

CAPITAL BUDGETING

Capital Budgeting Techniques

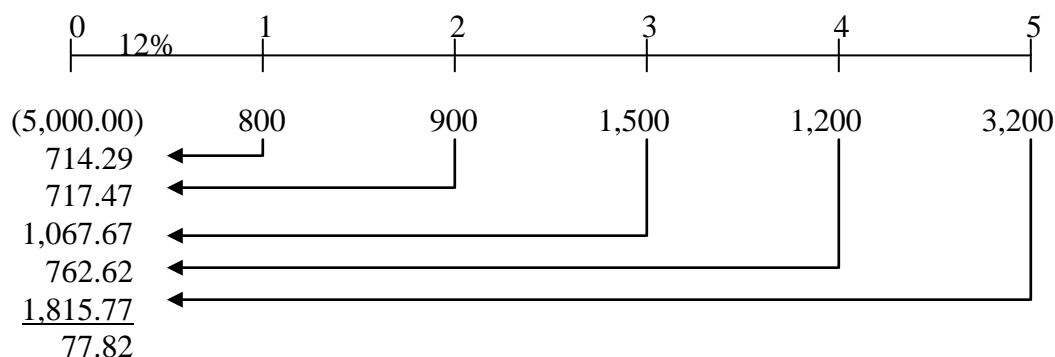
Capital budgeting refers to the process we use to make decisions concerning investments in the long-term assets of the firm. The general idea is that the capital, or long-term funds, raised by the firms are used to invest in assets that will enable the firm to generate revenues several years into the future. Often the funds raised to invest in such assets are not unrestricted, or infinitely available; thus the firm must budget how these funds are invested.

- Importance of Capital Budgeting—because capital budgeting decisions impact the firm for several years, they must be carefully planned. A bad decision can have a significant effect on the firm's future operations. In addition, the timing of the decisions is important. Many capital budgeting projects take years to implement. If firms do not plan accordingly, they might find that the timing of the capital budgeting decision is too late, thus costly with respect to competition. Decisions that are made too early can also be problematic because capital budgeting projects generally are very large investments, thus early decisions might generate unnecessary costs for the firm.
- Generating Ideas for Capital Budgeting—ideas for capital budgeting projects usually are generated by employees, customers, suppliers, and so forth, and are based on the needs and experiences of the firm and of these groups. For example, a sales representative might continue to hear from some of his or her customers that there is a need for products with particular characteristics that the firm's existing products do not possess. The sales representative presents the idea to management, who in turn evaluates the viability of the idea by consulting with engineers, production personnel, and perhaps by conducting a feasibility study. After the idea is confirmed to be viable in the sense it is saleable to customers, the financial manager must conduct a capital budgeting analysis to ensure the project will be beneficial to the firm with respect to its value.
- Project Classifications—capital budgeting projects usually are classified using the following terms:
 - Replacement decision—a decision concerning whether an existing asset should be replaced by a newer version of the same machine or even a different type of machine that does the same thing as the existing machine. Such replacements are generally made to maintain existing levels of operations, although profitability might change due to changes in expenses (that is, the new machine might be either more expensive or cheaper to operate than the existing machine).
 - Expansion decision—a decision concerning whether the firm should increase operations by adding new products, additional machines, and so forth. Such decisions would expand operations.
 - Independent project—the acceptance of an independent project does not affect the acceptance of any other project—that is, the project does not affect other projects. For example, if you have a large sum of money in the bank that you would like to spend on yourself, say, \$150,000. You decide you are going to buy a car that costs about \$30,000 and a new stereo system for your house that costs less than \$5,000. The decision to buy the car does not affect the decision to buy the stereo—they are independent decisions.

- Mutually exclusive projects—in this case, the decision to invest in one project affects other projects because only one project can be purchased. For example, if in the above example you decided you were going to buy only one automobile, but you were looking at two different types of cars, one is a Chevrolet and the other is a Ford. Once you make the decision to buy the Chevrolet, you have also decided you are not going to buy the Ford.
- Similarities Between Capital Budgeting and Asset Valuation—to make a capital budgeting decision, we need to compare the cost of the project to the value the project will provide the firm. To determine the value of an asset, we need to compute the present value of the cash flows the assets is expected to generate over its life. This computation of value is the same as was discussed in the section about valuation of financial assets—that is, bonds and stocks. Once the value of the asset is determined, the firm can determine whether to invest in the asset by comparing its computed value to how much the asset costs to purchase. Following this decision-making procedure helps ensure the firm will maximize its value—that is, if an asset has a value to the firm that is greater than its cost, the firm’s value would be increased if the firm purchases the asset.
- Capital Budgeting Evaluation Techniques—in this section, the basic techniques that are used to make capital budgeting decisions are described. To illustrate the techniques, let’s assume a firm is considering investing in a project that has the following cash flows:

