

# Dates and Timing

**T**he importance of dates and timing could not resonate more strongly than in the field of finance. From simple present value equations to more complex concepts such as yields and duration, time is an essential variable. Not surprisingly, dates and timing are also extremely important to cash flow modeling. Both dictate the core format of the model and permeate throughout many formulas and analyses.

For Excel-based modeling, dates and timing can be separated into their own individual categories. Dates are often in calendar format and widely used to initiate or terminate preplanned events such as rate step-ups, final maturity, and the like. Timing is typically represented in numerical format or a vector of numbers to control payment frequency and most analytics involving periodicity.

## TIME PROGRESSION

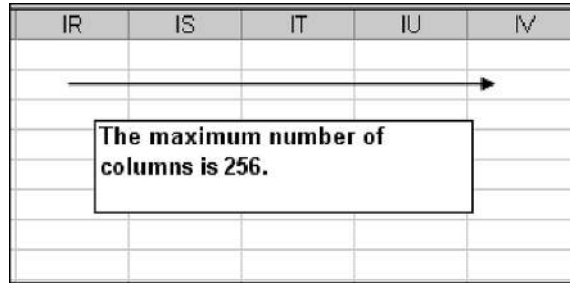
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Before jumping right to specific methods and examples, it is worth a few minutes to think about the structure of the transaction and whether to have time “progress” horizontally or vertically. The key to this decision is understanding Excel’s constraints within the context of the necessary payment frequency and overall length of the analysis. The designers of Excel limited the number of rows to 65,536 and columns to 256. If a transaction required modeling quarterly over a period of 25 years, it would not matter whether the payments move horizontally or vertically because only 100 (4 payments per year \* 25 years = 100) columns or rows would be needed. However, if for some reason the frequency had to be switched to monthly, the payments would have to move vertically because 300 columns (12 payments per year \* 25 years = 300) would exceed Excel’s column constraint (see Figure 1.1).<sup>1</sup>

While it is generally recommended to have time progressing in the same direction through all sections of the model, a sheet will be required to have time progressing in

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<sup>1</sup>Some modelers attempt to overcome the constraints by using additional sheets to continue the same section. While a viable option, it unnecessarily complicates the model flow and allows more opportunity for error.



**FIGURE 1.1** Notice that there are only 256 columns on a sheet, ending with column IV.

an alternate direction in some instances. There are a number of methods to transpose data in Excel, but many can be problematic when it comes time to refresh data or time consuming to implement. The best method is to use Excel's OFFSET function, which is described in Chapter 2's Toolbox.

## **DATES AND TIMING ON THE INPUTS SHEET**

Regardless of the type of transaction, the dates and timing section of the Inputs sheet at bare minimum consist of two dates and two timing inputs. The first of the two minimum dates is the *closing date*. This date is the day that the deal closes and funds have been issued. Many timing factors initiate off this date such as fees and interest charges, asset lives, and so on. The second date that is close in time to the closing date is the *first payment date*. This is the date that the first payments of fees, interest, and principal are due. It is important to distinguish between these two dates as many transactions have first payment dates that are irregularly spaced between closing. This means that the initial period could have a partial month's payment requirement, which can only be calculated if both the closing date and the first payment date are inputted.

The two absolute necessities for timing are actually one concept, *payment frequency*. Payment frequency is an integer or fraction representing the time difference between payment dates. There are many possibilities for representing how often a transaction pays, but conventionally time is "represented" in years, which can be parsed into 2 for semiannual pay, 4 for quarterly pay, and 12 for monthly pay. However, it is extremely important to understand that time can sometimes be "measured" more accurately on a daily basis for the purpose of calculating payment amounts. This difference occurs because in finance the same months do not always have the same number of days in them depending on the day-count system used.

## **DAY-COUNT SYSTEMS: 30/360 VERSUS ACTUAL/360 VERSUS ACTUAL/365**

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Day-count systems evolved due to the nuances of the Gregorian calendar (i.e., different numbers of days in certain months and leap years). The *30/360-day-count system* simplifies the annual calendar by assuming there are 12 months with 30 days each, for a total of 360 days. Payment frequency is then every 30 days per month, 90 days per quarter, 180 days per semiannual, and so on. The 30/360 system is the most common in the United States because it is used for most municipal, corporate, and agency bonds, mortgage-backed securities, and many other types of notes and certificates.

Working with the 30/360-day-count system is made very easy in Excel, thanks to the DAYS360 function. This function requires three inputs: a start date, an end date, and a method.

