestment rate. This is normally the appropriate assumption to make (it is the same assumption that is implicit within the *NPV* calculation). But if you have other information which suggests a different reinvestment rate, then that different rate should be used.

Sensitivity Analysis

Probably the most important benefit of using a spreadsheet program is that it allows us to play "what-if" games with the data. That is, we can experiment with different values to determine how sensitive the results are to changes in the assumptions.

NPV Profile Charts

One useful technique that we can use is referred to as the *NPV profile*. This is simply a chart of the *NPV* at various discount rates. The analyst can determine, at a glance, how sensitive the *NPV* is to the assumed discount rate. To create an *NPV* profile chart, we merely set up a range of discount rates and *NPV* calculations and then create a chart.

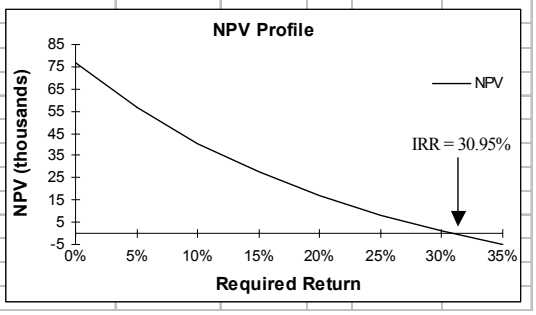
To create an *NPV* profile chart for Supreme Shoe, let's create a range of discount rates from 0% to 35% in 5% increments. Move to cell A36 and enter: `0`. To create the range of discount rates, select A36:A43 and then choose **E**dit F**i**ll **S**eries… from the menus. In the dialog box, change the **S**tep Value to: `0.05` and then click the OK button. You should now have a range of discount rates from 0% to 35%. We will use these rates in our *NPV* calculations.

To calculate the *NPV* at each discount rate, enter: `=NPV(A36,D$20:D$24)+D$19` in B36. Notice that this is exactly the same formula as in B27, except that we have added a few dollar signs to freeze the references and we changed the discount rate to reference A36. Copying this formula to B37:B43 will calculate the *NPV* for each discount rate. Note that the *NPV* becomes negative at a discount rate just over 30% because the *IRR* was 30.95%.

Finally, to create the chart select the B35:B43 and press the Chart Wizard button on the toolbar. Follow the prompts, choosing a line chart, until your chart appears. This section of your worksheet should resemble the one in Exhibit 10-4.

EXHIBIT 10-4
***NPV* PROFILE FOR SUPREME SHOE**

	A	B
33		
34	**NPV Profile Data**	
35	Required Return	NPV
36	0%	$76,560.00
37	5%	$56,404.62
38	10%	$40,415.58
39	15%	$27,552.24
40	20%	$17,070.16
41	25%	$8,427.90
42	30%	$1,225.62
43	35%	($4,836.13)
44		
45		



Notice that the chart clearly shows the *IRR* is just over 30%. This is the point where the *NPV* line crosses the X-axis of the *NPV* profile chart. Furthermore, it is obvious that for any discount rate below 30% the project has a positive *NPV*, thus it is acceptable. Typically, an *NPV* profile chart is used to compare two mutually exclusive projects. Whenever there is a ranking conflict, the *NPV* profiles will cross at a rate at which the firm would be indifferent between the two projects. This "crossover rate" can be found exactly by calculating the IRR of the difference in the cash flows of the two projects.

Scenario Analysis

Excel contains a very powerful tool called the *Scenario Manager* which helps in analyzing the effects of different assumptions. Scenario Manager can be used to toggle your worksheet between various alternative scenarios, or it can create a summary of the effects of changing the assumptions.

As an example we will create three scenarios in which the estimates of maintenance and defect costs are different than expected. The three scenarios are listed in Table 10-4.

TABLE 10-4
THREE POSSIBLE SCENARIOS FOR SUPREME SHOE

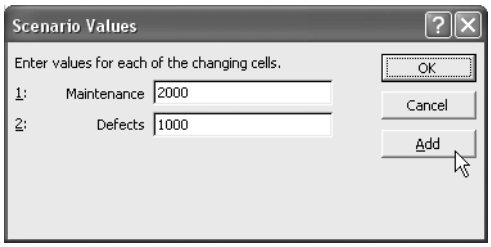
	Best Case	Expected Case	Worst Case
Maintenance	$2,000	$5,000	$8,000
Defects	$1,000	$2,000	$5,000

In the Best Case scenario both maintenance and defects are lower than in the Expected Case (which represents the original estimates). In the Worst Case, both are higher than expected. Since we are going to be changing our assumed values for maintenance and defects, it will be helpful to first define range names for these cells. Click on cell C14 and then choose **I**nsert **N**ame **D**efine and assign the name `Maintenance` to this cell. Now define the name `Defects` for cell C15 (see page 9 for a discussion of named ranges).

Creating scenarios is quite simple. First select **T**ools Sc**e**narios from the menus. Since no scenarios are defined at this point, the first dialog box will ask you to click the **A**dd button to define your scenarios. In this case we want the maintenance and defect estimates to change, so press the **A**dd button, then for the name enter: `Best Case`. Click in the Changing Cells edit box, highlight cells C14:C15, and then click the OK button.

The next dialog box will ask you to supply the new values for the changing cells. In the edit box labeled "Maintenance:" enter: `2000` and in the edit box labeled "Defects:" type: `1000`. Note that this dialog box prompts you for the values using the names that we earlier defined for these cells. If you didn't define the names, then you will be prompted with the cell addresses instead of names.

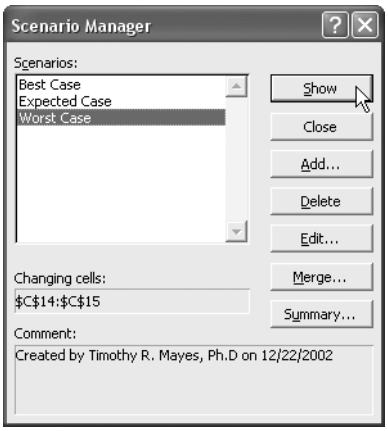
FIGURE 10-6
THE SCENARIO VALUES DIALOG BOX



Click the **A**dd button to enter the next scenario. Now, repeat these steps for the other two cases using the names "Expected Case" and "Worst Case" and the appropriate values from Table 10-4.

Figure 10-7 shows how the dialog box will look when you have entered all three scenarios.

FIGURE 10-7
THE SCENARIO MANAGER



At this point, you can change the worksheet to display the scenario of your choice by highlighting the name of the case and clicking the **S**how button. For example, if you highlight "Worst Case" and click the **S**how button, the maintenance and defect cells will change and the worksheet will update. You can now see the effects of these changes on the cash flows and profitability measures (for example, the NPV is $14,277.70 under the Worst Case scenario). Return to the original data by choosing "Expected Case" from the list, and pressing the **S**how button. This type of flexibility is one of the promised results of proper worksheet design. Scenario analysis will not work properly unless you are diligent about using formulas, rather than retyping values, whenever possible.

It would be nice to see a summary of the different scenarios, and we can do just that. But first, exit from the Scenario Manager and define a name for each cell in B25:B30 so that the output will be easier to understand. Now, bring back the Scenario Manager and click the S**u**mmary button. When the Scenario Summary dialog box appears, select cells B25:B30 for the **R**esult cells and click OK. Excel

will then automatically create a new worksheet that displays the changed values and the resulting profitability measures. Exhibit 10-5 shows the summary worksheet.

EXHIBIT 10-5
SCENARIO SUMMARY REPORT FOR SUPREME SHOE

Scenario Summary	Current Values:	Best Case	Expected Case	Worst Case
Changing Cells:				
Maintenance	5,000	2,000	5,000	8,000
Defects	2,000	1,000	2,000	5,000
Result Cells:				
Payback_Period	2.58	2.33	2.58	3.09
Discounted_Payback	3.53	3.08	3.53	4.25
NPV	27,552.24	36,401.93	27,552.24	14,277.70
PI	1.44	1.58	1.44	1.23
IRR	30.95%	35.85%	30.95%	23.41%
MIRR	23.69%	26.03%	23.69%	19.82%

Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

We have defined three simple scenarios, but other problems may require more scenarios or more changing variables. You can define as many scenarios as your PC's memory will hold, but only the first 251 will be displayed on the scenario summary worksheet. There is also a limit of 32 changing cells per scenario.

The Optimal Capital Budget

How large a firm's capital budget should be is a serious problem that confronts financial managers. One solution that is often chosen is capital rationing. *Capital rationing* is the arbitrary limiting of the amount of capital available for investment purposes. This solution is, however, economically irrational and contrary to the goal of the firm. In order to maximize shareholder wealth, the firm must accept all positive *NPV* projects. Remember that a positive *NPV* project is one which will cover the cost of financing (i.e., the weighted average cost of capital). In effect, a positive *NPV* project is self-liquidating, so there should be no problem raising the

required funds to make the investment. No matter how much must be raised, as long as positive *NPV* projects exist, a firm should continue to invest until the cost of investing exceeds the benefits to be gained.[10]

Optimal Capital Budget Without Capital Rationing

We have seen in the previous chapter that a firm's weighted average cost of capital will increase as the amount of capital to be raised increases. We can make use of this fact to determine exactly what a firm's optimal capital budget should be in the absence of capital rationing. Briefly, we rank all projects by their IRR and compare this ranking to the marginal weighted average cost of capital schedule.

Recall from the previous chapter the Rocky Mountain Motors (RMM) example. Assume that RMM has found 10 potential new projects, each of which would be profitable at their current *WACC* of 10.51% (i.e., all have *IRR*s > 10.51%). The projects are listed in Table 10-5.

TABLE 10-5
ROCKY MOUNTAIN MOTORS PROJECTS

Cost	Cumulative Cost	IRR
$445,529	$445,529	15.02%
439,207	884,736	15.87%
407,769	1,292,505	16.51%
396,209	1,688,714	16.16%
271,477	1,960,191	15.38%
201,843	2,162,034	11.69%
189,921	2,351,955	13.82%
146,661	2,498,616	12.19%
138,298	2,636,914	11.48%
74,950	2,711,864	13.00%

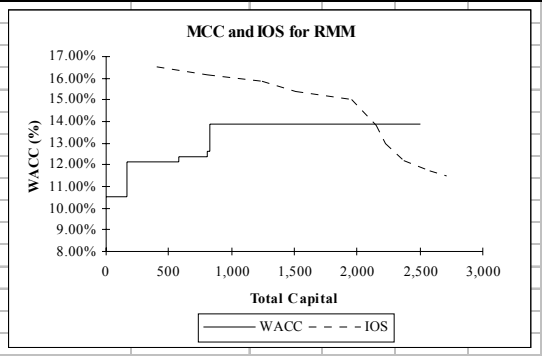
10. From your economics classes, recall that to maximize profits a firm should continue to produce until the marginal cost equals the marginal revenue. This is the same idea, but in a different context. Furthermore, we are evaluating costs and benefits in present value terms and, as we will see in the next chapter, we are taking risk into account.

Enter the data from Table 10-5 into your RMM worksheet beginning with the labels in A50. The cumulative cost can be calculated by entering: `=SUM(A$51:A51)` into B51 and then copying the formula to the other cells. The first step in determining the optimal capital budget is to sort all independent projects by their *IRR*. Select the data in A51:C60. To sort the data choose **D**ata **S**ort… from the menus, and select *IRR* in the "**S**ort by" list. Since we want to select the projects with the highest *IRR*s, choose to sort in **D**escending order. This sorted list of *IRR*s is known as the Investment Opportunity Schedule (IOS).

Next, we want to add the project *IRR*s to the marginal *WACC* chart that was created earlier (see Exhibit 9-5 and Exhibit 9-6). To add the new data, right-click in the chart area and choose **S**ource Data from the shortcut menu. Under the Series list, click on the **A**dd button to create a new data series. Now, for the **N**ame of the series type `IOS` and then enter B51:B60 for the **X** Values and C51:C60 for the **Y** Values. Your worksheet should look like the one in Exhibit 10-6.

EXHIBIT 10-6
MARGINAL *WACC* AND THE IOS FOR RMM

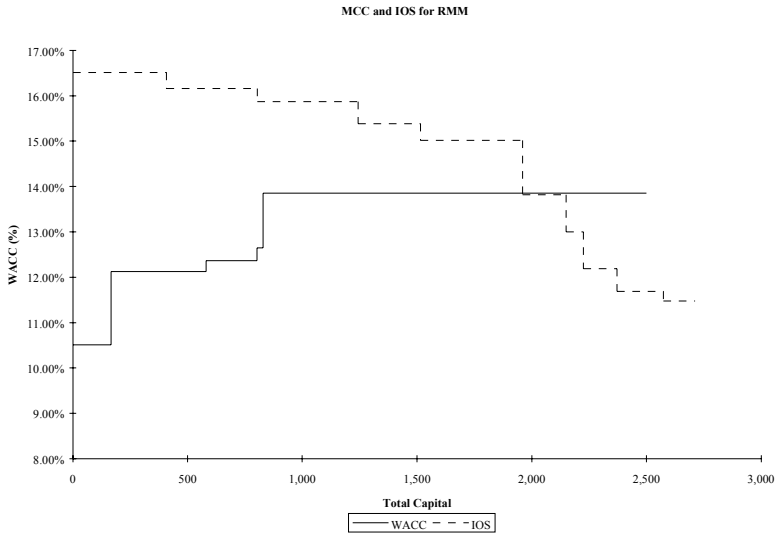
	A	B	C
50	Cost	Cumulative Cost	IRR
51	407,769	407,769	16.51%
52	396,209	803,978	16.16%
53	439,207	1,243,185	15.87%
54	271,477	1,514,662	15.38%
55	445,529	1,960,191	15.02%
56	189,921	2,150,112	13.82%
57	74,950	2,225,062	13.00%
58	146,661	2,371,723	12.19%
59	201,843	2,573,566	11.69%
60	138,298	2,711,864	11.48%
61			
62			
63			
64			
65			



As was shown on page 280, we can make the IOS line into a step function. The process is exactly the same as before: we must add additional data points for the cumulative cost and *IRR* so that we have two points at each change in the *IRR*. Once that is finished we can simply edit the data series by right-clicking the IOS and choosing **S**ource Data from the menu. Now, edit the X and Y data ranges to the new ones. Once complete, your chart should look like the one in Exhibit 10-7.

The optimal capital budget without capital rationing is the level of total capital at which the marginal *WACC* schedule and the Investment Opportunity Schedule cross. In this case that would be $1,960,191.

EXHIBIT 10-7
COMPLETED MCC AND IOS CHART



Optimal Capital Budget Under Capital Rationing

Though technically irrational, capital rationing is common. How then can we determine the optimal capital budget in the presence of restricted capital? In this situation we need to find that combination of projects which maximizes the total net present value, subject to a capital constraint.

This can be a tedious exercise when there are a large number of positive *NPV* projects from which to choose. For example, assume that we have four positive *NPV* projects to choose among. At a minimum we must select one project, but we can select up to four. If we must look at every possible combination of these four projects, then we must examine sixteen possible combinations. As the number of projects grows, the number of combinations grows even faster. In general there are 2^N possible combinations, where N is the number of positive *NPV* projects. Note

that negative *NPV* projects are excluded from this calculation and further consideration because we cannot increase the total *NPV* by adding a negative *NPV* project.[11]

Excel provides a tool called the *Solver* which can be used in any type of constrained maximization or minimization problem. The Solver provides a dialog box in which you describe the problem, the cells that may be changed, and the constraints under which the Solver must operate. It then finds the optimal solution. Let's look at an example.

> Because of declining demand for high-pressure frammis valves, the Frammis Valve Corporation of America (FVCA) is considering expanding into a number of other businesses. After discussions with its consultants, FVCA has determined that it has 13 potential new investments (see Table 10-6). The total cost of these investments would be $7,611,990, but they are limited to a maximum total investment of only $3,000,000. You have been asked to determine which combination of the projects the company should choose.

Since there are thirteen acceptable projects, you will have to examine each of the 8,192 ($= 2^{13}$) possible combinations and determine which provides the highest total *NPV*. This problem is obviously going to be time consuming unless you have access to a computer. Enter the data from the problem into a new worksheet beginning in cell A4.