Year (t)	Expected After-Tax Net Cash Flows, \hat{CF}_t
0	\$(5,000)
1	800
2	900
3	1,500
4	1,200
5	3,200

$\hat{CF}_0 = \$ (5,000)$ represents the net cost, or initial investment, that is required to purchase the asset—the parentheses indicate that the cash flow is negative. If the firm’s required rate of return is 12 percent, the cash flow time line for the asset is:



- Payback period—the number of years, including the fraction of the year, it takes to recapture the initial investment. The following table shows the payback for this project:

<u>Year</u>	<u>Cash Flow</u>	<u>Cumulative CF</u>
0	\$(5,000)	\$(5,000)
1	800	(4,200)
2	900	(3,300)
3	1,500	(1,800)
4	1,200	(600)
5	3,200	2,600

This table shows that the payback period is between four years and five years. The actual payback is:

$$\begin{aligned}
 \text{Payback period} &= \left(\begin{array}{l} \text{Number of years} \\ \text{before recovery of} \\ \text{original investment} \end{array} \right) + \left(\frac{\text{Amount of investment remaining to be recaptured}}{\text{Total cash flow during year of payback}} \right) \\
 &= 4 + \frac{\$600}{\$3,200} \\
 &= 4.19 \text{ years}
 \end{aligned}$$

As the computation shows, it takes a little more than four years for the firm to recapture its original investment for this project. The acceptance rule for payback can be stated as follows:

Accept the project if Payback, PB < some number of years set by the firm

This project would be acceptable if the firm wants to recapture its investments' costs within five years, but it would not be acceptable if the firm wants to recapture the costs within three years.

Even though the concept of payback is very simple, there are problems with using payback to make capital budgeting decisions. The primary problem is that this technique does not use time value of money concepts—that is, we do not compute the present values of the future cash flows. Another

problem is that the cash flows beyond the payback period are ignored. For example, if the project described above had a \$1,000,000 cash flow in Year 5 rather than the \$3,200 given, the project would still have a payback equal to just over four years and it would not be an acceptable project if the payback period imposed by the firm is three years.

- Net present value (NPV)—to determine the NPV of a project, you need to compute the present value of all the future cash flows associated with the project, sum them up, and then subtract (or add a negative amount to) the initial investment of the project. The resulting value represents the amount by which the firm's value will increase, on a present value basis, if the firm invests in the project. For example, if the NPV of a project is \$1,000, then the value of the firm should increase by \$1,000 today. Thus, a project is acceptable if its NPV is positive. If a project has a positive NPV, then it generates a return that is greater than the cost of the funds that are used to purchase the project.

The NPV computation is:

$$\begin{aligned} \text{NPV} &= \frac{CF_0}{(1+r)^0} + \frac{\hat{CF}_1}{(1+r)^1} + \frac{\hat{CF}_2}{(1+r)^2} + \cdots + \frac{\hat{CF}_n}{(1+r)^n} \\ &= CF_0 + \frac{\hat{CF}_1}{(1+r)^1} + \frac{\hat{CF}_2}{(1+r)^2} + \cdots + \frac{\hat{CF}_n}{(1+r)^n} \\ &= \sum_{t=0}^n \frac{\hat{CF}_t}{(1+r)^t} \end{aligned}$$

The NPV for the project in our example is:

$$\begin{aligned} \text{NPV} &= -\$5,000 + \frac{\$800}{(1.12)^1} + \frac{\$900}{(1.12)^2} + \frac{\$1,500}{(1.12)^3} + \frac{\$1,200}{(1.12)^4} + \frac{\$3,200}{(1.12)^5} \\ &= -\$5,000 + \$800(0.89286) + \$900(0.79719) + \$1,500(0.71178) + \$1,200(0.63552) + \$3,200(0.56743) \\ &= \$77.82 \end{aligned}$$

The result of this computation is the same as that given in the cash flow time line diagram. According to the acceptance criterion, the project in our example should be purchased. Remember that if the firm accepts a project with a positive NPV its value should increase, and vice versa. Therefore, if the project had a negative NPV it would not be acceptable because such a project would decrease the value of the firm.