= DAYS360(start date, end date, method)

The start date is the first date to begin counting the days in between, the end date is the date to count the days up to, and finally the method is FALSE if the day count system desired is the U.S./National Association of Securities Dealers (NASD) system or TRUE if the system is European. The subtle difference between the two systems is that the U.S. system's starting date becomes equal to the 30th of the start month if the starting date is actually the 31st of that month. For the ending date, if it lands on the 31st of a month and the starting date is before the 30th of a month, the ending date become the 1st of the next month. However, if the start date is the 31st of a month, the ending date becomes equal to the 30th of the same ending date month. The European system is much simpler. If the starting or ending date lands on the 31st, the date just becomes the 30th of that month. The more common of the two is the U.S. system, which is the default method if a TRUE or FALSE is omitted.

Another popular day-count system is *actual/360*, which is primarily used for money market securities and U.S. Treasury bills. This system calculates an interest period as the actual number of days between two dates. It is important to note that to represent the day difference as a fraction of a year, the denominator uses 360 days, rather than 365. Since the natural format for dates in Excel are serial numbers, beginning with 1 for January 1, 1900, the actual difference between two dates can be calculated by subtracting the beginning date from the end date.

The final day-count system used is *actual/365* or *actual/actual*. Created to be as realistic to a year as possible, the calculation is virtually identical to *actual/360*, but instead of a year having 360 days it has 365.

An example of the differing date-count systems and their respective fractions of a year can be seen in Figure 1.2. While a few hundredths of a percent does not seem like much of a difference, this can be tens of thousands of dollars on deals in the hundred millions or billions of dollars.

<i>Day Count Systems</i>			
	<u>30/360</u>	<u>Actual/360</u>	<u>Actual/Actual</u>
1/1/2007	0.0833	0.0889	0.0877
2/2/2007			

**FIGURE 1.2** A different fraction of time exists for the period January 1, 2007 to February 1, 2007 depending on the day-count system used.

### **MODEL BUILDER 1.1: INPUTS SHEET — DATES AND TIMING**

As this book suggested, the reader can develop a cash flow model from an entirely blank workbook. This Model Builder section begins with the assumption that the reader is staring at Sheet1 of a blank workbook in Excel. This first Model Builder exercise introduces basic labels and the fundamental date and timing inputs.

Keep in mind two minor details while trying to follow the Model Builder section. The first detail is formatting. The most important formatting concept to remember is to format a cell with the correct data format. Many cells have different data formats such as dates, numerical values, text, and the like. If a number is appearing instead of a date, it could mean that the format for that cell is set to number and should be changed to date. Be mindful of cell data formats.

Another detail is the color scheme that has been used. Not only does it make the model more professional looking, but grouping related sections together by color makes it easier to read. There are no specific instructions on formatting, but it is very useful to have a well-formatted model.

If there is any question as to what a completed section or formula should look like, each Model Builder section (along with a completed Project Model) can be found on the CD-ROM that comes with this book. Otherwise the first Model Builder begins with:

1. When Microsoft Excel is first opened most systems' default layout is to begin with three worksheets labeled Sheet1, Sheet2, and Sheet3. The first Model Builder exercise requires two worksheets. The worksheet tabs should be renamed from Sheet1 and Sheet2 to **Inputs** and **Hidden**, respectively.
2. Instead of beginning on column A, this column should be adjusted to a width of 1.0. The reason for this is readability, since some formatting can be cut off by the edge of the screen. With column A adjusted, move to cell B1 and enter, **Project Model Builder**. Make sure to change the font to blue and bold. In most financial models assumptions that are variables to be altered are denoted in bold blue font. This cell should be named **ProjName**. If naming cells is unclear, jump ahead to the Toolbox section at the end of this chapter.

	A	B	C
1	<b>Project Model Builder</b>		
2			
3	<b>DATES &amp; TIMING</b>		
4		Closing Date	2/1/2007
5		First Payment Date	3/1/2007
6		Day-Count System	30 / 360
7		Pmt Frequency	Monthly
8			