---

11. Strictly speaking, this is not always true. Under a multi-period capital budgeting scenario with multi-period cash flow constraints, it is possible that adding negative *NPV* projects could increase the total *NPV*.

TABLE 10-6
FVCA'S AVAILABLE PROJECTS UNDER CAPITAL RATIONING

Project	Cost	*NPV*
A	$237,005	$84,334
B	766,496	26,881
C	304,049	23,162
D	565,178	82,598
E	108,990	20,590
F	89,135	90,404
G	795,664	18,163
H	814,493	97,682
I	480,321	52,063
J	826,610	53,911
K	734,830	56,323
L	910,598	88,349
M	978,621	69,352

To solve this problem, we need some way to determine the sum of the costs and *NPV*s for only those projects which are to be selected. Since each project will either be selected or not, this is a perfect use for a binary variable. A binary variable can take on one of two values, most commonly 0 or 1. In this case, we will set up a column with 0s and 1s where 1 indicates that a project is selected, and 0 indicates rejection. Your worksheet should resemble that in Exhibit 10-8.

Note that we have initially set each cell in D4:D16 to `1`. Also, due to the nature of the problem, we can not use an ordinary **SUM** function to total columns B and C. Recall that we only want the sum of the costs and *NPV*s of the projects which are to be selected. This requires an array formula.

EXHIBIT 10-8
FVCA'S CAPITAL BUDGETING PROBLEM

	A	B	C	D
1	The Optimal Capital Budget			
2	Under Capital Rationing			
3	Project	Cost	NPV	Include
4	A	237,005	84,334	1
5	B	766,496	26,881	1
6	C	304,049	23,162	1
7	D	565,178	82,598	1
8	E	108,990	20,590	1
9	F	89,135	90,404	1
10	G	795,664	18,163	1
11	H	814,493	97,682	1
12	I	480,321	52,063	1
13	J	826,610	53,911	1
14	K	734,830	56,323	1
15	L	910,598	88,349	1
16	M	978,621	69,352	1
17	Total	7,611,990	763,812	13
18	Constraint	3,000,000		

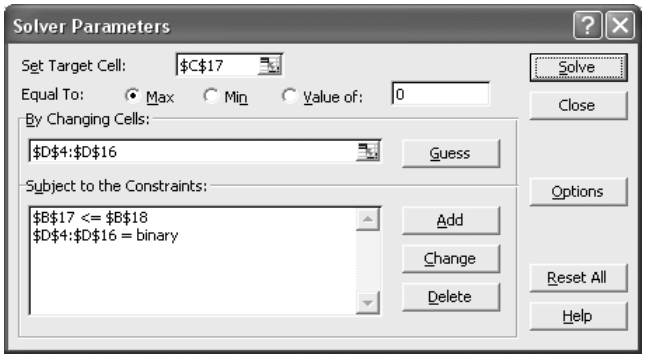
An *array formula* is one which operates on each element in a range, but without specifying each element separately. Array formulas are therefore easier to write and save space. To calculate the total cost of the accepted projects in B17, we want to write a formula which multiplies the costs in column B by the corresponding 0 or 1 in column D and keeps a running total of the results. One way to do this is to write a formula such as: =B4*D4 + B5*D5 + B6*D6. . . . However, this would be a long formula to enter. The equivalent array formula would be: `=Sum(B4:B16*$D4:$D16)`. This is much shorter and easier to understand.

Excel will not understand this formula unless you enter it in a specific way. You must enter array formulas by holding down the Shift+Ctrl keys when you press the Enter key. After correctly entering an array formula, it will appear in the formula bar surrounded by a pair of curly braces ({}). The formula in B17 will be displayed as: {`=Sum(B4:B16*$D4:$D16)`}. If you see a #VALUE! error in B17, you probably did not hold down Shift+Ctrl when pressing the Enter key. Copy the formula from B17 to C17, and your totals should be the same as those in Exhibit 10-8.

To restate the problem, we want to maximize the total *NPV* in C17 by changing the cells in D4:D16 subject to two constraints. The first constraint is that the total cost, in B17, must be less than or equal to 3,000,000. Next we must constrain the values in D4:D16 to be either 0 or 1, but they cannot take on any non-integer values (i.e., they must be binary values).

Bring up the Solver by selecting **T**ools Sol**v**er... from the menus.[12] In the S**e**t Target Cell edit box enter: `C17` and then click on the **M**ax radio button. This tells the Solver that we want to maximize the function in C17. Note that, under different circumstances, we could also minimize this formula or force it to a specific value. Next we need to tell Solver which cells it may change to find a solution. In the **B**y Changing Cells edit box enter: `D4:D16`.

FIGURE 10-8
THE SOLVER DIALOG BOX



The hardest part of solving many problems is setting up the appropriate constraints. In this problem we have two constraints, and it will take only two statements to fully specify them. In other cases it may take more than one statement to fully specify a single constraint. To add a constraint, click on the **A**dd button. This will bring up a second dialog box in which we can enter a cell reference and the constraint. Note that the dialog box contains a drop-down list in the center which describes the possible relationships. These are <=, =, >=, int, and bin. "int" tells

12. In Excel 2002 you should have this menu item even if the Solver has not been installed. If the Solver is not installed, Excel will prompt you to insert the Office XP CD so that it can be installed.

the Solver that the values in the cells must be an integer, and "bin" says that they must be either 0 or 1.

Add the first constraint by entering B17 in the Cell Reference edit box, select <=, and enter B18 in the constraint exit box. This will make sure that the total cost is less than the $3,000,000 constraint. For the second constraint, we must constrain the cells in D4:D16 to be >= 0, <= 1, and to be an integer value. In other words, D4:D16 must be constrained to be binary. Add this constraint and the problem is almost ready to solve.

Because of the large number of possible solutions, the default configuration of the Solver may not find the solution. In the main Solver dialog box click on the **O**ptions… button. This will bring up another dialog box containing the options that you can set. Most of these are beyond the scope of this text. Set the Max **T**ime to at least 500 seconds (higher if you have a very slow PC) and **I**terations to at least 500. These two options control how long the Solver will try to solve the problem (they are maximums and Solver will stop as soon as it finds the solution). Finally make sure that Assume Linear **M**odel is checked. Click on the OK button.

Finally, to start the Solver working on the problem click the **S**olve button.[13] When Solver finds the solution it will present you with a dialog box which asks if you would like to save the solution or return to the original values. If you choose to save the optimal solution, your worksheet will resemble the one in Exhibit 10-9. Note that projects A, C, D, F, H, and L are selected.

13. This is a computation intensive problem which may take up to a minute or more on slow machines, even with only 13 projects. For this reason, firms with a very large number of projects to evaluate will want to use an optimized stand-alone program to solve problems of this type.

EXHIBIT 10-9
THE OPTIMAL SOLUTION FOR THE FVCA CAPITAL BUDGET

	A	B	C	D
1	The Optimal Capital Budget			
2	Under Capital Rationing			
3	Project	Cost	NPV	Include
4	A	237,005	84,334	1
5	B	766,496	26,881	0
6	C	304,049	23,162	1
7	D	565,178	82,598	1
8	E	108,990	20,590	0
9	F	89,135	90,404	1
10	G	795,664	18,163	0
11	H	814,493	97,682	1
12	I	480,321	52,063	0
13	J	826,610	53,911	0
14	K	734,830	56,323	0
15	L	910,598	88,349	1
16	M	978,621	69,352	0
17	Total	2,920,458	466,529	6
18	Constraint	3,000,000		

As a final point about the Solver, you can easily change the constraint of $3,000,000 to any other value and then run the Solver again. Since the Solver settings are saved, you do not need to re-enter the data every time. Further, once the optimal solution is found you can save it as a named scenario and then use the Scenario Analysis tool to view all of the different scenarios. For example, we could create scenarios with total investment constraints of $3 million, $5 million, and $7 million. Once you've run the Solver with each of those constraints, choose **T**ools Sc**e**narios and view the scenarios. You can also create a scenario summary as shown in Exhibit 10-10. In this case, we have edited the worksheet a bit to label the result cells (B17:D17) and hidden the changing cells to improve readability.

EXHIBIT 10-10
SCENARIO SUMMARY FOR OPTIMAL CAPITAL BUDGETING PROBLEM

Scenario Summary			
	$3 million constraint	$5 million constraint	$7 million constraint
Changing Cells:			
Result Cells:			
Total Investment	2,920,458	4,919,171	6,816,326
Total NPV	466,529	641,695	745,649
Number of Projects	6	9	12

Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

Other Techniques

Because of the time required to maximize the total *NPV*, other techniques can be used to approximate the optimal capital budget. The first is to select the projects with the highest profitability indices. You may have to discard some high *PI* projects, and you will likely not achieve the maximum *NPV*, but the solution can often be found with less work than maximizing *NPV*. As an alternative, we could choose the projects with the highest *IRR*s. However, this could be misleading if the projects are of greatly different sizes (as in the RMM example).

Summary

Capital budgeting is one of the most important functions of the corporate financial manager. In this chapter we have seen how to calculate the relevant cash flows and how to evaluate those cash flows to determine the profitability of accepting the project.

We demonstrated six profitability measures which are summarized in Table 10-7.

TABLE 10-7
SUMMARY OF PROFITABILITY MEASURES

Profitability Measure	Acceptance Criteria
Payback Period	<= Maximum allowable period
Discounted Payback	<= Maximum allowable period
Net Present Value	>= 0
Profitability Index	>= 1
Internal Rate of Return	>= *WACC*
Modified *IRR*	>= *WACC*

In addition, we introduced the Scenario Analysis and Solver tools provided by Excel. The Scenario Analysis tool allows us to easily compare the outcomes based on various inputs. The Solver allows us to find optimal values for a cell in a model.

TABLE 10-8
FUNCTIONS INTRODUCED IN THIS CHAPTER

Purpose	Function	Page
Calculate straight-line depreciation	**SLN(*COST*, *SALVAGE*, *LIFE*)**	288
Calculate the payback period	**FAME_PAYBACK(*CASHFLOWS*,*RATE*)**	293
Calculate the *IRR*	**IRR(*VALUES*,*GUESS*)**	300
Calculate the *MIRR*	**MIRR(*VALUES*, *FINANCE_RATE*, *REINVEST_RATE*)**	304

Problems

1. Chicago Turkey is considering building a new turkey farm to service their western region stores. The stores currently require 500,000 turkeys per year, and they are purchased from various local turkey farms for an average price of $7 per bird. The managers of Chicago Turkey believe that their new farm would

lower the cost per bird to $6, while maintaining their average selling price of $10 per bird. However, due to the centralized structure of this operation, shipping expenses will increase to $1.50 per bird from the current average of $1.00. In addition, the firm will need to increase its inventory of live turkeys by $12,000. It is estimated that it will cost $100,000 to purchase the land, and $300,000 to construct the buildings and purchase equipment. In addition, labor expenses will rise by $120,000 per year. The buildings and equipment will be depreciated using the straight line method over five years to a salvage value of $100,000. At the end of five years the company will sell the farm for $300,000 ($100,000 for the buildings and equipment and $200,000 for the land). Assume that the firm's marginal tax rate is 40%, and note that land is not depreciable.

a. Calculate the initial outlay, annual after-tax cash flows, and terminal cash flow for this project.

b. If the *WACC* is 12%, calculate the payback period, discounted payback period, *NPV*, *PI*, *IRR*, and *MIRR*.

c. The managers of Chicago Turkey are uncertain about several of the variables in your analysis and have asked you to provide three different scenarios. Create a scenario analysis showing the profitability measures for this investment using the information in the table below. (Note: The salvage value of the buildings is the actual forecasted salvage value, not the salvage value used for depreciation.)

Scenario	Labor Expense	Salvage Value of Buildings	Salvage Value of Land
Best Case	$100,000	$150,000	$300,000
Expected Case	120,000	100,000	200,000
Worst Case	140,000	50,000	100,000

2. You are considering an investment in two projects, A and B. Both projects have an initial cash outlay of $50,000 and the projected cash flows are as follows:

Year	Project A	Project B
1	20,000	35,000
2	25,000	30,000
3	30,000	25,000
4	35,000	20,000
5	40,000	15,000

   a. Assuming that the WACC is 15%, calculate the payback period, discounted payback period, *NPV*, *PI*, *IRR*, and *MIRR*. If the projects are mutually exclusive, which project should be selected?

   b. Create an NPV profile chart for projects A and B. What is the exact crossover rate for these two projects?

3. The Chief Financial Officer of Eaton Medical Devices has determined that the firm's capital investment budget will be $5,000,000 for the upcoming year. Unfortunately, this amount is

not sufficient to cover all of the positive *NPV* projects that are available to the firm. You have been asked to choose which investments, of those listed in the table below, should be made.

Project	Cost	*NPV*
A	$628,200	$72,658
B	352,100	36,418
C	1,245,600	212,150
D	814,300	70,925
E	124,500	11,400
F	985,000	56,842
G	2,356,400	93,600
H	226,900	65,350
I	1,650,000	48,842
J	714,650	39,815

a. Using the Solver, determine which of the above projects should be included in the budget if the firm's goal is to maximize shareholder wealth. (Note: Make sure to set the Solver options to Assume Linear Model.)

b. Now assume that the CFO has informed you that projects A and B are mutually exclusive, but one of them must be selected. Change your Solver constraints to account for this new information and find the new solution.

c. Ignore the constraints from Part b. The CFO has now informed you that Project I is of great strategic importance to the survival of the firm. For this reason it must be accepted. Change your Solver constraints to account for this new information and find the new solution.

11 *Risk, Capital Budgeting, and Diversification*

After studying this chapter, you should be able to:

1. *Define the five major statistical measures used in finance and calculate these both manually and in Excel.*
2. *Explain how risk can be incorporated into capital budgeting decisions, and show how to calculate the "risk-adjusted discount rate" (RADR) in Excel.*
3. *Explain five alternative techniques for incorporating risk into the analysis.*
4. *Explain diversification and give an example using Excel.*
5. *Calculate portfolio risk measures with Excel.*

Risk is a difficult concept to define, but most people recognize such obvious risks as swimming in shark-infested waters. If you consider risky situations for a moment, you will realize that the thing that they all have in common is the possibility of a loss. Many times we face the loss of life or money. In this chapter we are concerned with the possibility of a financial loss. Specifically, we will say that the larger the possibility of loss, the larger the risk.

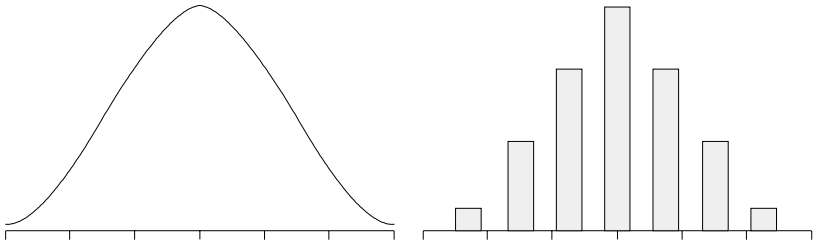
We will begin by attempting to measure the riskiness of an investment, and then we will consider how we can adjust our decision-making process to account for the risk

that we have measured. Finally, we will consider how we can reduce risk through diversification.

Review of Some Useful Statistical Concepts

Any situation that has an uncertain outcome can be said to have a probability distribution associated with the possible outcomes. A *probability distribution* is simply a listing of the probabilities associated with potential outcomes. A probability distribution is said to be *discrete* if a limited number of potential outcomes are possible and *continuous* if an infinite number of possible outcomes can occur. Figure 11-1 illustrates both continuous and discrete probability distributions. Continuous probability distributions can be approximated by discrete distributions if we have enough possible outcomes. To keep things simple, in this chapter we will use only discrete distributions in our examples.

FIGURE 11-1
CONTINUOUS VS. DISCRETE PROBABILITY DISTRIBUTIONS



One type of probability distribution has numerous properties that make it attractive for our use: the *normal distribution*. In particular, the normal distribution can be completely described by its mean and variance, which will prove useful in our efforts to understand risk.

The Expected Value

The *expected value* of a distribution is a weighted average of all possible outcomes where the weights are the probabilities of occurrence. The expected value can be thought of as the most likely outcome, or the average outcome if we could run an

experiment thousands of times. For any discrete probability distribution, the expected value is given by:

$$E(X) = \sum_{t=1}^{N} \rho_t X_t \qquad \textbf{(11-1)}$$

where $E(X)$ is the expected or most likely X, X_t is the t^{th} possible outcome, and ρ_t is the probability that X_t will occur. For the normal distribution, the expected value is the same as the more familiar arithmetic mean.

