Table 12-4, we calculate the NPVs for Investments A and B using an assumed cost of capital, or discount rate, of 10 percent.

Table 12-4 Calculating NPV for Investments A and B

	A	B	C	D	E	F	G	H	I
1	Investment A					Investment B			
2	Discount Rate		10.00%			Discount Rate		10.00%	
3	Year (n)	CF	$\frac{1}{(1+i)^n}$			Year (n)	CF	$\frac{1}{(1+i)^n}$	
4	0	−$10,000	1.000	−$10,000.00		0	−$10,000	1.000	−$10,000.00
5	1	5,000	0.909	4,545.45		1	1,500	0.909	1,363.64
6	2	5,000	0.826	4,132.23		2	2,000	0.826	1,652.89
7	3	2,000	0.751	1,502.63		3	2,500	0.751	1,878.29
8	Net Present Value			$180.32		4	5,000	0.683	3,415.07
9						5	5,000	0.621	3,104.61
10						Net Present Value			$1,414.49
11									
12									
13		=+NPV(10%,B5:B7)+B4		=$180.32			=+NPV(10%,G5:G9)+G4		=$1,414.49
14		NPV(**rate**, value1, [value2], [value3], ...)					NPV(**rate**, value1, [value2], [value3], ...)		
15									

For Investment A, the timing of each cash flow is shown in column A with the amount of each cash flow shown in column B. Together these columns produce a vertical timeline of cash flows. The discount rate of 10 percent is shown in cell C2, and each of the values in cells C4 to C7 is the present value factor needed to convert the values in column B into the present values in column D. The net present value is simply the sum of all the individual present values in column D. The NPV of $180.32 is highlighted in cell D8.

Excel also provides an **NPV** function, which is shown in cell C13. Unfortunately, when the initial cash flow occurs at time zero (as the $10,000 investment outflow does in our example), the **NPV** function does not provide an accurate calculation unless the user conducts a slight manipulation. Excel's **NPV** function behaves badly because it assumes that the first cash flow comes at the end of the first year. To treat the initial outlay properly, we must leave the initial outlay out of the **NPV** function. Then we must subtract the initial outlay separately. Also note that because the initial outlay is entered as a negative number in cell B4, we must actually *add* the outlay to the **NPV** calculation. For Investment A, the cash flows in cells B5 through B7 are entered inside the **NPV** function, and the initial outlay in cell B4 must be added to the **NPV** function value. Unless you look carefully at cell C13, you may overlook this subtle but important point.

The NPV for Investment B is calculated in an identical manner. The cash flow timeline is inserted in columns F and G. Present value factors are computed in column H using the 10 percent discount rate from cell H2, and the present value of each cash flow is shown in column I. The sum of the present values is the NPV of $1,414.49 value highlighted in cell I10. Using the Excel **NPV** function yields the same result in cell H13.

The standard decision rule for NPV analysis is as follows:

NPV > 0; Accept the project because the project increases firm value.
NPV < 0; Reject the project because the project reduces firm value.

While both proposals here are acceptable, Investment B has a considerably higher net present value than Investment A.[2]

Internal Rate of Return

The **internal rate of return (IRR)** is another important metric used to make capital budgeting decisions. While NPV measures the attractiveness of a project in dollar (i.e., currency) terms, the IRR measures the profitability of investments as a return percentage—much like finding the interest rate (i) in a time value of money problem. The key to fully understanding the meaning of the internal rate of return is to understand how IRR relates to NPV: The internal rate of return on an investment or project is the "rate of return" that makes the net present value of the project equal to zero.

The IRR is the interest rate (i) that makes NPV = 0.

Let us return to our analysis of Investment A and Investment B. At the top of Table 12-5, the cash flows for Investment A are set up exactly as before when we calculated the NPV of the investment. However, you will notice that instead of using a discount rate of 10 percent, the discount rate is 11.16 percent. This is the discount rate that forces the NPV value shown in cell D8 to be exactly zero! Because the NPV is zero when the discount rate is 11.16 percent, we have found the IRR. The internal rate of return is 11.16 percent.

An inquisitive student like you may not be satisfied with simply understanding this definition of the IRR (the rate that makes NPV = 0). Instead, you would probably like to know *how* the IRR was found. Unfortunately, there is usually no simple equation to find the IRR. However, once again we can make use of the Goal Seek function that was introduced in Chapter 10. Recall that Goal Seek was used in Chapter 10 to find the yield to maturity of a bond (YTM). In fact, the concept behind IRR is almost identical to the YTM concept.

YTM equates the present value of inflows (bond payments) to an outflow (the bond's cost).
IRR equates the present value of inflows (project returns) to an outflow (the project's cost).

Excel's Goal Seek feature doesn't use an equation. It operates by using an iterative method to find a solution. Specifically, it tries an initial input value to see whether that

FINANCIAL CALCULATOR

IRR (Uneven Inflows)

Value	*Function*
	CF
	2nd
	CLR WORK
−10000	ENTER
	↓
5000	ENTER
	↓ ↓
5000	ENTER
	↓ ↓
2000	ENTER

Function	*Solution*
IRR	
CPT	11.1635

[2] A further possible refinement under the net present value method is to compute a profitability index.

$$\text{Profitability index} = \frac{\text{Present value of the inflows}}{\text{Present value of the outflows}} = \frac{\text{NPV + PV of outflows}}{\text{PV of outflows}}$$

For Investment A the profitability index is 1.0180 ($10,180/$10,000), and for Investment B it is 1.1414 ($11,414/$10,000). The profitability index can be helpful in comparing returns from different-size investments by placing them on a common measuring standard. This was not necessary in this example.