**FIGURE 1.3** Basic inputs for dates and timing.

3. Moving under the transaction name in cell B3, input the title **Dates & Timing**. Now starting in cell B4 and continuing through to cell B7, enter the following text into the cells respectively: **Closing Date**, **First Payment Date**, **Day-Count System**, and **Pmt Frequency**. Highlight cells B3:C8 and format the area with a border. At this point, aside from stylistic preference, the upper corner of the Inputs sheet should look like Figure 1.3.
4. Before filling in starting values for the dates and timing inputs, switch over to the Hidden sheet to create data validation lists. The first one that will be needed is the day-count system. Input **Day-Count System** into cell A5 as a header. The list will start in cell A6 with the first type of day-count system that can be activated, cell A7 with the second, and so on. For this model input **30 / 360** into cell A6, **Actual / 360** into cell A7, and **Actual / 365** into cell A8. Highlight A6:A8 and name the range **lstDayCountSys**.
5. Similarly, it is inefficient to constantly enter what type of payment frequency there is. So, in cell A10, enter the heading **Payment Frequency**. Starting in cell A11 and continuing down a cell for each label, enter the following: **Monthly**, **Quarterly**, **Semiannual**, **Annual**. Highlight the cells that were just entered (A11:A14) and name them **lstPaymentFreq**.
6. Switching back to the Inputs sheet, cells C4 and C5 contain date-formatted values, for now enter **02/01/07** for the closing date and **3/01/07** for the First Payment Date. Name these cells **ClosingDate** and **FirstPayDate**, respectively.
7. The two named ranges that were created from the Hidden sheet are used for the Column C values corresponding to cells B6 and B7. In C6 use the data validation function to create a list using = **lstDayCountSys** as the source. Repeat for cell C7 using = **lstPaymentFreq** as the source. Name these two cells **DayCountSys** and **PmtFreq**, respectively. Similar to naming ranges and cells, if creating data validation lists is new jump to the Toolbox section at the end of this chapter.
8. Finally, switch back to the Hidden sheet. A formula cell needs to be created to represent the payment frequency numerically, depending on which payment frequency was selected. It is important to keep the payment frequency in monthly

terms because there are many functions in Excel that can adjust dates on a monthly basis (e.g., EDATE). In C11 input the following formula:

```
= IF(PmtFreq="Monthly",1,IF(PmtFreq="Quarterly",3,  
IF(PmtFreq="Semi-Annual",6,12)))
```

The last step for this section is to name C11 **PmtFreqAdd**. For a complete example of Model Builder 1.1, review the Excel file named *MB1-1.xls* on the CD-ROM.

## **DATES AND TIMING ON THE CASH FLOW SHEET**

As a first introduction to the cash flow sheet, a general overview is helpful. The cash flow sheet is the section that will “move” the cash created by the asset amortization engine through the transaction’s priority of payments according to the user defined inputs and assumptions. Dates and timing are typically the first three columns or rows seen on this sheet because the entire concept of cash flow modeling relies on time.

While many finance professionals are familiar with a balance sheet type model, where time progresses horizontally across rows, cash flow modeling is more flexible if time progresses vertically, up and down columns. The examples in this book are based off a vertical progression of time (see Figure 1.4).

The first of the three columns, usually the A column, should be for tracking the *period*. The period is a numeric representation of time as it progresses. There is usually a period 0 that represents the closing date, with period 1 being the first payment date. Thereafter, the period simply grows in an ordinal fashion, increasing by one. Even if the model is switched to quarterly or semiannual frequency, the periods should not change. For example, in a monthly model, period 1 will be a month and period 2 will be the next month. When switched to a quarterly model, period 1 is a quarter and period 2 is the next quarter.

The second column is where the dates corresponding to the period are tracked. As mentioned, period 0 is the closing date and period 1 is the first payment date. Dates after that are determined by the desired frequency of payment. That is, if it is a monthly model, the next date after the first payment date is the next month; if it is a quarterly model, the next date is three months from the first payment date, and so on.

The third column is termed the day factor and is a precise calculation of the number of days between each period, represented as a fraction of the year. The calculation is quite simple: the number of days between the last period date and the current period date over the number of days in the year. This factor will provide a more precise breakdown of annual rates if an Actual/360 or Actual/365 day count system is selected. Refer to Figure 1.4, columns A, B, and C as an example.