To illustrate the calculation of the expected value, suppose that you have been offered an opportunity to participate in a game of chance. The rules of this particular game are such that you must pay $200 to play, and Table 11-1 describes the possible payoffs.

TABLE 11-1
PROBABILITY DISTRIBUTION FOR A GAME OF CHANCE

Probability	Cash Flow
0.25	100
0.50	200
0.25	+300

To determine whether or not you should play this game, we must compare the expected payoff to the cost of playing. If the expected cash flow is equal to or exceeds your cost it makes sense to play. The expected cash flow [E(Cf)] of this game is:

$$ECf = 0.25(100) + 0.50(200) + 0.25(300) = 200$$

so that you expect to break even after subtracting your cost to play. Note that in actuality, if the game is played only once you could lose as much as $100 or win as much as $100 net of your cost of entry. However, the most likely outcome is a net gain of $0.00. The arithmetic mean of cash flows ($\overline{Cf}$) is:

$$\overline{Cf} = \frac{100 + 200 + 300}{3} = 200$$

and subtracting your cost, you can see that they are the same. Again, in this case, the expected value and the arithmetic mean are the same because the outcomes of this game are symmetrically distributed.

It is important to understand that many times the assumption of a symmetrical distribution is not accurate, and in this case the arithmetic mean and the expected value will not be the same.[1] Whenever possible, it is better to use the expected value as an estimate instead of the arithmetic mean.

Measures of Dispersion

Whenever we use an expected value, it is useful to know how much, on average, the actual outcome might deviate from the expected outcome. The larger these potential deviations are, the less confidence we will have that the expected outcome will actually occur. Another way of saying this is that the larger the potential deviations from the expected value, the higher the probability of an outcome far away from the expected outcome.

Recall that we earlier said that high probabilities of loss indicate a high risk situation. Therefore, when comparing distributions we can say that the distribution with the larger potential deviations has a higher probability of greater loss, and therefore has higher risk.

The Variance and Standard Deviation

To measure risk, what we need is a way to measure the size of the potential deviations from the mean. One measure we could use is the average deviation. The average deviation is calculated as:

$$\overline{D} = \sum_{t=1}^{N} \rho_t (X_t - \overline{X}) \qquad \textbf{(11-2)}$$

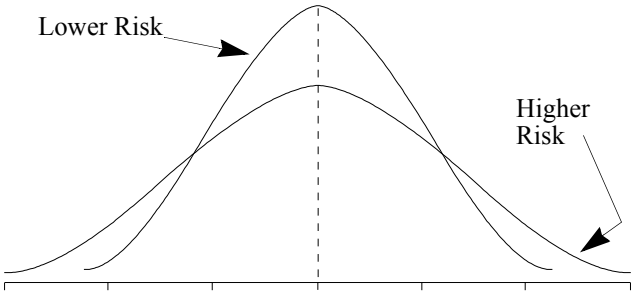
1. This is particularly true in many financial situations where your maximum loss is limited to 100% of the investment, but your potential gain is unlimited. This results in a distribution which is skewed to the right.

But, in the case of the normal distribution (or any symmetrical distribution) the average deviation will always be zero (why?). So we need another measure of dispersion that doesn't suffer from this flaw. One possibility is the *variance*. The variance is the average of the squared deviations from the mean and is calculated as:[2]

$$\sigma_X^2 = \sum_{t=1}^{N} \rho_t (X_t - \bar{X})^2 \qquad \textbf{(11-3)}$$

Because we are squaring the deviations from the mean, and the result of squaring a number is always positive, the variance must be positive.[3] The larger the variance, the less likely it is that the actual outcome will be near the expected outcome, and the riskier it is considered to be. Figure 11-2 illustrates this by comparing two distributions.

FIGURE 11-2
COMPARISON OF THE RISKINESS OF TWO DISTRIBUTIONS



Returning to the example in Table 11-1, we can calculate the variance of possible outcomes as follows:

2. Note that in your beginning statistics class you probably defined the population variance as:

$$\sigma_X^2 = \frac{1}{N} \sum_{t=1}^{N} (X_t - \bar{X})^2$$

Our definition is equivalent if we assume that all outcomes are equally likely.

3. It is possible that the variance could be zero, but only if just one possible outcome exists.

$$\sigma^2 = 0.25(100 - 200)^2 + 0.50(200 - 200)^2 + 0.25(300 - 200)^2 = 5{,}000$$

So the variance of possible outcomes is 5,000. But 5,000 in what units? In this case the units are squared dollars, an unusual unit of measurement to be sure. In order to make this measurement more understandable, we commonly take the square root of the variance which gives us the *standard deviation* in the original units:

$$\sigma_X = \sqrt{\sigma_X^2} = \sqrt{\sum_{t=1}^{N} \rho_t (X_t - \bar{X})^2} \qquad \textbf{(11-4)}$$

The standard deviation of potential outcomes in our game example is:

$$\sigma = \sqrt{5{,}000} = 70.71$$

which means that about 68% of all outcomes will be within one standard deviation of the mean (200 ± 70.71), and about 95.5% will be within two standard deviations (200 ± 141.42). Furthermore, it is exceedingly unlikely (< 0.30%), but not impossible, that the actual outcome will fall beyond three standard deviations from the mean.[4]

The Coefficient of Variation

Suppose that after playing our original game, you are offered a chance to play the game again, but this time the game is 10 times larger and so is your cost to play. The possible outcomes are presented in Table 11-2.

TABLE 11-2
SAME GAME, BUT TEN TIMES LARGER

Probability	Cash Flow
0.25	1000
0.50	2000
0.25	3000

4. This is known as the empirical rule. For non-normal distributions, Chebyshev's Theorem gives similar (though not as precise) results.

Is this game riskier than the old game? Let's look at the standard deviation to see:

$$\sigma = \sqrt{0.25(1000 - 2000)^2 + 0.50(2{,}000 - 2{,}000)^2 + 0.25(3{,}000 - 2{,}000)^2}$$
$$\sigma = 707.106$$

Since the standard deviation is 10 times larger, it appears that the new game is much riskier. Recall, however, that we said that high risk was associated with a high probability of loss. In the new game your probability of loss is unchanged (25%). Since the probability of loss is unchanged, the risk should be the same.

Apparently the standard deviation has a scale problem. That is, larger numbers cause larger standard deviations, even if the relative dispersion is unchanged. The coefficient of variation handles the scale problem by dividing the standard deviation by the mean:

$$\gamma_X = \frac{\sigma_X}{\bar{X}} \qquad \textbf{(11-5)}$$

If the new game is truly riskier than the old game, it will have a higher coefficient of variation. Let's compare the coefficients of variation for both games:

$$\gamma_1 = \frac{70.7106}{200} = 0.3535$$
$$\gamma_2 = \frac{707.106}{2{,}000} = 0.3535$$

Since $\gamma_1 = \gamma_2$, both games must be equally risky.

Using Excel to Measure Risk

Now that we understand how risk can be evaluated, let's look at how Excel might be used to simplify the calculations. In this section we will introduce several of Excel's built-in functions and several macro functions that are contained in the file FameFncs.xls. Before continuing, open that file and also a new workbook, into which we will enter data from an example of a capital budgeting project.

The Freshly Frozen Fish Company Example

> The Freshly Frozen Fish Company currently markets frozen fish fillets and other related products. While seeking expansion ideas, management of the company decided to look into the possibility of a line of frozen catfish fillets. Entry into this business would require the purchase of an existing 80-acre catfish farm in western Alabama at a cost of $250,000 for the land, and $400,000 for the buildings and equipment. The buildings and equipment will be depreciated at a rate of $40,000 per year for the five-year life of the project. At the end of the five years, management anticipates that the farm can be sold for $550,000 ($350,000 for the land and $200,000 for the buildings and equipment).
>
> The marketing department estimates that the firm will be able to sell 200,000 pounds of fillets at an average wholesale price of $2.50 per pound during the first year. Unit demand is expected to grow at a rate of 8% annually thereafter. Variable operating expenses are expected to average 60% of gross sales, and fixed costs (not including depreciation) will be $80,000 per year. The company's marginal tax rate is 35% and its weighted average cost of capital is 10%.

Before we can determine the riskiness of this project, we must determine its cost and annual cash flows. Let's begin by entering all of the data from the problem into the worksheet starting in cell A1. The easiest way to extract data from a problem such as this is to take it as it comes and enter it into the worksheet in that order, being careful to label every row. This way, you are less likely to overlook an important piece of data. That is exactly what we've done in Exhibit 11-1. If necessary, we can rearrange this table later.

Recall from Chapter 10 (page 283) that our first task is to determine the initial outlay. The example problem in that chapter was a little different than this one because it was a replacement problem. However, exactly the same techniques can be used to determine the cash flows. Just realize that in the case of this entirely new project we aren't replacing anything, so cash flows associated with selling off old equipment are set to zero.

EXHIBIT 11-1
FRESHLY FROZEN FISH COMPANY INPUTS

	A	B
1	**Frozen Catfish Fillet Project Inputs**	
2	Cost of Land	250,000
3	Cost of Buildings & Equipment	400,000
4	Annual Depreciation	40,000
5	Life of Project (Years)	5
6	Terminal Value of Land	350,000
7	Terminal Value of Buildings & Equipment	200,000
8	First Year Catfish Sales (lbs)	200,000
9	Price per Pound	2.50
10	Unit Sales Growth Rate	8%
11	Variable Costs as % of Sales	60%
12	Fixed Costs	80,000
13	Tax Rate	35%
14	WACC	10%

Before continuing, let's take a little time to set up our calculation area on the worksheet. Realize that the annual after-tax cash flows are going to be different in each of the five years. To keep things as simple as possible, we will set up the calculations in a modified income statement format. In A16 enter: `Annual Cash Flows for Frozen Catfish Fillet Project`, and center this title over A16:G16. Next, in B17 enter: `Year 0` and use AutoFill to extend that to Year 5 in G17.

We have purposely simplified this example, so we have no shipping, installation, training, or construction costs. The initial outlay is simply the cost of the land and buildings. In A18 enter: `Initial Outlay`, and in B18 enter: `=-(B2+B3)`. This will give us the initial outlay as a negative number. The result is $–650,000.

Our next step is to calculate the annual after-tax cash flows for each year. As noted above, the cash flows will be different each year because sales and variable operating expenses are expected to increase every year by 8%. We will calculate the ATCF for each year as:

$$\text{ATCF}_N = (S_N - V_N - F_N)(1 - t) + tD_N$$

where S_N is the total revenue in year N, V_N is the total variable costs, F_N is the fixed costs, t is the marginal tax rate, and D_N is the annual depreciation expense. Note that tD_N is the annual tax savings from the additional depreciation expense. This is exactly the same equation as shown on page 289, except it has been modified slightly to suit this problem.

In A19 enter: `Sales` as the label. We will calculate the first year sales in C19 by multiplying unit sales (200,000 pounds) by the selling price ($2.50), so the equation is: `=B8*B9`. This gives us $500,000 in sales revenue for the first year. Each additional year's sales will be 8% greater than previous sales, so in D19 enter: `=C19*(1+$B$10)`. Now copy this formula over the range E19:G19. As a check, note that under these assumptions sales will grow to $680,244.48 by year 5.

Next, to calculate the annual variable costs enter: `=C19*$B$11` into C20, and copy it across over D20:G20. In A20 enter: `Variable Costs` as the label for the row. In A21 enter: `Fixed Costs` for the label, and then in C21 enter: `=$B$12`. Copy this over D21:G21.

We can now calculate the taxable cash flows before depreciation in row 22. In A22 add the label: `Taxable Cash Flows`. Subtract the fixed and variable costs from sales in C22 with the formula: `=C19-SUM(C20:C21)` and copy this across the other columns. In A23 enter the label: `Taxes`, and in C23 enter: `=C22*$B$13` and copy it to D23:G23.

At this point, to get the ATCF we need to add the depreciation tax benefit. In A24 enter: `Depreciation Tax Benefit` as the label, and then in C24: `=$B$4*$B$13`. Copy this to the remaining cells, and then in A25 enter: `Annual After-tax Cash Flows`. Finally, in C25 we can enter: `=C22-C23+C24`. Copy this to the other cells in D25:G25.

The last cash flow that we must calculate is the terminal cash flow. Recall that this is the sum of the non-operating cash flows that occur at the end of the life of the project. In this problem, those would be the sale of the land and buildings as well as any taxes required on the gains. The land is not depreciable, so any gain on the sale of land is taxable. To calculate the tax on the buildings and equipment we must first determine their book value at year 5. Since the firm will pay $400,000 and receive $40,000 per year in depreciation, the book value will be $200,000. In this case, the expected selling price is exactly equal to the book value, so no tax is due. However, our formula must account for the possibility of taxes in case we change

the expected selling price. In A26 enter: `Terminal Cash Flow`, and the formula in G26 is: `=B6-(B6-B2)*B13+B7-(B7-(B3-B4*B5))*B13`.

In order to summarize our calculations we will add one more row. In A27 enter: `Total Annual Cash Flows`. In B27 enter: `=B18`. In C27 enter: `=C25+C26`, and copy it across. Check your worksheet against that shown in Exhibit 11-2 to be sure that your calculations are correct.

EXHIBIT 11-2
CALCULATION OF THE ANNUAL AFTER-TAX CASH FLOWS

	A	B	C	D	E	F	G
16	Annual Cash Flows for Frozen Catfish Fillet Project						
17		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
18	Initial Outlay	(650,000)					
19	Sales		500,000	540,000	583,200	629,856	680,244
20	Variable Costs		300,000	324,000	349,920	377,914	408,147
21	Fixed Costs		80,000	80,000	80,000	80,000	80,000
22	Taxable Cash Flows		120,000	136,000	153,280	171,942	192,098
23	Taxes		42,000	47,600	53,648	60,180	67,234
24	Depreciation Tax Benefit		14,000	14,000	14,000	14,000	14,000
25	Annual After-Tax Cash Flow		92,000	102,400	113,632	125,763	138,864
26	Terminal Cash Flow						515,000
27	Total Annual Cash Flows	(650,000)	92,000	102,400	113,632	125,763	653,864

At this point we are ready to calculate the net present value to give a preliminary assessment of the merits of this project. In A29 enter: `Net Present Value`, and in B29 enter: `=NPV(B14,C27:G27)+B27`. The *NPV* is $95,533.22, which, would seem to indicate that the project is acceptable.

Introducing Uncertainty

If we lived in a world of perfect certainty, the catfish fillet project would be accepted without question. After all, it appears that it will increase shareholder wealth by $95,533.22. Unfortunately, the world is not certain. Even in this simplified example, it should be clear that many sources of uncertainty may arise. For example, the marketing department doesn't really *know* that the firm will sell 200,000 pounds of catfish fillets in the first year. Likewise, it doesn't know that it will be able to get the assumed $2.50 per pound or that demand will grow at an annual rate of 8% per year. Consumer demand may be far less than expected. This could lead to a double whammy: Not only would unit demand be less than expected, but the wholesale price would likely be less than $2.50 per pound. Poor first year acceptance could also mean lower subsequent growth rates. These and

many other uncertainties naturally result in uncertainty surrounding our expected annual cash flows which, in turn, results in uncertainty surrounding the estimated *NPV*.

In such an uncertain world, it is helpful to develop models that allow us to determine how much uncertainty surrounds our estimate of the *NPV*. For example, we might like to make an educated guess as to the probability that the *NPV* will actually turn out to be less than zero. The following sections will lead us to an answer to this question.

Sensitivity Analysis

As noted above, many uncertain variables exist in our catfish fillet example. In fact, we could say that virtually all of the variables are uncertain, as are many others that we have not explicitly considered. However, some of these variables have more of an impact on the *NPV* than others. Since it would take a lot of time and effort to generate precise forecasts of every variable, it is helpful to concentrate on only the most important variables. Sensitivity analysis is the tool that helps us to identify the variables that deserve the most attention.