The easiest way to compute the NPV for a project is to use the cash flow register on your

calculator. Refer to the instructions that came with your calculator to determine how to use the CF register. If you have a Texas Instruments BAII PLUS, you can use the steps given in the “Time Value of Money” section of the notes. The inputs should be $CF_0 = -5,000$, $CF_1 = 800$, $CF_2 = 900$, $CF_3 = 1,500$, $CF_4 = 1,200$, $CF_5 = 3,200$, and $I = 12$. Press the NPV key (or CPT, then the NPV key) to find $NPV = 77.82$.

You can also use a spreadsheet to compute NPV. Using Excel, you could set up the spreadsheet as follows:

	A	B	C	D	E
1	Year	Cash Flow			
2	0	(5,000)			
3	1	800	r =	0.12	
4	2	900	PV =	=NPV(D3,B3:B7)	
5	3	1,500	NPV =	=D4+B2	
6	4	1,200			
7	5	3,200			
8					

To solve for the present value of the future cash flows, put the cursor in cell **D3** and click on the “Financial” function named NPV. In the box that appears input the following cell locations:

Function Arguments

NPV

Rate D3 = 0.12

Value1 B3:B7 = {800;900;1500;1200;3200}

Value2 = number

= 5077.818208

Returns the net present value of an investment based on a discount rate and a series of future payments (negative values) and income (positive values).

Rate: is the rate of discount over the length of one period.

Formula result = \$5,077.82

[Help on this function](#) OK Cancel

The range **B3:B7** contains the values of the cash flows for Year 1 through Year 5 because the NPV function programmed into the spreadsheet computes the present value of the *future* cash flows only. When you click “OK” you will see the result of the computation, which is \$5,077.82, appear in cell **D3**. But, because this result represents the present value of the future cash flows, you need to add CF_0 to the result to include the amount of the initial investment. In this case, the computation is completed in cell **D4**, where CF_0 is added to the result of the NPV computation that appears in cell **D3**. Cell **D4** should now show the correct answer for the NPV, which is \$77.82.

We can use the present values of the future cash flows to compute the *discounted payback*. To do so, we simply apply the concept of the traditional payback to the present values of the future cash flows as follows:

<u>Year</u>	<u>Cash Flow</u>	<u>PV of CF</u>	<u>Cumulative PV</u>
0	\$(5,000)	\$(5,000.00)	\$(5,000.00)
1	800	714.29	(4,285.71)
2	900	717.47	(3,568.24)
3	1,500	1,067.67	(2,500.57)
4	1,200	762.62	(1,737.95)
5	3,200	1,815.77	77.82

Thus, the discounted payback is

$$\begin{aligned} \text{Payback period} &= \left(\frac{\text{Number of years before full recovery of original investment}}{\text{recovery of original investment}} \right) + \left(\frac{\text{PV of investment remaining to be recaptured}}{\text{PV of total cash flow during year of payback}} \right) \\ &= 4 + \frac{\$1,737.95}{\$1,815.77} \\ &= 4.96 \text{ years} \end{aligned}$$

When using the discounted payback, a project is acceptable if its payback is less than its life. In this case, 4.96 years is less than five years, so the project is acceptable. Notice, however, we could have made the decision by looking at the last line of the column labeled “Cumulative PV” because that value is the NPV. So, if you set up the problem as we did in the above table and the ending value for the “Cumulative PV” is greater than zero, then $\text{NPV} > 0$ and the project is acceptable.