	A	B	C	D
2				
3				
4	Period	Date	Day Factor	
5				
6	0	2/1/2007	-	
7	1	3/1/2007	0.083	
8	2	4/1/2007	0.083	
9	3	5/1/2007	0.083	
10	4	6/1/2007	0.083	
11	5	7/1/2007	0.083	
12	6	8/1/2007	0.083	
13	7	9/1/2007	0.083	
14	8	10/1/2007	0.083	
15	9	11/1/2007	0.083	
16	10	12/1/2007	0.083	
17	11	1/1/2008	0.083	
18	12	2/1/2008	0.083	
19	13	3/1/2008	0.083	▼
20	14	4/1/2008	0.083	

**FIGURE 1.4** Time will progress vertically in this model.

	A	B	C
1	<b>Cash Flow</b>		
2			
3			
4	Period	Date	Day Factor

**FIGURE 1.5** The beginning of the dates and timing section on the Cash Flow sheet.

**MODEL BUILDER 1.2: CASH FLOW SHEET — DATES AND TIMING**

1. The Cash Flow sheet is the third sheet in the model. Rename the third sheet from Sheet3 to **Cash Flow**.
2. In the Cash Flow sheet, Row 4 will be dedicated to headers. Input **Period** in cell A4, **Date** in cell B4, and **Day Factor** in cell C4.
3. The first column to work on is where the periods are tracked. In cell A6 input 0, followed by inputting 1 in the cell directly below, A7. Highlight both

of these cells, left click and hold down the small square on the bottom right cube of the highlighted cells, and drag the numbers down. As the cells are being dragged a box should appear with an increasing value. By dragging down, Excel automatically inputs increasing numbers in the cells. The increase is based on the difference between the two numbers that were originally highlighted. Since the model will only go out 30 years and the smallest periodicity option is a month, there is only a need for 360 periods. Stop dragging when the number reaches 360; all of the numbers between 0 and 360 should have populated into the cell range A6:A366.

4. The next column to work on is the Date column. Because it would be inefficient to constantly have to change this column every time the dates are changed for a transaction, the cells in this column are a formula. Looking back to the Inputs sheet, the first date that was created was the closing date, which is the initial date the transaction begins. This date always corresponds to the start of period 0. Similarly, the second important date on the Inputs sheet, the first payment date, always corresponds to period 1. The formula for the correct date must differentiate between periods 1 and 2. The use of an IF statement is the simplest method to make sure that the date for period 0 is always the closing date and that the date for period 1 is the first payment date.<sup>2</sup> The first part of the formula should look like this:

$$=IF(A6=0,ClosingDate,IF(A6=1,FirstPayDate$$

The rest of the periods grow by the increments that are set by the payment frequency cell (PMTFreq) on the Inputs sheet. The payment frequency cell is mainly set up for a model user and will only offer word values.

Recall that on the Hidden sheet a cell named PMTFreqAdd was created that returns numeric values depending on the word value in PMTFreq. With a numeric value for the frequency between payments, the EDATE function can be used to grow the dates after period 1. The completed formula should look as follows:

$$=IF(A6=0,ClosingDate,IF(A6=1,FirstPayDate,EDATE(B5,PmtFreqAdd)))$$

The completed formula will return the Closing Date for period 0, the First Pay Date for period 1, and will then return a date that is PmtFreqAdd number of months from the First Pay Date. Copy this formula down to the final period.

5. The final column affecting dates and timing on the Cash Flow sheet is the day factor, which quantifies the time difference between periods as a fraction of the

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<sup>2</sup>In general a high-quality financial model uses one consistent formula for every column in a section that involves timing. Often a model builder uses a different formula for period 0 versus the remaining periods because the remaining period calculations are based on period 0. The use of IF statements allows for consistent formulas that make a model easier to audit, faster to build, and less prone to errors.



year. As mentioned earlier, depending on the type of day count system that is selected there can be varying amounts of time between dates.

6. Recall that a cell specifically for selecting the day count was created on the Inputs sheet (DayCountSys). This cell has three options: 30/360, Actual/360, and Actual/365. The functionality needed in the model is to have all of the calculations based on the day count system switch when the cell DayCountSys is changed on the Inputs sheet.
7. The actual formula for C6 is composed of many different parts. The first part is due to the fact that period 0 will always have a zero value between dates, since there is no date prior to 0. An IF statement for period 0 takes care of this problem:

$$=IF(A6=0,0,$$

8. The next part of the formula is written to calculate the time difference for the 30/360 system. As explained earlier, the DAYS360 function is perfect for this task:

$$=IF(A6=0,0,IF(DayCountSys="30 / 360",DAYS360(B5,B6)/360,$$

First, notice that in order to handle the possible changing value of DayCountSys, a second IF statement was inserted. Next, the DAYS360 function is used if 30/360 is selected. This function takes the date from the previous period (B5) and calculates the difference in days between the current period (B6). Because the return value for the DAYS360 function is in days and all of the calculations relying on the Day Factor are annual rates, the return value needs to be divided by 360 to produce a fraction value (assuming a 360 day year as the 30/360 system does).