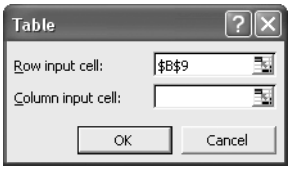
The idea is to make small changes in variables, one at a time, and observe the effect on the *NPV* (or any other variable). For example, we might change the selling price from $2.50 per pound to $2.25 (a change of –10%) and then calculate that the *NPV* would decline to $38,552.35. Record this fact and reset the selling price to its original value. Now, reduce the terminal value of the land to $225,000 (a change of –10%) and note that the *NPV* declines to $81,407.26. Reducing the selling price by 10% leads to a much bigger decline in the *NPV* than does a similar reduction in the terminal value of the land. Therefore, we should devote more resources to determining the selling price.

There are two problems with the procedure outlined above. First, by making only a single small change to each variable, we may miss non-linear relationships. Second, to carry out this procedure for each uncertain variable would be cumbersome. We would have to change a variable, write down the resulting *NPV*, reset the variable to its original value, change another variable, write down the resulting *NPV*, and so on. To solve the first problem we can simply make several changes in each variable, both up and down. For example, we could change the selling price per pound by –30% to +30% in, say, 10% increments. This, however, exacerbates the second problem by making the analysis even more onerous. Fortunately, Excel provides a solution.

Using Data Tables

A data table is an Excel tool that automatically performs the process described previously. To see how they work, let's set up a simple example. Suppose that we wish to see what happens to the expected *NPV* as the selling price varies from $1.50 to $3.50 per pound. To start, enter `$1.50` in G5 and `$2.00` in H5.[5] Now use AutoFill to create the rest of the price series. The next step is to enter a formula into F6. In this case, we are interested in the *NPV* so we need to enter: `=NPV(B14,C27:G27)+B27`.

FIGURE 11-3
THE DATA TABLE DIALOG BOX



When we execute the data table command, Excel will automatically substitute the values from G5:K5 into our model (in cell B9) one at a time, and record the resulting *NPV*s in the table. Select F5:K6 (this is the entire area of the table we are creating, including the *NPV* formula) and then choose **D**ata **T**able from the menu. In the resulting dialog box type `B9` into the Row input cell edit box as shown in Figure 11-3. After clicking the OK button, this section of your worksheet should look like the one in Exhibit 11-3.

EXHIBIT 11-3
THE DATA TABLE FOR DIFFERENT PRICES

	F	G	H	I	J	K
5	Unit Price	$ 1.50	$ 2.00	$ 2.50	$ 3.00	$ 3.50
6	95,533.22	(132,390.24)	(18,428.51)	95,533.22	209,494.94	323,456.67

The values in G6:K6 are the *NPV*s. For example, if the price per pound was $1.50 the *NPV* would be $–132,390.24. Similarly, if the price was $3.50 the *NPV* would

5. The data table can be created anywhere on this worksheet, but it cannot be in another worksheet. You can get around this limitation by carefully constructing your formulas.

be $323,456.67. If necessary, you can change any or all of the prices in rows and the table will automatically update.

Note that the original *NPV* in F6 is not a part of the table per se, and it might confuse some people. It is only there so that Excel knows what formula to use when calculating the table. We can easily hide this value by simply selecting F6 and changing the font color to white. This will make the table easier to read.

Excel allows for other types of data tables than we have demonstrated here. The data table in Exhibit 11-3 is called a row-oriented one-variable table because our prices are in a row. If the prices were in a column instead, we could create a column-oriented one-variable table. To create a column-oriented table, the only difference is that you would enter the changing cell (B9) into the Column input cell edit box (see Figure 11-3). The result would be exactly the same, except for the orientation table. We can also create two-variable data tables that allow for two changing variables. The procedure is similar, but you should check the online help for the details.

Since we have more than one uncertain variable in our catfish fillet problem, we will need several data tables. It will also be helpful, for comparison purposes, to deviate a bit from the methodology described above. Specifically, we can set up several data tables based on percentage changes in our uncertain variables. This will make it easier to compare the result from a change in unit sales to the result from a change in the growth rate.

Let's start by changing the input area of the worksheet so that it can accommodate this type of sensitivity analysis more easily. In D5 enter: `Sensitivity %`, and then in D6:D11 enter: `0%` in each cell. Change B6 so that it has a formula rather than a number: `=350000*(1+D6)`. Now if we put 10% into D6, for example, the terminal value of the land will change from $350,000 to $385,000. Make similar changes in cells B7:B11 so that those values change as we change the corresponding percentages. Your input area should now look like the one in Exhibit 11-4. Note that we will be doing the sensitivity analysis on only six of the variables.

EXHIBIT 11-4
THE INPUT AREA SET UP FOR SENSITIVITY ANALYSIS

	A	B	C	D
1	**Frozen Catfish Fillet Project Inputs**			
2	Cost of Land	250,000		
3	Cost of Buildings & Equipment	400,000		
4	Annual Depreciation	40,000		
5	Life of Project (Years)	5		Sensitivity %
6	Terminal Value of Land	350,000		0%
7	Terminal Value of Buildings & Equipment	200,000		0%
8	First Year Catfish Sales (lbs)	200,000		0%
9	Price per Pound	2.50		0%
10	Unit Sales Growth Rate	8%		0%
11	Variable Costs as % of Sales	60%		0%
12	Fixed Costs	80,000		
13	Tax Rate	35%		
14	WACC	10%		

At this point we can proceed in a similar manner as we did above. Let's first create a percentage-based data table for the terminal value of the land. Go to A38 and enter: `Terminal Value of Land`. In B38:H38 enter a series from –30% to +30% in 10% increments (–30%, –20%, –10%, etc.). In A39, enter the ***NPV*** function: `=NPV(B14,C27:G27)+B27`. We have now set up the table and all that remains is to select it and execute the **D**ata **T**able command. In this case the row input cell is D6, which is the percentage that corresponds to the terminal value of the land. The data table will plug –30% into D6 which will change the terminal land value in B6 resulting in a different *NPV*. Next, it will plug in –20% and so on.

Using the same procedure, create data tables for each of the uncertain variables, each time changing the row input cell (D7, D8, etc.). You should end up with six data tables as shown in Exhibit 11-5. Note that, as mentioned above, we have hidden the original *NPV* formula so that the table is easier to read.

EXHIBIT 11-5
DATA TABLES FOR THE UNCERTAIN VARIABLES

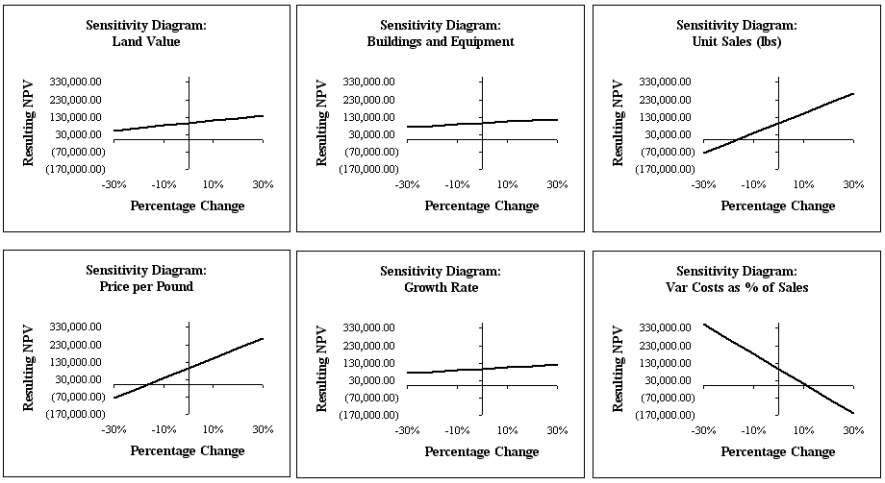
	A	B	C	D	E	F	G	H
37	**Sensitivity Tables**							
38	Terminal Value of Land	-30%	-20%	-10%	0%	10%	20%	30%
39		53,155.34	67,281.30	81,407.26	95,533.22	109,659.18	123,785.14	137,911.10
40								
41	Value of Buildings & Equipment	-30%	-20%	-10%	0%	10%	20%	30%
42		71,317.29	79,389.26	87,461.24	95,533.22	103,605.19	111,677.17	119,749.15
43								
44	First Year Catfish Sales (lbs)	-30%	-20%	-10%	0%	10%	20%	30%
45		(75,409.37)	(18,428.51)	38,552.35	95,533.22	152,514.08	209,494.94	266,475.81
46								
47	Price per Pound	-30%	-20%	-10%	0%	10%	20%	30%
48		(75,409.37)	(18,428.51)	38,552.35	95,533.22	152,514.08	209,494.94	266,475.81
49								
50	Unit Sales Growth Rate	-30%	-20%	-10%	0%	10%	20%	30%
51		71,214.34	79,201.23	87,307.07	95,533.22	103,880.99	112,351.75	120,946.85
52								
53	Variable Costs as % of Sales	-30%	-20%	-10%	0%	10%	20%	30%
54		351,947.10	266,475.81	181,004.51	95,533.22	10,061.92	(75,409.37)	(160,880.67)

Sensitivity Diagrams

Many people can look at the data tables and see at a glance that the most important variables are the unit sales, price per pound, and the variable cost as a percentage of sales. Others, however, find it helpful to create charts of the data. The most appropriate type of chart for this analysis is an XY Scatter chart. We can either create a separate chart for each variable, or put all of the variables in one chart.

To create one chart that shows all of the variables we must first start with a chart of one of the variables. Select B38:H39 and create an XY Scatter chart and place it somewhere convenient on the screen. Now, select B42:H42 and drag the range over the chart and drop it there. You have now added a second data series. Continue adding each of the other data series in the same way. For this example problem, it turns out that some of the lines overlap, so it is impossible to tell them apart on the chart. This is not generally the case. However, even when we don't have this problem, it can be much easier to see which variables are most important if they are all in separate charts. This is particularly true when we have a lot of variables.

FIGURE 11-4
SENSITIVITY DIAGRAMS FOR EACH VARIABLE



Creating a separate chart for each variable is more time consuming, and you need to make sure that the scaling of the axis is the same in each chart. The advantage to this approach is that it is much easier to identify the individual data series. As can be seen in Figure 11-4, the lines with the steepest slopes are the same as those previously identified as the most important variables. In order to make this comparison, it is vital that the axis scaling is identical in each chart. To make creating all of these charts easier, you can copy and paste the first one and then simply change the data ranges.

Scenario Analysis

The sensitivity analysis has identified the three most important variables, but we've only seen their impact on the *NPV* in isolation. A *scenario analysis* will allow us to see the combined effect of changing all of these variables simultaneously. Suppose that after seeing the sensitivity analysis report, a meeting was held to determine

three possible scenarios. The best and worst cases are shown in Table 11-3 along with the base case which represents the current expectations.

TABLE 11-3
THREE SCENARIOS

Variable	Worst Case 20%	Base Case 60%	Best Case 20%
Unit Sales	125,000	200,000	275,000
Price per Pound	$2.25	$2.50	$2.65
Variable Cost %	65%	60%	55%

Note that the worst case scenario is one in which all of the variables are at their worst possible values. Similarly, the best case assumes that all of the variables take on their best possible values simultaneously. While such extreme outcomes are unlikely, they are useful for determining the extreme boundaries around the expected *NPV*.

Excel provides the Scenario Manager to help us to analyze such scenarios. In Chapter 3 (page 81) we used the Scenario Manager to perform a sensitivity analysis to see the effect of the timing of a large capital expenditure on total borrowing. In Chapter 10 (page 306) we performed a scenario analysis to determine the combined effect of changing maintenance and defect costs on the profitability measures of a replacement project.[6]

In this section, we will again use the Scenario Manager, but our goal is to get a better understanding of the riskiness of the frozen catfish product. Specifically, we want to get an idea of the probability distribution around the expected *NPV*, especially the range of possible outcomes. Before using the Scenario Manager, it is helpful to define names for the changing cells. Set up the scenarios given in Table 11-3, and create a scenario summary report with the *NPV* as the result cell.

6. We could have used the Scenario Manager to do the sensitivity analysis, but that would have required us to set up 42 different scenarios. It is much easier to use data tables for sensitivity analysis, but they are not adequate for scenario analysis because data tables only allow (at most) two variables to change at the same time.

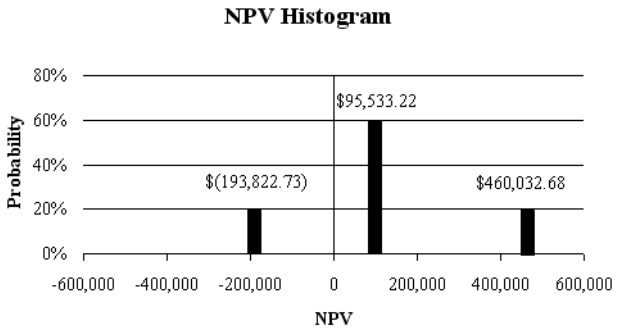
EXHIBIT 11-6
SCENARIO SUMMARY REPORT

Scenario Summary	Worst Case	Base Case	Best Case
Changing Cells:			
Catfish_Sales_Pounds	125,000	200,000	275,000
Price_Per_Pound	2.25	2.50	2.65
Var_Costs_Percent	65%	60%	55%
Result Cells:			
Net_Present_Value	$ (193,822.73)	$ 95,533.22	$ 460,032.68

Exhibit 11-6 shows the scenario summary report. Note that in the worst case, where the price and unit sales are low and variable costs are high, the *NPV* is significantly negative. On the other hand, the *NPV* is very high in the best case. So far, the scenario analysis has shown a risk of a negative *NPV*. However, we haven't yet quantified that risk.

Assume that the experts who defined the three scenarios were also asked to assign the probabilities of occurrence to each scenario. Feeling that the extreme scenarios are relatively unlikely, they assigned a probability of 20% to the best and worst cases. This leaves 60% for the base case. On your Scenario Summary worksheet, enter: `Probabilities` in D12, `20%` in E12, `60%` in F12, and `20%` in G12. Figure 11-5 shows a histogram of the probability distribution.

FIGURE 11-5
PROBABILITY DISTRIBUTION OF *NPV*



Calculating Expected Values in Excel

With this information we can now calculate the expected *NPV* for the project. We might try to calculate the expected value in several ways. For example, we might try using the **AVERAGE** function. Recall from Chapter 1 that the **AVERAGE** function calculates the arithmetic (unweighted) average of the observations. However, a glance at Figure 11-5 shows that the distribution is somewhat skewed to the right, and the possible outcomes are not all equally likely, so the average will overstate the expected value (as we discussed on page 328).

It would be more appropriate to calculate the expected value. Recall that the expected value is found by multiplying each possible outcome by its associated probability and summing the results. In C13 enter: `Expected NPV`. We might make this calculation in any one of several ways. For example, in D13 we could enter: `=D10*D12+E10*E12+F10*F12`, but that's not the best way. A better way would be to use an array formula: `=SUM(D10:F10*D12:F12)`, just remember to hold down the Shift and Ctrl keys when pressing the Enter key. Finally, we have supplied a macro called **FAME_EXPVALUE** that will calculate the expected value of a probability distribution. It is defined as:

FAME_EXPVALUE(*VALUES*, *PROBABILITIES*)

where ***VALUES*** is the range of possible outcomes, and ***PROBABILITIES*** is the range of probabilities. To use this function, make sure that the file FameFncs.xls is open, then enter: `=FameFncs.xls!Fame_ExpValue(D10:F10,D12:F12)` in D13. As an alternative, you can use the Insert Function tool which will list this function in the "User Defined" category.

Whichever way you choose to calculate it, the expected *NPV* for this project is $110,561.92. This means that, if our assumptions are correct, it is likely that this project is a good investment. If we could repeat this investment thousands of times under the same conditions, the average *NPV* would be $110,561.92. Unfortunately, we only get one chance, so it would be nice to know a little more about the distribution around the expected value, that is, a measure of dispersion.

Calculating the Variance and Standard Deviation

The scenario summary report makes it obvious that a negative *NPV* is possible. The question to ask is, "How risky is this project, and what is the likelihood that the *NPV* will be negative?" The first step towards answering this question is to calculate one or more of the measures of dispersion (variance, standard deviation, and coefficient of variation) that were mentioned earlier in this chapter.