9. The next part of the formula is when Actual/360 is used. Another IF statement is required to identify when DayCountSys is set to Actual/360. If the statement is true the Actual/360 calculation is very simple; it is the difference between the current date and the date the period before.

$$= IF(A6=0,0,IF(DayCountSys="30 / 360",DAYS360(B5,B6)/360,  
IF(DayCountSys="Actual / 360", (B6-B5)/360,$$

Remember that the return value will also be in days and needs to be divided by 360 for Actual/360.

10. The final step is when Actual/365 is selected. Because there are only three possible values for DayCountSys and if the first two IF statements are false, the setting must be Actual/365. This means that the calculation for Actual/365, which is virtually the same as Actual/360 except that the divisor is 365, can be set as the final FALSE value for the last IF statement. The complete formula should read:

$$= IF(A6=0,0, IF(DayCountSys="30 / 360", DAYS360(B5,B6)/360,  
IF(DayCountSys="Actual / 360", (B6-B5)/360, (B6-B5)/365)))$$

	A	B	C	D
1	<b>Cash Flow</b>			
2				
3				
4	<b>Period</b>	<b>Date</b>	<b>Day Factor</b>	
5				
6	0	2/1/2007	-	
7	1	3/1/2007	0.083	
8	2	4/1/2007	0.083	
9	3	5/1/2007	0.083	
10	4	6/1/2007	0.083	
11	5	7/1/2007	0.083	
12	6	8/1/2007	0.083	
13	7	9/1/2007	0.083	
14	8	10/1/2007	0.083	
15	9	11/1/2007	0.083	

**FIGURE 1.6** The completed dates and timing section on the Cash Flow sheet.

Finally, copy this formula down to the final period. See Excel file *MB1-2.xls* in the Ch01 folder on the CD-ROM for complete Excel examples.

## TOOLBOX

### Naming Cells and Ranges

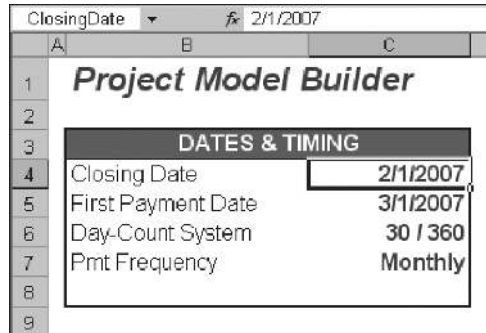
Naming cells and ranges is a technique that saves time, improves clarity, and reduces errors when working with financial models. At the most basic level, naming a cell or range changes how the cell or range is referred to in formulas and functions. For example, if cell A1 were named Input1, and cell A2 had the value 5 in it, a formula in cell A3 that added cells A1 and A2 would appear as:

$$=\text{Input1}+A2$$

Also, a named cell or range changes any reference to that cell or range from a relative reference to an absolute reference. This change reduces errors when named cells are used in formulas that are copied down over multiple cells. Normally the referenced cell would have to be “locked” using dollar signs (F4 shortcut), but a named range does not change as it is copied down.

Naming a cell or range can be accomplished in one of two ways. The formal method is:

1. Select a cell or a range of cells.



**FIGURE 1.7** The active cell is C4 which shows the value in the Formula Bar and the cell name in the Name Box.

2. From the menu bar, click Insert, Name, and Define.
3. Enter the name of the cell or range in the field titled Names in Workbook. Then click Add or OK. Add would be used if multiple names were to be added from the Define Name dialogue box. Also note the Refers to textbox at the bottom of the Define Name dialogue box. This is where the reference is established and edited if changes need to be made.

The simpler solution to naming a range is to select the cell or range of cells on the active sheet and enter the desired name directly in the Name Box and press Enter. The Name Box is in the upper left corner of the Excel window, to the left of the Formula Bar. If a cell or range is already named, the name appears in the Name Box when the cell or range is selected. See the named cell ClosingDate (cell C4) in Figure 1.7.

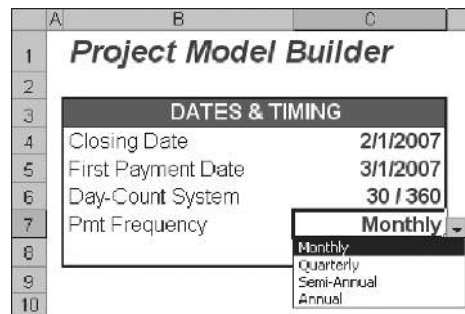
It is a good habit to name all inputs and important ranges because they help the model builder and any operators understand formulas faster. This is particularly important if the model uses Visual Basic for Applications to a high degree. The named cells and ranges can be understood and accessed faster than with the conventional Column/Row reference.

### Data Validation Lists

Using data validation lists for inputs that can have a value from a set list saves time and reduces errors for model operators. Data validation lists essentially take a list of values in the workbook and offer them for selection in a combo box format for a specific cell.

Creating a data validation list is very easy since it is a prebuilt Excel operation:

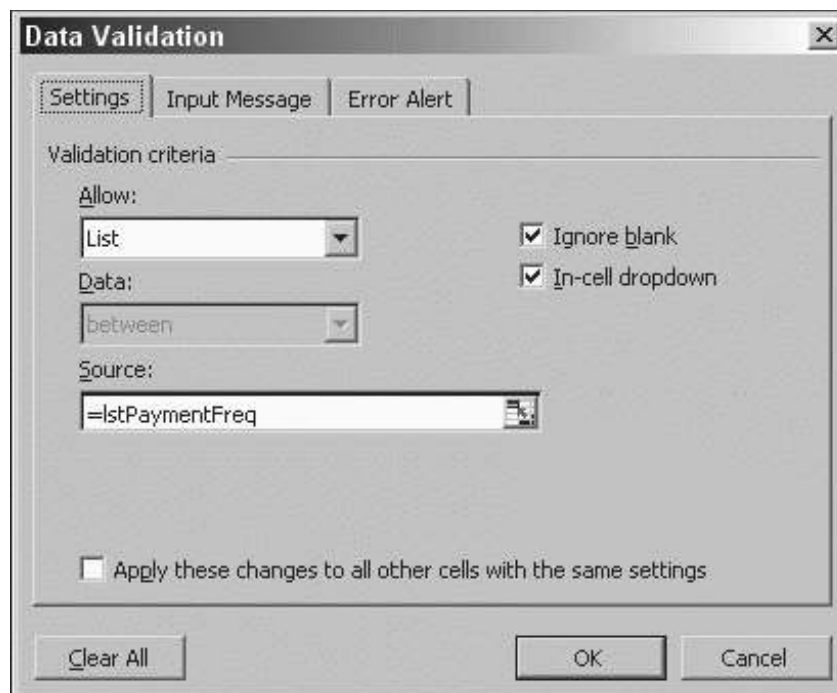
1. The first step is creating the list that will be the possible values. In the case of Figure 1.8 the list would be a range of four cells with the first cell



The screenshot shows an Excel spreadsheet with the following data:

	A	B	C
1		<b>Project Model Builder</b>	
2			
3		<b>DATES &amp; TIMING</b>	
4		Closing Date	2/1/2007
5		First Payment Date	3/1/2007
6		Day-Count System	30 / 360
7		Pmt Frequency	Monthly
8			Monthly
9			Quarterly
10			Semi-Annual
			Annual

**FIGURE 1.8** An example of a data validation list.



**FIGURE 1.9** Create a data validation list in the Data Validation dialogue box.

having the label Monthly, the second cell Quarterly, and so on. For organizational purposes, this list should be stored on a separate sheet. (In the Model Builder, this sheet is known as Hidden because it will be hidden from view later.)

2. Once the range is created it has to be named. A good convention for lists is to begin the name with *lst* so it can be identified when searching through a list of names.
3. The last step is to select the cell where the list will be active (cell C7 in Figure 1.8). Once the cell is selected, in the menu bar click Data and then Validation. The Data Validation dialogue box appears. Click the Allow arrow and select List. The Source textbox appears. This is where the range name that references the list should be entered as a formula as shown in Figure 1.9.

## EDATE

An extremely useful function to increase the date in an orderly manner over time is *EDATE*. *EDATE* has two inputs: a date and a numeric value.

=EDATE(starting date, numeric value)

The function treats the numeric value in terms of number of months. *EDATE* returns the date that is the number of months away from the numeric value. For example, if the cell containing the date had a value of 07/15/05 and the numeric value was 1, *EDATE* would return 08/15/05. Similarly, if the 1 had been a 2 it would return 09/15/05. *EDATE* also works with negatives and would return 06/15/05 if -1 were used as the numeric cell reference.

For *EDATE* to work, the Analysis ToolPak must be installed—otherwise the workbook will be full of NAME errors. To install the Analysis ToolPak, in the menu bar click Tools and Add-Ins. In the Add-Ins dialogue box, select the Analysis ToolPak checkbox and click OK.