Excel provides two functions for calculating the variance of a range of numbers: **VAR** calculates a sample variance while **VARP** calculates a population variance.[7] These functions are defined as:

VAR(*NUMBER1*, *NUMBER2*, . . .)

and

VARP(NUMBER1, *NUMBER2*, . . .)

Again, we can substitute a range of numbers for the individual numbers in the definition. For our purposes we should use the population version of the variance because we know the entire set of possible outcomes. In C14 enter: `Variance`, and in D14 enter: `=VARP(D10:F10)`. The result is 71,568,179,048.23, which is a huge number! One problem with this is that it ignores the probabilities that we assigned to the scenarios. To calculate the variance correctly, we can use equation (11-3). Again, we have some choices about how to implement the equation. One way is to use an array formula: `=SUM(D12:F12*(D10:F10-AVERAGE(D10:F10))^2)`. Much easier, we could use a macro from FameFncs.xls called FAME_Var which is defined as:

FAME_VAR(*VALUES*, *PROBABILITIES*)

and the inputs are the same as with the **FAME_EXPVALUE** function. To use this macro enter: `=FameFncs.xls!FAME_Var(D10:F10,D12:F12)` into D14. Whether you use the array formula or the macro, you will get the correct answer of 43,191,865,094.31.

Of course, the problem with the variance is that it is difficult to interpret because the basic units (dollars) are squared. The standard deviation will correct this problem. As with the variance, Excel provides two functions: **STDEVP** and **STDEV**. These functions are defined as:

STDEVP(*NUMBER1*, *NUMBER2*, . . .)

and

7. The difference between a sample *statistic* and a population *parameter* is that the sample statistic includes an adjustment to account for the bias introduced because we aren't dealing with the full population. In this case the adjustment is to divide by *N*–1 instead of *N*.

STDEV(*NUMBER1*, *NUMBER2*, . . .)

However, these functions do not take into account the probabilities that have been provided.[8] Since we have already calculated the variance in D14, the easiest way to calculate the standard deviation is to enter: `=SQRT(D14)` into D15. Alternatively, we could use an array function or the macro **FAME_STDEV**:

FAME_STDEV(*VALUES*, *PROBABILITIES*)

The inputs are the same as with **FAME_VAR**. To use this function, enter: `=FameFncs.xls!Fame_StdDev(D10:F10,D12:F12)` in D15. The result is 207,826.53.

Now we know quite a bit more about the distribution around the expected *NPV*. For example, we know that the 95.5% confidence interval for the *NPV* is from $–305,091 to $526,215 (plus or minus two standard deviations). Implied by that wide confidence interval is the fact that the probability of a negative *NPV* is quite high.

Given the expected *NPV* and its standard deviation, we can calculate the probability of a negative *NPV* using a test statistic. Specifically, we would like to know the probability of the *NPV* being less than or equal to zero, so the test statistic is:

$$z = \frac{0 - \mathrm{E}(NPV)}{\sigma_{NPV}} \qquad \textbf{(11-6)}$$

Equation (11-6) tells us how many standard deviations 0 is away from the mean. Using the expected *NPV* and standard deviation from the scenario analysis, we find:

$$z = \frac{0 - 110{,}561.92}{207{,}826.53} = -0.5320$$

This means that zero is 0.532 standard deviations below the expected value. We can look up this value in a statistical table showing the area under a standard normal curve to determine the probability that the *NPV* is less than or equal to zero. Go

8. That's not to say that **VAR**, **VARP**, **STDEV**, and **STDEVP** are useless functions. Anytime you don't have information regarding probabilities, or anytime you can safely assume that your data are normally distributed, they are very useful.

ahead, pull out your dusty old statistics textbook and you'll see that the probability is about 29.81% (–0.532 isn't in the table, so look up –0.53 as an approximation).

Of course, we can automate this calculation. Excel provides the **NORMSDIST** function which calculates the area under a standard normal curve. This function is defined as:

NORMSDIST(*z*)

where z is calculated as above, and measures the number of standard deviations above or below the expected value. In C16 enter: `Prob(NPV <= 0)` as the label, and in D16 enter: `=NORMSDIST((0-D13)/D15)`. The result is that we have a 29.74% chance of the *NPV* being less than or equal to zero.

Obviously, we have learned a lot more about the nature of this project than we knew before. But, what are we to make of this almost 30% chance of a negative *NPV*? Should we accept the project because it has a positive expected *NPV*, or reject it because there is a relatively high probability of a negative *NPV*? The answer is that there is no answer. The individual decision maker must decide. However, this result certainly suggests that it would be prudent to go back and expend more effort to firm up the estimates of the uncertain variables which would reduce the uncertainty surrounding the estimated *NPV*.

Monte Carlo Simulation

Still another method for dealing with risk is *Monte Carlo simulation*. A simulation is similar to a scenario analysis, but a computer generates thousands of scenarios automatically. Each of the uncertain variables in the model is assumed to be a random variable with a known probability distribution. So, we can create a scenario by randomly drawing a value for each of the uncertain variables from their probability distributions and plugging those numbers into the model. The model is then recalculated and the model outputs (e.g., *NPV*) are collected and stored. This process is then repeated thousands of times, resulting in thousands of potential *NPV*s.

From this long list of *NPV*s, we can get a much better understanding of the expected *NPV* of the project, and the amount of uncertainty surrounding it. As we saw in the scenario analysis, we can learn about the range of potential *NPV*s, the standard deviation of the *NPV*s, and the probability that the *NPV* will actually turn out to be negative (or positive, depending on how you choose to look at it). Furthermore, rather than seeing just an unlikely best and worst case scenario, we

can see all of the potential in-between scenarios. The result is that we have a much better understanding of the risks of the project than the scenario analysis can provide. An additional benefit of simulation over scenario analysis is that it should result in less uncertainty (standard deviation around the expected *NPV*) because we have many more, and more realistic, possible outcomes.

The key to getting good results from a simulation is to choose the correct probability distributions and correlation structure for the variables.[9] This can be difficult and may require a good deal of judgement on the part of the analyst, especially when historical data is not available. On occasion, the analyst can use general principles or theoretical knowledge to determine the correct distribution of a variable. For example, any variable that is the product of two normally distributed variables will be lognormally distributed. Suppose that we need to make a guess at the distribution of total revenue. Since total revenue is the product of unit sales and the price per unit, and since it could be very large but never fall below zero, a lognormal distribution would seem to be appropriate.

Excel does not have any built-in simulation tools, however, we have included an add-in to do simulations on the book's Website at http://mayes.swlearning.com. We will use this add-in to perform a Monte Carlo simulation on the catfish fillet problem. Make sure that your workbook is on the catfish fillet worksheet that you used to do the scenario analysis and then open the ExcelSim.xla file.[10] Note that a new menu item will be added to the menu bar. Choosing Excel**S**im Sim**u**late will launch the program.

Before beginning the simulation, let's define the problem. We have identified three important uncertain variables in the model: Unit sales in the first year, price per unit, and the variable costs as a percentage of sales. Further, let's assume that

9. For an excellent discussion of several commonly used probability distributions see "Uncertainty & Risk Analysis," by Chris Rodger and Jason Petch, PricewaterhouseCoopers, United Kingdom, April 1999.

10. Please see the "ExcelSim 2003 Documentation" file on the Website for this book at http://mayes.swlearning.com for more information on installing and using this add-in.

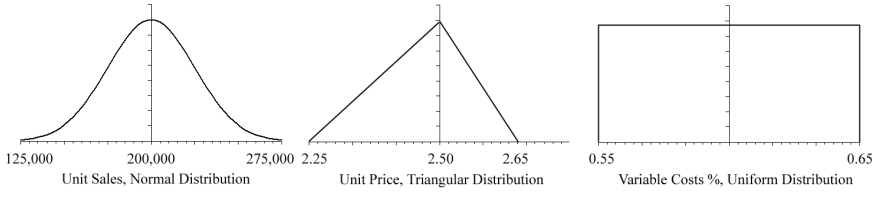
management has specified the probability distributions for each of these variables as shown in Table 11-4.

TABLE 11-4
PROBABILITY DISTRIBUTIONS FOR SIMULATION

Variable	Probability Distribution
Unit sales in pounds	Normal with mean 200,000 and standard deviation of 25,000.
Price per pound	Triangular with minimum of 2.25, most likely of 2.50, and maximum of 2.65.
Variable cost as % of sales	Uniform with minimum of 55% and maximum of 65%.

These distributions were chosen primarily to demonstrate three of the most commonly used distributions, but also with some logic. We assume that unit sales will tend to cluster around 200,000 pounds in the first year. Even though the distribution of unit sales will be skewed to the right (it can be very high, but not below 0), it was felt that the skewness will be so minor as to be safely ignored. Therefore, a normal distribution seems appropriate. A triangular distribution was chosen for the unit price because management feels confident that it can identify the minimum, maximum, and most likely prices but is not confident in choosing any particular distribution. Finally, a uniform distribution was chosen for variable costs because management feels that it could be anywhere between 55% and 65%, but isn't comfortable in saying that any one value is more likely than another. Figure 11-6 shows the distributions graphically.

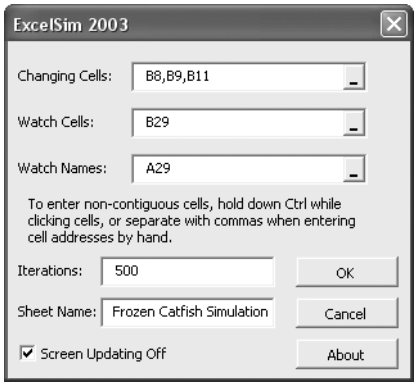
FIGURE 11-6
GRAPHS OF PROBABILITY DISTRIBUTIONS



Again, make sure that your catfish fillet worksheet is open and then choose Excel**S**im Sim**u**late from the menus. The main ExcelSim dialog box will appear. The first edit box is for the "Changing Cells." These are the cells that contain the

uncertain variables (unit sales, etc.). Type `B8,B9,B11` into this edit box, or you may select the cells with the mouse (hold down the Ctrl key as you click on each cell). Next we need to select the "Watch Cells" which are the cells that will be stored after each trial. In this case, we would like to keep track of the *NPV* for each trial, so enter `B29` into the edit box. The "Watch Names" edit box is optional. You can use it to specify a cell that contains a descriptive label for each of the watch cells. Type `A29` into this edit box. At this point, all that remains is to tell ExcelSim how many trials to run and what to name the worksheet that will be created for the output (this is optional). Keep in mind that the more trials you run, the more accurate the simulation will be. The maximum number of iterations is 30,000 but we will only run 500 to keep the output more manageable. Type `500` into the "Iterations" edit box. Finally, enter `Frozen Catfish Simulation` into the "Sheet Name" edit box. If you choose not to enter a sheet name for the output, it will be named "Simulation Report" by default. Figure 11-7 shows the main dialog box with the data entered.

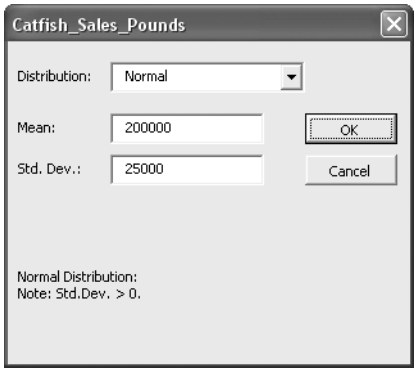
FIGURE 11-7
EXCELSIM MAIN DIALOG BOX



After clicking the OK button, you will be presented with the first of the distribution dialog boxes. These dialog boxes are where you will describe the probability distribution for the uncertain variables. There will be one for each changing cell. Note that if you have used defined names for the changing cells (as we have already done before running the scenario analysis), the names will be shown in the title bar. The first variable is the unit sales. Table 11-4 tells us that the distribution is normal with a mean of 200,000 and standard deviation of 25,000. So, select "Normal" from the distribution list. At this point, the dialog box will change to prompt you

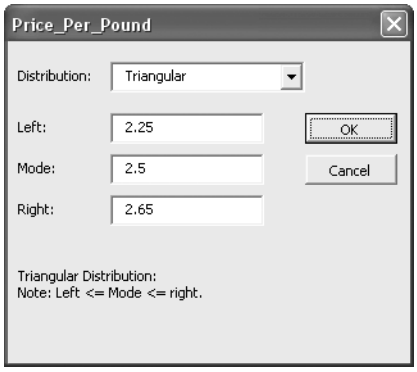
for a mean and standard deviation for the distribution. Enter `200,000` for the mean, and `25,000` for the standard deviation. Figure 11-8 shows the completed dialog box.

FIGURE 11-8
DISTRIBUTION DIALOG BOX FOR UNIT SALES



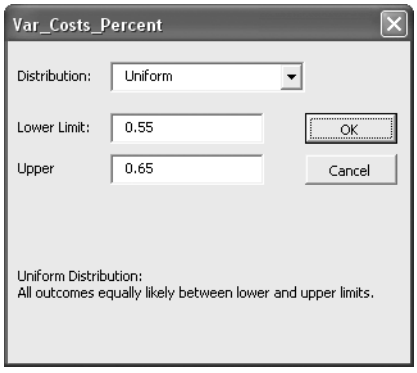
Click the OK button, and we will repeat this process for the other two changing cells. The next dialog box is for the unit price. Note that the dialog box is, at first, showing the exact settings as were previously entered. That is helpful if the distribution is the same, but we need to choose a different distribution. Choose a triangular distribution from the drop down list. You will now be prompted for the left side, mode (or most likely), and right side of this distribution. Enter `2.25` for the left side, `2.50` for the mode, and `2.65` for the right side as shown in Figure 11-9, and then click the OK button.

FIGURE 11-9
DISTRIBUTION DIALOG BOX FOR PRICE PER POUND



Finally, choose a uniform distribution for the variable costs. In this case, you will be asked to supply the lower and upper limits of the distribution. Since variable costs are expected to be somewhere between 55% and 65% of sales, enter `0.55` for the lower limit and `0.65` for the upper limit.

FIGURE 11-10
DISTRIBUTION DIALOG BOX FOR VARIABLE COSTS



When you click the OK button, the simulation will begin to run. You can follow the progress by watching the status bar at the lower left corner of the Excel window. (If you re-run the simulation, uncheck the Screen Updating Off box and you can watch the spreadsheet change.) After a few seconds, a new worksheet containing the output will be displayed. The output consists of the 500 *NPV*s that were

generated during the simulation, and some descriptive statistics at the bottom. Exhibit 11-7 shows the results of the first five and last five trials (the rest are hidden to save space), as well as the summary statistics. Since these results are based on random draws from the probability distributions, your results will be somewhat different. However, the mean and standard deviation of the *NPV*s should be similar.

Just as we did with the output from the scenario analysis, we can draw some important conclusions from this data. It will also be useful to compare the results of the simulation to the scenario analysis. First, note that the mean *NPV* was $94,202 while the minimum and maximum *NPV*s were $–155,668 and $332,746 respectively. Note that the minimum and maximum *NPV*s are not as extreme as the worst case and best case *NPV*s from the scenario analysis. This suggests that the extra information provided by the simulation has reduced the uncertainty.

EXHIBIT 11-7
THE SIMULATION OUTPUT

	A	B
1	***Simulation Report by ExcelSim***	
2	**Trial Results**	
3	**Trial**	**Net Present Value**
4	1	$204,665.95
5	2	$58,482.36
6	3	$159,176.81
7	4	$21,327.41
8	5	$198,178.68
499	496	$36,975.52
500	497	$90,791.74
501	498	$103,596.78
502	499	$187,176.41
503	500	$44,633.45
504	Min	($155,668.00)
505	Max	$332,745.75
506	Mean	$94,202.27
507	Median	$87,827.03
508	Mode	#N/A
509	Avg Dev	65,319.05
510	Std Dev	80,883.83
511	Coef. Var.	0.8586
512	Skewness	0.0423
513	Kurtosis	(0.2083)

The standard deviation of the *NPV*s is $80,884, which is considerably less than the standard deviation from the scenario analysis. The reason for the reduction in uncertainty is that we have run many more scenarios, and most of them are not nearly as extreme as the best and worst case scenarios. The reduction in uncertainty is also reflected in the probability that the *NPV* is less than or equal to zero. Recall that we can use the **NORMSDIST** function to calculate this probability as we did for the scenario analysis. In D506 enter the label `Prob(NPV <= 0)`, and in E506 enter the formula `=NORMSDIST((0-B506)/B510)`. The result shows a 12.21% chance of a negative *NPV* (again, your results may vary slightly depending on the mean and standard deviation from your simulation). We can also verify this by doing an actual count of the *NPV*s that are less than 0. Copy the label from D506 and paste it into D507. Excel has a useful function called **COUNTIF** that is defined as:

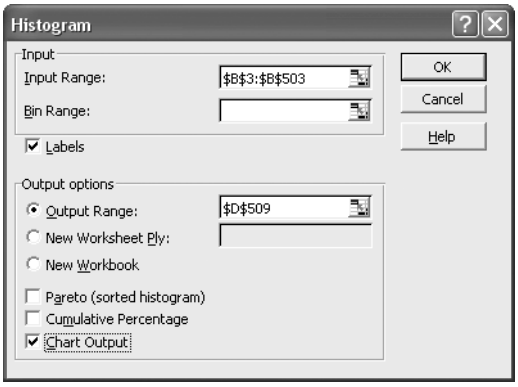
COUNTIF(*RANGE*, *CRITERIA*)

where ***RANGE*** is the range of numbers, and ***CRITERIA*** is the particular counting rule that you wish to apply. In this case, we wish to count the number of *NPV*s that are less than or equal to 0, so in E507 enter the formula: `=COUNTIF(B4:B503, "<=0")/500`. From our simulation there were 64 negative *NPV*s out of 500 total, or 12.80%, which conforms closely to the previous result.[11] So, the project appears to be far less risky than was suggested by the scenario analysis.

Finally, we can use Excel's built-in Histogram tool to get a visual look at the probability distribution. Choose **T**ools **D**ata Analysis Histogram from the menus. This will display the dialog box pictured in Figure 11-11.

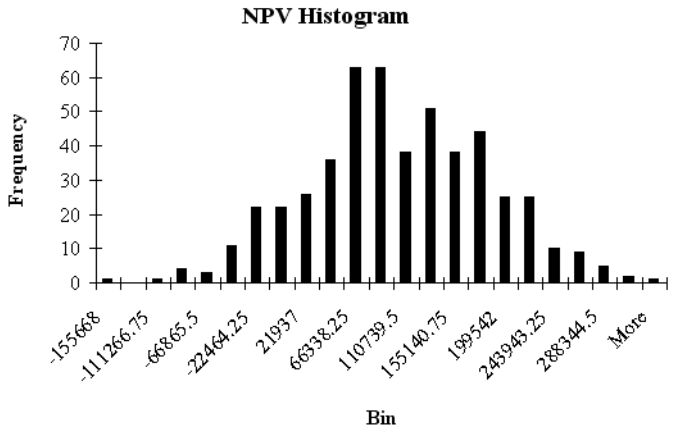
11. The array formula `=SUM((B4:B503<=0)*1)/500` will give the same result.

FIGURE 11-11
THE HISTOGRAM DIALOG BOX



All you need to do is to specify the **I**nput Range (B3:B503), check the **L**abels box, specify the **O**utput Range (D509), and that you want to create **C**hart Output. Excel will automatically decide how to group the data and will create the histogram as shown in Figure 11-12.

FIGURE 11-12
HISTOGRAM OF *NPV*S FROM THE SIMULATION



The Risk-Adjusted Discount Rate Method

Yet another method of incorporating risk into our capital budgeting decision process is to use a risk-adjusted discount rate. As we discussed how to determine the required rate of return in Chapter 8 we mentioned a model referred to as a "simple risk premium model." The risk-adjusted discount rate (RADR) is an example of this model. Recall that the simple risk premium model was defined as:

$$\text{Required Return} = \text{Base Rate} + \text{Risk Premium}$$

and that the base rate and risk premium are subjectively determined. The idea behind this model is that the investor (or firm) has some minimum required return for tying up her funds to which a premium is added in order to compensate for risk. Projects with greater risk require larger risk premiums. In using the RADR technique, we will modify this model so that it becomes:

$$\text{RADR} = \text{WACC} + \text{Risk Premium}$$

Note that the risk premium is still subjectively determined, but the base rate is the firm's *WACC*. The correct discount rate for average risk projects is the *WACC*, but for riskier-than-average projects a positive risk premium is added. This higher discount rate is meant to penalize the riskier project and will result in a lower, and possibly negative, *NPV*. If the project still has a positive *NPV* then the project is expected to more than compensate the shareholders for the extra risk and it should be accepted. For projects with less risk than average the risk premium would be negative.

Normally, the risk premium will be determined according to a schedule that has been approved by the firm's upper management. This schedule will typically assign risk premiums according to the type of project. For example, if the firm is analyzing the possibility of replacing an existing machine, it would probably be considered a very low risk project and the risk premium might be –2%. On the other hand, a new product line, such as we are examining in this chapter, would be considered quite risky and might require a 3% risk premium. Expansion of an existing and successful project would probably be considered an average risk and the *WACC* with no risk premium would be used as the discount rate. Ultimately, the risk premium will be determined by managerial judgement. This judgement may be based on experience, some statistical measure of risk, or the outcome of a scenario analysis or a Monte Carlo simulation.

In our Freshly Frozen Fish problem, suppose that in the managerial judgement a 3% risk premium is required. Since the *WACC* for the firm is 10%, the required

return for this project would be 13%. Plugging this rate into your frozen catfish fillet worksheet reveals that the risk-adjusted *NPV* is $22,386.31. The fact that the *NPV* is still positive suggests that this is a good investment. It will likely more than compensate shareholders for the extra risk.

We can also look at the *IRR* of the project and turn the question around. Instead of asking what risk premium is required, we can ask if the expected risk premium is sufficient. Under the original assumptions the *IRR* was calculated to be 14.01%. Recall that the *IRR* is the discount rate that would result in the *NPV* being equal to zero. Since the *IRR* is 4.01% greater than the *WACC*, this is the expected risk premium. The project will obviously have a positive *NPV* for any risk premium up to 4.01% (RADR up to 14.01%). Therefore, the question is, "Is an extra 4.01% per year enough of a risk premium to compensate for the extra risk of this project?"

The Certainty Equivalent Approach

The problem with the RADR approach to adjusting for risk is that it combines two adjustments: one for risk and another for time. This approach implicitly assumes that risk is an increasing function of time. In many cases this may be true. Cash flow forecasts for a period five years from now are generally less certain than are forecasts for next year. However, such is not necessarily the case. For example, suppose that a firm has a maintenance contract which calls for a major overhaul of a machine in three years. If the cost of this overhaul is specified in the contract, this is a very low risk cost, even though it occurs in three years.

The *certainty-equivalent* (*CE*) approach separates the adjustments for time and risk. Where the RADR technique increases the discount rate to adjust for risk, the *CE* approach decreases the cash flow. To adjust for risk with the *CE* approach, we multiply the cash flow by the certainty equivalent coefficient. The net result is the same: The cash flow is penalized for risk. To adjust for time, we discount the cash flows at the risk-free rate of interest. This is the basis for the technical superiority of the certainty equivalent approach: It makes separate adjustments for risk and time rather than the intermingled adjustments of the RADR.

Certainty equivalent coefficients are determined as follows: The decision maker is asked what *certain* cash flow she would be willing to accept in exchange for the risky cash flow at some point in the future. The ratio of these cash flows determines the *CE* coefficient (α).

$$\alpha = \frac{\text{Riskless cash flow}}{\text{Risky cash flow}} \qquad \textbf{(11-7)}$$

As an example, assume that you are willing to accept $95 dollars for sure in place of a risky $100 one year from now. Your *CE* coefficient for this cash flow would be:

$$\alpha = \frac{95}{100} = 0.95$$

Cash flows that are riskier would be deflated with lower *CE* coefficients. In effect, this risky cash flow times $(1 - \alpha)$ is the amount that you would be willing to pay for an insurance policy to guarantee that you receive the risky cash flow (we are ignoring the time value of money for the moment). Note that the *CE* coefficient will always be between 0 and 1, and will generally decrease with time because of increased risk. To use the certainty equivalent approach, each cash flow is multiplied by the appropriate coefficient, α_n, and then the net present value is found using the risk-free rate of interest as the discount rate. The risk-free rate is used to discount the cash flows because all of the risk has been removed by the adjustment. Effectively, the *CE* technique converts a risky stream of cash flows into a risk-free stream of cash flows.

Let's remake our Freshly Frozen Fish worksheet to see how the *CE* approach works. First, make a copy of your worksheet. To do this, right-click the sheet tab and choose **M**ove or Copy from the menu. Now, in the new worksheet, change A14 to: `Risk-free Rate`, and B14 to: `4%`. Assume that management has given you the following information regarding the appropriate certainty equivalent coefficients:

TABLE 11-5
FRESHLY FROZEN FISH CE COEFFICIENTS

Year	CE Coefficient (α)
0	1.00
1	0.95
2	0.90
3	0.85
4	0.80
5	0.75

Select rows 28 and 29 and then choose **I**nsert **R**ows to add two new rows just below the annual cash flows. In A28 enter `Certainty Equivalent Coefficients` and then enter the certainty equivalents coefficients from the table in B28:G28. In A29 enter `Risk-adjusted Cash Flows`. In B29 enter the formula `=B27*B28` and copy it across. To calculate the risk-adjusted *NPV*, in B23 enter the formula: `=NPV(B14,C29:G29)+B29`. Note that the risk-adjusted *NPV* is $94,184.26, which is very close to our previous result. We actually, need not calculate the risk-adjusted cash flows in separate cells (B29:G29). Instead, we could calculate the *NPV* with the array formula: `=NPV(B14,C27:G27*C28:G28)+B27`.

We can also calculate the *IRR* and *MIRR* of the risk-adjusted cash flows. The formula for the *IRR* in B33 is: `=IRR(B29:G29)`. Similarly, the formula for the *MIRR* is: `=MIRR(B29:G29,B14,B14)`. Just remember that these measures must now be compared to the risk-free rate of interest, not to the firm's *WACC*. Since both are greater than the 4% risk-free rate, the project is acceptable. Exhibit 11-8 shows the completed worksheet.

If the certainty equivalents and the RADR are correctly determined, the decision that results from both methods will usually be the same. However, the *CE* technique suffers from the need to understand the utility function of the decision maker, and thus is very difficult to correctly implement in practice. At best, the *CE* coefficients could be found by interviewing the relevant decision maker as described earlier. Unfortunately, most modern corporations are owned by many shareholders and it is their risk preferences that we need to be concerned about, not those of some individual corporate officer. For this reason, the certainty equivalent method is not generally used in practice.

EXHIBIT 11-8
THE CATFISH FILLET WORKSHEET USING THE CE METHOD

	A	B	C	D	E	F	G
16	Annual Cash Flows for Frozen Catfish Fillet Project						
17		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
18	Initial Outlay	(650,000)					
19	Sales		500,000	540,000	583,200	629,856	680,244
20	Variable Costs		300,000	324,000	349,920	377,914	408,147
21	Fixed Costs		80,000	80,000	80,000	80,000	80,000
22	Taxable Cash Flows		120,000	136,000	153,280	171,942	192,098
23	Taxes		42,000	47,600	53,648	60,180	67,234
24	Depreciation Tax Benefit		14,000	14,000	14,000	14,000	14,000
25	Annual After-Tax Cash Flow		92,000	102,400	113,632	125,763	138,864
26	Terminal Cash Flow						515,000
27	Total Annual Cash Flows	(650,000)	92,000	102,400	113,632	125,763	653,864
28	Certainty Equivalent Coefficients	1.00	0.95	0.90	0.85	0.80	0.75
29	Risk-adjusted Cash Flows	(650,000)	87,400	92,160	96,587	100,610	490,398
30							
31	Net Present Value	$ 94,184.26					
32	Profitability Index	1.14					
33	Internal Rate of Return	7.75%					
34	Modified Internal Rate of Return	6.85%					

Portfolio Diversification Effects

So far, we have examined investment risk in isolation. However, from the stockholder's point of view, a corporation is nothing more than a collection of investments managed by a professional management team. Therefore, it will be helpful to examine the effect that the addition of risky projects has on the overall risk of the firm. Let's look at an example, using stock selection rather than a capital investment project.

Suppose that you have $10,000 available for investment purposes. Your stockbroker has suggested that you invest in either Stock A or Stock B, but you are concerned about the riskiness of these stocks. During your investigation, you have gathered the historical returns for these stocks, which is presented in Table 11-6.

TABLE 11-6
HISTORICAL ANNUAL RETURNS FOR A AND B

Year	Stock A Returns	Stock B Returns
2000	10.30%	10.71%
2001	–0.10%	25.00%
2002	23.30%	0.38%
2003	2.20%	26.20%
2004	14.00%	11.52%

To quantify your concerns about the riskiness of these stocks, you open a new worksheet and enter the data from Table 11-6.

Since both firms have had their ups and downs, you want to calculate the average annual return for the last five years. Further, to get a feeling for their riskiness, you want to calculate the standard deviation of these returns. Assuming that you have entered the data from Table 11-6 starting in A1, you can calculate the average return for Stock A in B7 with: `=AVERAGE(B2:B6)`. Copying this to C7 will calculate the average return for Stock B. The results show that Stock A has earned an average of 9.94% per year over the last five years, while Stock B has earned 14.76% per year.[12]

Obviously, if the average historical return reflects the expected future average return, Stock B is to be preferred. Recall, however, that higher returns are generally accompanied by higher risk. We can measure the riskiness of these returns with the standard deviation. To calculate the standard deviation of Stock A's returns enter: `=Stdev(B2:B6)` in B8 and copy it to C8. We can use Excel's built-in formula in this case because we do not have information regarding the probability distribution of returns. The results show that the standard deviation of returns is 9.43% for Stock A and 10.83% for Stock B.

Now we have a problem. If the risk of Stock B was less than Stock A, we would obviously prefer B with a higher return for less risk. In this case, though, we do not have enough information to know if the extra 4.82% return per year from Stock B is enough to offset the extra risk. Suppose that we decided to purchase both stocks

12. We are ignoring compounding for simplicity. To find the compound average annual rate of return use the **GEOMEAN** function (see page 22).

instead of just one of them. We will put 50% of your funds in Stock A, and 50% in Stock B. We can determine the returns that you would have earned in each year, by calculating a weighted average of each stock's return. In D2 enter the formula: `=0.5*B2+0.5*C2`. This will calculate the return that our portfolio would have earned in the year 2000. Copy this formula to each cell in the range D3:D6, and then copy the expected return formula from C7 to D7.

Notice that the expected portfolio return is 12.35%, exactly halfway between the returns on the individual stocks (remember that we put 50% into each stock). Now, let's see what happens to the standard deviation. Copy the formula from C8 to D8. Notice that the standard deviation of the portfolio is only 1.35%—significantly less than the standard deviation of either stock alone! This is a demonstration of the benefits of diversification. Exhibit 11-9 shows these results.

EXHIBIT 11-9
PORTFOLIO OF STOCKS A AND B

	A	B	C	D
1	Year	Stock A Returns	Stock B Returns	Portfolio
2	2000	10.30%	10.71%	10.51%
3	2001	-0.10%	25.00%	12.45%
4	2002	23.30%	0.38%	11.84%
5	2003	2.20%	26.20%	14.20%
6	2004	14.00%	11.52%	12.76%
7	Exp. Ret.	9.94%	14.76%	12.35%
8	Std. Dev.	9.43%	10.83%	1.35%

Because the portfolio consisting of both A and B provides a higher return and less risk than Stock A, you would certainly prefer the portfolio to Stock A. We cannot, however, definitively say that you would prefer the portfolio to Stock B. To determine which you would pick, we would need information regarding your risk/return preferences.[13] In this case, most people would prefer the portfolio because the difference in returns is slight, but the difference in risk is relatively large.

13. More specifically, we would require knowledge of your utility function.

Determining Portfolio Risk and Return

Expected Portfolio Return

As you have seen in the previous example, combining assets into a portfolio (whether that portfolio consists of stocks or equipment or product lines) may result in the reduction of risk below that of any individual asset. You have also seen that the expected return for a portfolio will be between that of the lowest return asset and the highest return asset. In general, we can say that the expected return for a portfolio is a weighted average of the expected returns for the individual assets. The weights are given by the proportion of total portfolio value that each asset represents. In mathematical terms:

$$E(R_P) = \sum_{t=1}^{N} w_t E(R_t) \qquad \textbf{(11-8)}$$

where w_t is the weight and $E(R_t)$ is the expected return of the t^{th} asset. Equation (11-8) is applicable regardless of the number of assets in the portfolio. From the previous example, the expected return for the portfolio is:

$$E(R_P) = 0.5(0.0994) + 0.5(0.1476) = 0.1235 = 12.35\%$$

which is exactly the result we got when we calculated it in D7 using a different methodology. The difference with equation (11-8) is that we can use the expected future returns which may differ from the average of historical returns.

Portfolio Standard Deviation

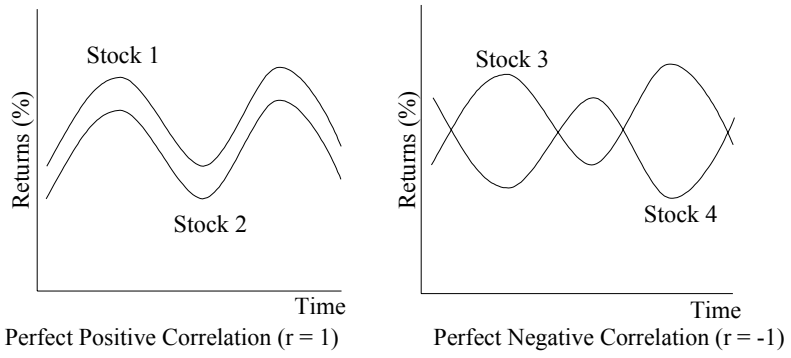
While the expected return of the portfolio is a weighted average of the expected returns for the assets, the portfolio standard deviation is not so simple. If we calculated a weighted average of the standard deviations of Stocks A and B, we would get:

$$\text{Weighted average } \sigma = 0.5(0.0943) + 0.5(0.1083) = 0.1013 = 10.13\%$$

But we know that the portfolio standard deviation is only 1.35%. Obviously, there is something else going on here.

What is going on is that we have ignored the *correlation* between these two stocks. Correlation describes how the returns of two assets move relative to each other through time. The easiest way to measure correlation is with the correlation coefficient (r). The correlation coefficient can range from –1 to 1. Figure 11-13 illustrates the extremes that the correlation coefficient can have.

FIGURE 11-13
PERFECT POSITIVE AND PERFECT NEGATIVE CORRELATION



Another way to measure the co-movement of returns is with the *covariance*. The covariance is calculated in the same way as the variance, except that we have two return series rather than one. The covariance is calculated as:

$$\sigma_{X,\ Y} = \sum_{t=1}^{N} \rho_t (X_t - \bar{X})(Y_t - \bar{Y}) \qquad \textbf{(11-9)}$$

The covariance is a very useful statistic, but it is difficult to interpret. The correlation coefficient is related to the covariance by the following relation:

$$r_{X,\ Y} = \frac{\sigma_{X,\ Y}}{\sigma_X \sigma_Y} \qquad \textbf{(11-10)}$$

So the correlation coefficient is the same as the covariance, but it has been transformed so that it will always be between –1 and +1, which makes it much easier to interpret. The closer the correlation coefficient is to 1, the more the returns tend to move in the same direction. The closer it is to –1, the more the

returns tend to move in opposite directions. A correlation coefficient of 0 means that there is no identifiable linear relationship between the returns (i.e., they are independent).

Assume that you wish to form a portfolio consisting of 50% in Stock 1 and 50% in Stock 2 (from Figure 11-13). Because these stocks are perfectly positively correlated, a plot of the portfolio returns would be exactly halfway between the plots of the returns for Stocks 1 and 2. Your portfolio returns would be just as volatile as if you owned either stock alone. On the other hand, a similar portfolio of Stocks 3 and 4 would result in a substantial reduction in volatility. Notice that the volatility of returns of Stock 3 are canceled out by the volatility of the returns of Stock 4. This risk reduction is due to diversification.

The correlation is obviously important in the calculation of the portfolio risk. For a portfolio of two securities, the portfolio variance is given by:

$$\sigma_P^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2r_{1,\ 2}\sigma_1\sigma_2 \qquad \textbf{(11-11)}$$

where the w's are the weights of each security, and $r_{1,2}$ is the correlation coefficient for the two securities. The standard deviation of a two-security portfolio is:

$$\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2r_{1,\ 2}\sigma_1\sigma_2} = \sqrt{\sigma_P^2} \qquad \textbf{(11-12)}$$

From the above equation, it is clear the lower the correlation ($r_{1,2}$) between the securities, the lower the risk of the portfolio will be. In other words, the lower the correlation, the greater the benefits of diversification.

Returning to our example with Stocks A and B, we can calculate the correlation coefficient with Excel's built-in function **CORREL**. This function is defined as:

CORREL(*ARRAY1*, *ARRAY2*)

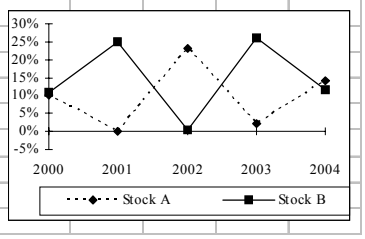
where ***ARRAY1*** and ***ARRAY2*** are the two ranges containing the stocks' returns. Before using **CORREL**, lets create a graph of the returns to see if you can guess what the correlation coefficient is. Select B2:C6 and then use the Chart Wizard to create a line chart of the returns.

Examining the chart, it is clear that when Stock A's returns are high, Stock B's returns are low, and vice versa. The correlation coefficient is obviously negative, and probably near –1. We can confirm this by using the **CORREL** function. In B9

enter the formula: `=CORREL(B2:B6,C2:C6)`. Note that the answer is –0.974, so our suspicions are confirmed. This low correlation is the reason that the standard deviation of the portfolio is so low. Your worksheet should now resemble that in Exhibit 11-10.

EXHIBIT 11-10
WORKSHEET DEMONSTRATING LOW CORRELATION BETWEEN A AND B

	A	B	C	D
1	Year	Stock A Returns	Stock B Returns	Portfolio
2	2000	10.30%	10.71%	10.51%
3	2001	-0.10%	25.00%	12.45%
4	2002	23.30%	0.38%	11.84%
5	2003	2.20%	26.20%	14.20%
6	2004	14.00%	11.52%	12.76%
7	Exp. Ret.	9.94%	14.76%	12.35%
8	Std. Dev.	9.43%	10.83%	1.35%
9	Correlation	-0.9741		

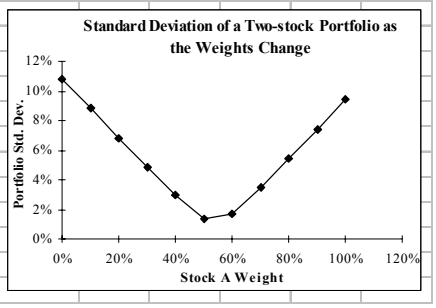


As one final exercise, we can examine the portfolio standard deviation as we change the weights of A and B. Place the following labels in your worksheet. In A11: `Stock A`, in B11: `Stock B`, and in C11: `Port Std Dev`. Enter a series in A12:A22 ranging from 1 down to 0 in increments of 0.1. These will represent the weights allocated to Stock A. In B12 we want the weight of Stock B, which is equal to 1 – weight of Stock A,[14] so enter: `=1-A12`. The portfolio standard deviation, in cell C12 can be found with the following formula: `=SQRT(A12^2*B$8^2+B12^2*C$8^2+2*A12*B12*B$8*C$8*B$9)`.
Now simply copy the formulas in B12:C12 down to the rest of the range. If you create an XY chart of the data (use the ranges: A12:A22,C12:C22) your worksheet should resemble that in Exhibit 11-11.

14. The weights must sum to 100%.

EXHIBIT 11-11
PORTFOLIO STANDARD DEVIATION AS WEIGHTS CHANGE

	A	B	C	D	E	F	G	H	I
10	Weights								
11	Stock A	Stock B	Port. Std. Dev.						
12	100%	0%	9.43%						
13	90%	10%	7.44%						
14	80%	20%	5.46%						
15	70%	30%	3.51%						
16	60%	40%	1.74%						
17	50%	50%	1.35%						
18	40%	60%	2.95%						
19	30%	70%	4.87%						
20	20%	80%	6.84%						
21	10%	90%	8.83%						
22	0%	100%	10.83%						



It is instructive to examine the extremes in the chart in Exhibit 11-11. First, note that when 100% of your funds are allocated to Stock A, the portfolio standard deviation is equal to that of Stock A. Similarly, if 100% is allocated to Stock B, the portfolio standard deviation is equal to that of Stock B. Also notice that the minimum standard deviation is achieved with about one-half of your funds allocated to each stock.[15]

The benefits of diversification in an individual's investment portfolio should be clear. By selecting securities that are less than perfectly positively correlated (e.g., in different industries, different countries, etc.) you can reduce risk significantly while reducing return slightly. Diversification works exactly the same way within corporations. A firm that invests in projects that are not perfectly correlated will reduce the volatility of its earnings. However, while diversification is undoubtedly a good idea for individuals, many believe that corporations should not seek out diversification. The reason is that the shareholders are perfectly capable of diversifying away company-specific risks on their own, and they can do it in a way that suits their unique purposes. On the other hand, a firm's managers, employees, customers, and suppliers will benefit if the company diversifies because of a lower possibility of financial distress. Whether or not a firm should diversify is, however, an open question.

15. The actual weights are 53.50% in Stock A and 46.50% in Stock B. We leave it as an exercise for you to find these weights using the Solver.

Portfolios with More Than Two Securities

Of course we can create portfolios of more than two securities. Most individuals who own stocks own more than two. And, many mutual funds own hundreds of stocks and/or other securities.

Regardless of the number of securities in a portfolio, the expected return is always a weighted average of the individual expected returns. The standard deviation is, however, more complicated. Recall that when we were evaluating the standard deviation of the two-stock portfolio, we had to account for the correlation between the two stocks. Similarly, when we have a three-stock portfolio, we must account for the correlation between each pair of stocks. The standard deviation of a three-stock portfolio is thus given by (using the covariance form):

$$\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + w_3^2\sigma_3^2 + 2w_1w_2\sigma_{1,\,2} + 2w_1w_3\sigma_{1,\,3} + 2w_2w_3\sigma_{2,\,3}} \qquad \textbf{(11-13)}$$

Obviously, the expression for the portfolio standard deviation gets to be cumbersome for more than two securities. Therefore, when more than two securities are included, the expression is usually simplified to:

$$\sigma_P = \sqrt{\sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j r_{i,\,j}\sigma_i\sigma_j} \qquad \textbf{(11-14)}$$

or, in the equivalent covariance form:

$$\sigma_P = \sqrt{\sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j \sigma_{i,\,j}} \qquad \textbf{(11-15)}$$

Equations (11-14) and (11-15), while not exactly simple, will calculate the standard deviation of a portfolio of any number of securities.

To avoid entering long formulas for the standard deviation of a portfolio, we have included several macros. Each macro (described in the summary to this chapter) requires the weight of each security and a variance/covariance matrix, or a correlation matrix and the individual standard deviations.

Summary

We began this chapter with a discussion of risk, and determined that risk is roughly equivalent to the probability of a loss. The higher the probability of a loss, the higher the risk. We also found that we could measure risk in any of several ways, but that the standard deviation or coefficient of variation are the generally preferred methods.

Risk can be incorporated into the analysis of capital investments in many ways. We've demonstrated that sensitivity analysis is an important first step in order to identify the variables that most impact the *NPV*. Once identified, we can focus our efforts on getting good estimates of these variables. Next, we can perform a scenario analysis or a Monte Carlo simulation to better understand the uncertainty surrounding the expected *NPV*.

While Monte Carlo simulation is beginning to be more widely used, the primary method of incorporating risk into capital budgeting is the risk-adjusted discount rate technique. This technique involves the addition of a premium to the *WACC* in order to account for the riskiness of the investment. We also discussed the certainty-equivalent (*CE*) method whereby the risky cash flows are deflated according to a decision maker's utility function. This method is superior to the RADR in theory, but is difficult to use in practice.

Finally, we introduced the concept of diversification. Diversification involves forming portfolios of risky investments so that some of the risk of the individual investments will be canceled by other investments whose returns are less than perfectly correlated. Diversification works just as well with corporate projects as it does with securities.

TABLE 11-7
FUNCTIONS INTRODUCED IN THIS CHAPTER

Purpose	Function	Page
Calculate the expected value	**FAME_EXPVALUE(*VALUES*, *PROBABILITIES*)**	344
Calculate a population variance	**VARP(*NUMBER1*, *NUMBER2*, . . .)**	345
Calculate a sample variance	**VAR(*NUMBER1*, *NUMBER2*, . . .)**	345

TABLE 11-7 (Continued)
FUNCTIONS INTRODUCED IN THIS CHAPTER

Purpose	Function	Page
Calculate variance when the probability distribution is known	**FAME_VAR(*VALUES*, *PROBABILITIES*)**	345
Calculate a population standard deviation	**STDEVP(*NUMBER1*, *NUMBER2*, . . .)**	345
Calculate a sample standard deviation	**STDEV(*NUMBER1*, *NUMBER2*, . . .)**	346
Calculate standard deviation when the probability distribution is known	**FAME_STDDEV(*VALUES*, *PROBABILITIES*)**	350
Calculate coefficient of variation when the probability distribution is known	**FAME_CV(*VALUES*, *PROBABILITIES*)**	N/A
Calculate the area under a standard normal curve	**NormSDist(Z)**	347
Count the numbers in a range that meet a specified criteria	**COUNTIF(*RANGE*,*CRITERIA*)**	354
Calculate the correlation coefficient	**CORREL(*ARRAY1*, *ARRAY2*)**	365
Calculate the portfolio variance	**FAME_PORTVAR1(*VARCOVMAT*,*WEIGHTS*)**	N/A

TABLE 11-7 (Continued)
FUNCTIONS INTRODUCED IN THIS CHAPTER

Purpose	Function	Page
Calculate the portfolio variance	**FAME_PORTVAR2**(***CORRMAT***,***WEIGHTS***)	N/A
Calculate the portfolio standard deviation	**FAME_PORTSTDEV1**(***VARCOVMAT***, ***WEIGHTS***)	N/A
Calculate the portfolio standard deviation	**FAME_PORTSTDEV2**(***CORRMAT***,***WEIGHTS***)	N/A

* All functions with names beginning in **FAME_** are macros supplied on the FameFncs.xls worksheet.

Problems

1. Trail Guides, Inc., is currently evaluating two mutually exclusive investments. After doing a scenario analysis and applying probabilities to each scenario, they have determined that the investments have the following distributions around the expected *NPV*s.

Probability	NPV_A	NPV_B
15%	$–25,000	$–15,000
20%	–5,000	0
30%	15,000	15,000
20%	35,000	30,000
15%	55,000	45,000

Several members of the management team have suggested that Project A should be selected because it has a higher potential *NPV*. Other members have suggested that Project B appears to be more conservative and should be selected. They have asked you to resolve this question.

a. Calculate the expected *NPV* for both projects. Can the question be resolved with this information alone?

b. Calculate the variance and standard deviation of the *NPV*s for both projects. Which project appears to be riskier?

c. Calculate the coefficient of variation for both projects. Does this change your opinion from Part b?

d. Which project should be accepted?

2. The Salida Salt Company is considering making a bid to supply the highway department with rock salt to drop on roads in the county during the winter. The contract will guarantee a minimum of 17,000 tons in each year, but the actual quantity may be above that amount if conditions warrant. Management believes that the actual quantity will average 25,000 tons per year. The firm will need an initial $1,500,000 investment in processing equipment to get the project started. The project will last for five years. The accounting department has estimated that annual fixed costs will be $300,000 and that variable costs should be about $90 per ton of the final product. The new equipment will be depreciated using the straight-line method to $100,000 over the five-year life of the project based on an estimate of the salvage value by the engineering department. The marketing department estimates that the state will grant the contract at a selling price of $130 per ton, though it may get some lower bids if the contract is opened for competitive bidding. The engineering department estimates that the project will need an initial net working capital investment of $90,000. The firm's weighted average cost of capital is estimated to be 12%, and the marginal tax rate is 35%.

   a. Set up a worksheet containing all of the relevant information in this problem, and calculate the initial outlay, annual after-tax cash flows, and the terminal cash flow.

   b. Calculate the payback period, discounted payback period, *NPV*, *IRR*, and *MIRR* of this project. Is the project acceptable?

c. If the state decides to open the project for competitive bidding, what is the lowest bid price that you can enter without reducing shareholder wealth? Explain why your answer is correct.

d. Perform a Monte Carlo simulation to determine the expected *NPV* and the standard deviation of the expected *NPV*. The uncertain variables and their probability distributions are given below. Note that each year's unit sales is a separate variable in the simulation.

Variable	Distribution
Tons of Rock Salt in Each Year	Triangular with a minimum of 17,000, most likely 25,000, and maximum of 35,000.
Variable Cost per Ton	Normal with a mean of $90, and a standard deviation of $3.
Actual Salvage Value of Equipment	Uniform with a minimum of $70,000 and a maximum of $120,000.

e. Create a histogram showing the probability distribution of *NPV*.

f. Using the output of the simulation, what is the probability that the *NPV* will be less than or equal to zero? Would you suggest that the project be accepted?

3. Ormsbee Aviation, Inc., is considering two potential investments. Each project will cost $60,000 and have an expected life of five years. The CFO has estimated the probability distributions for each project's cash flows as shown in the following table.

	Potential Cash Flows	
Probability	Project 1	Project 2
25%	$15,000	$14,000
50%	25,000	30,000
25%	35,000	46,000

The expected cash flow will be used for each of the five years of the projects' lives. Ormsbee Aviation uses the risk-adjusted discount rate technique to determine the worthiness of potential investments. As a guide for assigning the risk premiums, the CFO has put together the following table based on the coefficient of variation.

Coefficient of Variation	Risk Premium
0.0	–2.00%
0.2	0.00%
0.3	2.00%
0.4	3.00%
0.5	4.00%

a. Calculate the expected cash flows, standard deviation, and coefficient of variation for each project.

b. If the firm's weighted average cost of capital for average risk projects is 12%, what is the appropriate risk-adjusted discount rate for each project?

c. Using the appropriate discount rates, calculate the payback period, discounted payback period, *NPV*, *PI*, *IRR*, and *MIRR* for each project.

d. If the projects are mutually exclusive, which should be accepted? What if they are independent?

4. You are considering an investment in the stock market and have identified two potential stocks (XYZ and ABC) to purchase. The historical returns for the past five years are shown in the table below.

Year	XYZ Returns	ABC Returns
2000	11%	25%
2001	15%	12%
2002	21%	19%
2003	9%	13%
2004	13%	8%

a. Calculate the average return and standard deviation of returns for each stock over the past five years. Based on this information alone, which stock would you prefer to own? Would everybody make the same choice?

b. Calculate the correlation coefficient between the two stocks. Does it appear that a portfolio consisting of XYZ and ABC would provide good diversification?

c. Calculate the annual returns that would have been achieved had you owned a portfolio consisting of 50% in XYZ and 50% in ABC over the past five years.

d. Calculate the average return and standard deviation of returns for the portfolio. How does the portfolio compare with the individual stocks? Would you prefer the portfolio to owning either of the stocks alone?

e. Create a chart that shows how the standard deviation of the portfolio's returns changes as the weight of XYZ changes.

f. Using the Solver, what is the minimum standard deviation that could be achieved by combining these stocks into a portfolio? What are the exact weights of the stocks that result in this minimum standard deviation?

Internet Exercise

1. Choose two stocks from different industries that you think would have a low correlation. Get the closing prices for each month over the past five years for both stocks. To get the prices from Yahoo! Finance (http://quote.yahoo.com), follow the same procedure as was used in Chapter 8 to get the dividends, but this time select "Monthly" rather than "Dividends." Download the data to you disk drive and then load the files into Excel.

   a. Calculate the returns for both stocks in each month during the five year period.

b. Calculate the average monthly return and standard deviation of monthly returns for each stock. Using only this information, which of the two stocks would you have preferred to own over this period?

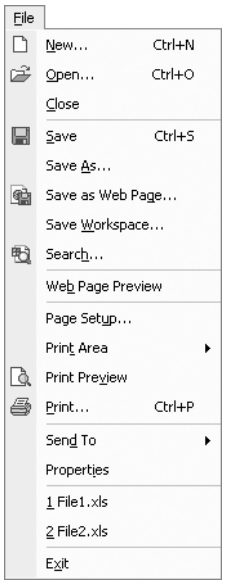
c. Calculate the correlation coefficient for the two sets of returns. Is it as low as you expected?

d. Assuming that the historical returns, standard deviations, and correlation fairly represent the future, calculate the expected return and standard deviation of a portfolio consisting of 50% invested in each stock. How does the portfolio compare on a risk/return basis with the individual stocks?

e. Using the Solver, find the weights for each stock that would result in the minimum portfolio standard deviation.

APPENDIX A

Excel 2002 Menu Descriptions



The File Menu

New — Opens a new (blank) workbook or template.

Open — Opens an existing workbook. Can also be used to import text files.

Close — Closes an open workbook. If changes have been made, Excel will prompt you to save the workbook before it is closed.

Save — Saves changes to an open workbook using its current name.

Save **A**s — Saves an open document. Excel will prompt you for a new name, with the current name as the default. You can also use this choice to change the file format (e.g., to Lotus 1-2-3, CSV, etc.).

Save as Web Pa**g**e — Saves the file as an HTML file. The resulting file may be viewed and manipulated in a Web browser from a Web site.

Save **W**orkspace — Saves any unsaved files and creates a workspace file. The workspace file stores the names of all open files so that they can be reopened with one command at a later time.

Search — Launches a search pane to help find files that meet the specified criteria.

Web Page Preview — Opens a Web browser and displays file as it will appear if saved as a Web page.

Page Setup — Shows the details of the page format (e.g., margin settings, headers and footers, etc.) and allows you to change them.

Print Area — Allows you to set or clear the area to be printed.

Print Preview — Shows a page by page preview of how the page will look when printed.

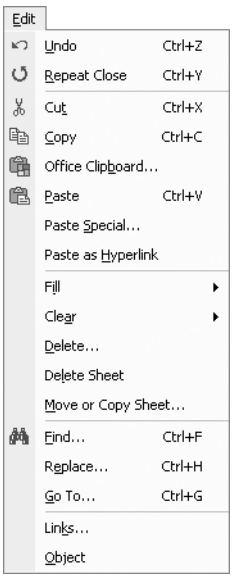
Print — Sends the file to the printer.

Send To — Allows you to e-mail the workbook.

Properties — Allows you to enter information regarding the author of the workbook, the subject, comments, etc. This information can then be used with Find command on the Open File dialog box to help locate the file.

1 . . . 4 — Lists the last several files that have been opened. Clicking on one of these choices will open that file.

Exit — Quits Excel.



The Edit Menu

Undo — Allows you to Undo the last action if possible, or indicates that the last option cannot be undone.

Repeat — Repeats the last action if possible, or indicates that the last action cannot be redone.

Cut — Copies the current selection to the clipboard, and deletes it when it is pasted elsewhere.

Copy — Copies the current selection to the clipboard without deleting it.

Office Clip**b**oard — Opens the Office Clipboard application.

Paste — Pastes the contents of the clipboard into the worksheet at the current location.

Paste **S**pecial — Same as **P**aste, but allows you to change the pasted data in certain ways (e.g., paste values only, formats only, transpose the selection, etc.).

Paste as **H**yperlink — Pastes the contents of the clipboard as a hyperlink to a Web page or e-mail address.

F**i**ll — Fills a range with selected data, or a series based on the selected data.

Cle**a**r — Deletes the contents of the selected area. Can also be used to delete only the formats, only the data, or notes attached to the cells.

Delete — Removes the current selection, rows, or columns from the worksheet.

De**l**ete Sheet — Removes the selected sheet(s) from the workbook.

Move or Copy Sheet — Moves or copies the selected sheet(s) to another location in the workbook or to another workbook.

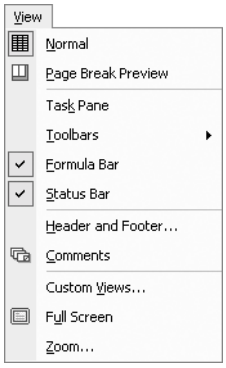
Find — Locates the specified text string in the selected worksheet(s).

R**e**place — Finds the specified text string in the selected worksheet(s) and replaces it with other specified text.

Go To — Makes the specified cell active.

Lin**k**s — Opens linked workbooks, or allows you to edit links.

Object — Edits an object (e.g., a Microsoft Word file, lines, circles, etc.).



The View Menu

Normal — Displays the worksheet in its normal view.

Page Break Preview — Displays the worsheet in a preview window, and displays and allows you to change the print area.

Tas**k** Pane — Opens the Task Pane so that you can open a new workbook, view the clipboard, launch a search, or insert clip art.

Toolbars — Turns on or off the display of the specified toolbar and allows you to customize a Toolbar.

Formula Bar — Turns the formula bar on or off.

Staus Bar — Turns the status bar on or off.

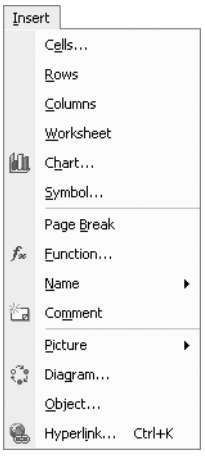
Header and Footer — Allows you to change the header and footer for printing. This may also be accessed via **F**ile Page Set**u**p.

Comments — Displays all of the cell comments in a worksheet and opens the Reviewing toolbar.

Custom **V**iews — Activates the Custom Views dialog box which allows you to define and display custom views of the worksheet.

F**u**ll Screen — Enlarges the current worksheet to full screen, and turns off Toolbars.

Zoom — Controls the magnification level of the worksheet.



The Insert Menu

C**e**lls — Inserts a new row, column, or cells at the current selection.

Rows — Inserts new rows above the current selection.

Columns — Inserts new columns to the left of the current selection.

Worksheet — Adds a new worksheet to the active workbook.

C**h**art — Adds a new chart to the worksheet or workbook and activates the Chart Wizard.

Symbol — Inserts special characters into the current cell or formula bar.

Page **B**reak — Inserts or removes a page break above and to the left of the selection.

Function — Activate the Paste Function dialog box and inserts a function into the cell.

Name — Defines, deletes, or applies a name to the selection.

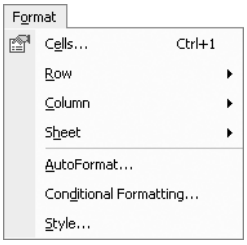
Co**m**ment — Adds or edits a comment in the selected cell.

Picture — Inserts a picture from a graphic file, clip art, organization chart, or autoshape in to the worksheet.

Dia**g**ram — Inserts an organization chart, Venn diagram, etc.

Object — Inserts an object (e.g., Microsoft Word file) into the worksheet.

Hyperl**i**nk — Allows you to add a hyperlink to a Web page or e-mail address in a cell.



*The F**o**rmat Menu*

C**e**lls — Allows you to change the font, border, alignment, and number format of the selected cells.

Row — Allows you to change the row height, or hide and unhide rows.

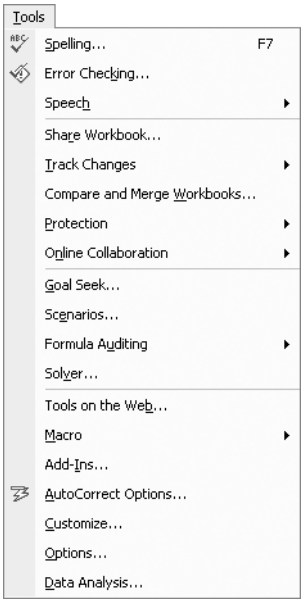
Column — Allows you to change the column width, or hide and unhide columns.

S**h**eet — Allows you to hide, unhide, rename, or set the background picture on selected worksheets.

Autoformat — Applies a predefined format to the selected cells.

Con**d**itional Formatting — Allows you to set a format that will change depending on the value in the cell.

Style — Applies or defines a formatting style.



*The **T**ools Menu*

Spelling — Activates the spelling checker.

Error Chec**k**ing — Runs the error checking tools. This is usually running automatically in the background at all times.

Speec**h** — Shows the Text to Speech toolbar which allows you to listen as Excel reads the worksheet.

S**h**are Workbook — Allows more than one user to edit a single spreadsheet at the same time.

Track Changes — Highlights suggested changes by other users to a worksheet.

Compare and Merge **W**orkbooks — Merges changes from one copy of a shared workbook into another.

Protection — Allows protection, or removes protection, for worksheets or workbooks.

O**n**line Collaboration — Allows you to set up an online meeting and to share a workbook over the Internet.

Goal Seek — Changes the value of one cell to force another to a target value.

S**c**enarios — Activates the Scenario Manager.

Tools on the We**b** — Launches a Web browser and connects you to a Microsoft Web site where you can download updates and tools for Office XP.

Formula A**u**diting — Helps to locate cell dependencies, locate errors, step through formulas, and display the Watch Window.

Sol**v**er — Activates the Solver.

Macro — Runs a selected procedure macro, or allows you to record a new procedure macro. Also controls the security levels for macros and opens the VBA editor.

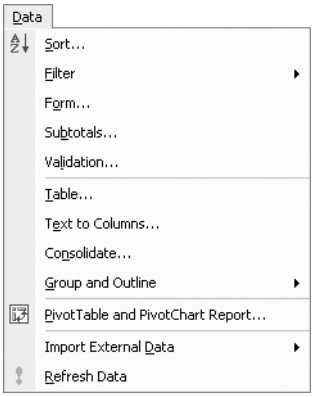
Add-**I**ns — Installs or removes add-in programs.

AutoCorrect Options — Allows you to change or set AutoCorrect options.

Customize — Allows you to customize toolbars and set menu options.

Options — Allows changes to various categories of options for the worksheet (e.g., turn gridlines on or off).

Data Analysis — Runs various data analysis tools (e.g., regression analysis).



*The **D**ata Menu*

Sort — Sorts the selected data by up to three keys.

Filter — Applies an automatic, or a user-defined, filter to the selected data.

F**o**rm — Creates a form for editing database records.

Su**b**totals — Creates subtotals with specified functions (e.g., **SUM**, **PRODUCT**).

Va**l**idation — Allows you to set up messages regarding acceptable data values in a cell.

Table — Creates a data table for what-if analysis.

T**e**xt to Columns — Activates the Text Wizard to parse text files into columns.

Co**n**solidate — Creates summaries of multiple worksheets.

Group and Outline — Creates or clears outlines for selected areas.

PivotTable and PivotChart Report — Creates or changes a pivot table.

Import External **D**ata — Runs a query on a database file or Web page to bring the data into Excel.

Refresh Data — Updates the data retrieved from a database or Web query.

*The **W**indow Menu*

New Window — Opens a new window on the workbook (i.e., a second copy).

Arrange — Arranges open workbooks.

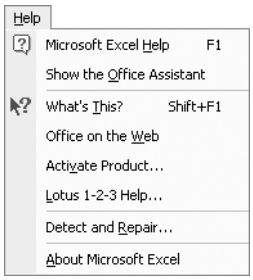
Hide — Hides the active workbook.

Unhide — Unhides workbooks selected from list.

Split — Splits or removes a split in the worksheet at the active cell.

Freeze Panes — Freezes or unfreezes panes at the active cell.

1...**9** — Activates the selected workbook.



*The **H**elp Menu*

Microsoft Excel **H**elp — Displays a table of contents for the help files.

Show the **O**ffice Assistant — Brings up an animated assistant to help you search for help.

What's **T**his? — Allows you to click on any object on the Excel screen and receive a description of its function.

Office on the **W**eb — Opens a connection to the Internet and takes you to the Office Update Web site.

Activate Product — Performs the product activation function which is required to use Office XP components for more than 30 days.

Lotus 1-2-3 — Brings up the help topics for Lotus 1-2-3 users.

Detect and **R**epair — Searches through the various Excel program files looking for errors. If any are found it will fix them. You will probably need the original disks or CD if errors are found.

About Microsoft Excel — Displays a dialog box which provides information about the version of Excel.