- Internal rate of return (IRR)—it was mentioned above that a project that has a positive NPV generates a return that is greater than the cost of the funds used to purchase the project. The IRR is defined as the rate of return the firm would earn, on average, if it purchases the project. To determine the IRR, we want to compute the rate of return that causes the NPV of the project to equal zero, or where the present value of the future cash flows equals the initial investment. In other words:

$$\begin{aligned} \text{NPV} &= \text{CF}_0 + \frac{\hat{\text{CF}}_1}{(1 + \text{IRR})^1} + \frac{\hat{\text{CF}}_2}{(1 + \text{IRR})^2} + \dots + \frac{\hat{\text{CF}}_n}{(1 + \text{IRR})^n} = 0 \\ \text{CF}_0 &= -\frac{\hat{\text{CF}}_1}{(1 + \text{IRR})^1} - \frac{\hat{\text{CF}}_2}{(1 + \text{IRR})^2} - \dots - \frac{\hat{\text{CF}}_n}{(1 + \text{IRR})^n} \end{aligned}$$

If this computation seems familiar, it should be, because the computation for IRR is the same as the computation for the yield to maturity (YTM) on a bond, which was discussed in the notes about valuation.

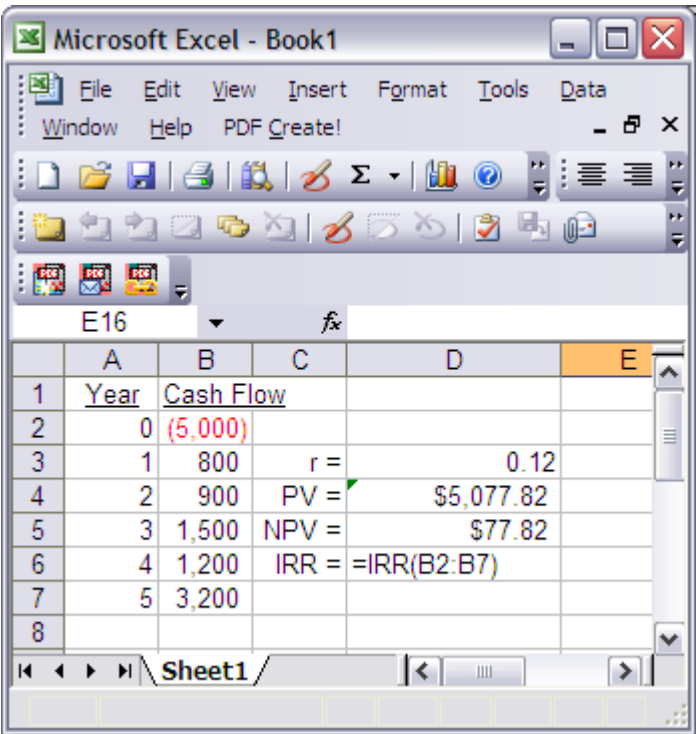
The IRR for our project is

$$\begin{aligned} \text{NPV} &= -\$5,000 + \frac{\$800}{(1 + \text{IRR})^1} + \frac{\$900}{(1 + \text{IRR})^2} + \frac{\$1,500}{(1 + \text{IRR})^3} + \frac{\$1,200}{(1 + \text{IRR})^4} + \frac{\$3,200}{(1 + \text{IRR})^5} = 0 \\ -\$5,000 &= -\frac{\$800}{(1 + \text{IRR})^1} - \frac{\$900}{(1 + \text{IRR})^2} - \frac{\$1,500}{(1 + \text{IRR})^3} - \frac{\$1,200}{(1 + \text{IRR})^4} - \frac{\$3,200}{(1 + \text{IRR})^5} \end{aligned}$$

It is not easy to solve for the IRR without a calculator because you have to use a trial-and-error method—that is, plug in various values for IRR until the right side of the equation equals the left side of the equation. With a financial calculator, however, it is very easy to solve for IRR.

Follow the same steps you would to compute the NPV, but press the IRR key (or CPT and then the IRR key) instead of the NPV key. You should find that IRR= 12.5%.

Using a spreadsheet to compute the IRR for the project, set up the problem as before:

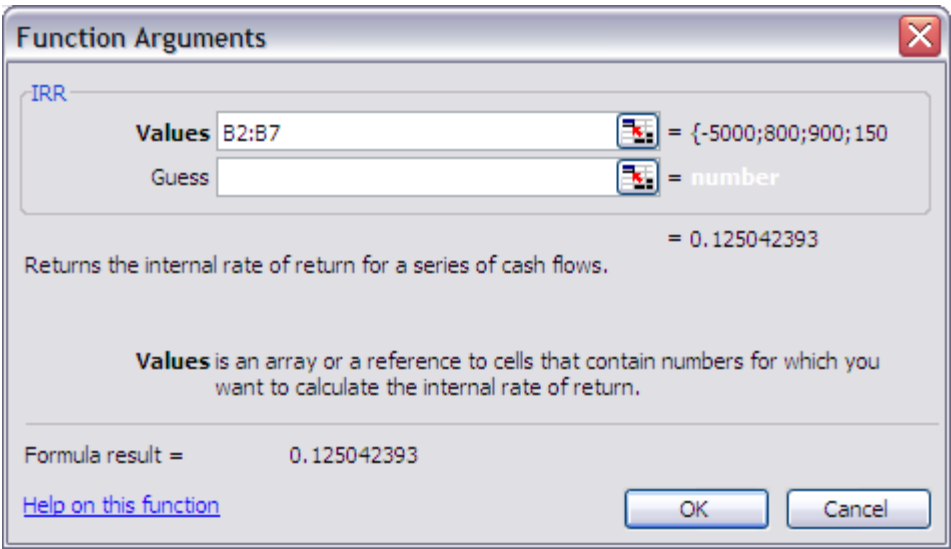


The screenshot shows a Microsoft Excel window titled "Microsoft Excel - Book1". The spreadsheet is set up to calculate the Internal Rate of Return (IRR) for a project. The data is organized as follows:

	A	B	C	D	E
1	Year	Cash Flow			
2	0	(5,000)			
3	1	800	r =	0.12	
4	2	900	PV =	\$5,077.82	
5	3	1,500	NPV =	\$77.82	
6	4	1,200	IRR =	=IRR(B2:B7)	
7	5	3,200			
8					

The formula bar shows "E16" and the formula "=IRR(B2:B7)" is entered in cell D6. The status bar at the bottom indicates "Sheet1".

To solve for the internal rate of return for this project, put the cursor in cell **D5** and click on the “Financial” function named IRR. In the box that appears input the following cell locations:



The screenshot shows the "Function Arguments" dialog box for the IRR function. The dialog box is titled "Function Arguments" and has a close button (X) in the top right corner. The function name "IRR" is displayed in the top left. The "Values" field is set to "B2:B7", and the "Guess" field is empty. The formula bar shows "= {-5000;800;900;150}" for Values and "= number" for Guess. The result of the function is displayed as "= 0.125042393". Below the result, a description states: "Returns the internal rate of return for a series of cash flows." A note explains: "Values is an array or a reference to cells that contain numbers for which you want to calculate the internal rate of return." The "Formula result =" is shown as "0.125042393". At the bottom, there are "OK" and "Cancel" buttons, and a link to "Help on this function".

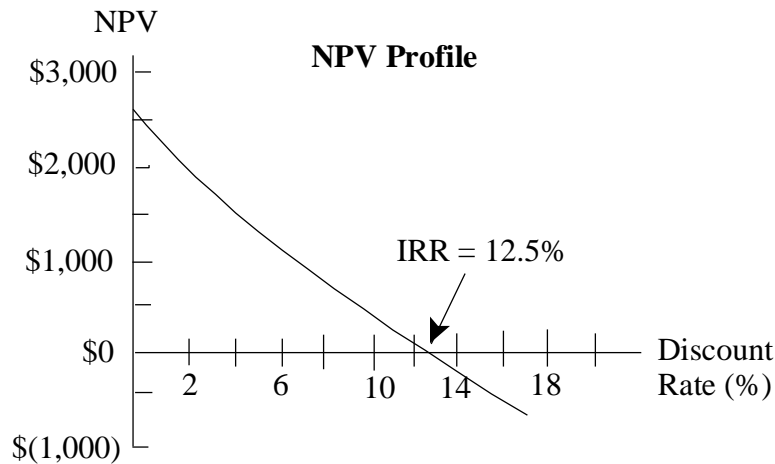
The range **B2:B7** contains the values of all the cash flows for the project. When you click “OK,” the answer, 12.50%, will appear in cell **D5**.

A project is acceptable using IRR if its IRR is greater than the firm’s required rate of return—that is, $IRR > r$. Remember that the IRR represents the rate of return the firm will earn if the project is purchased. So, simply stated, the project must earn a return that is greater than the cost of the funds used to purchase it. In our example, $IRR = 12.5\%$, which is greater than $r = 12\%$, so the project is acceptable.

- Comparison of the NPV and IRR Methods—summarizing what we have discussed to this point, we know that a project is acceptable if its NPV is greater than zero. If a project has an NPV greater than zero, then it *generates a return that is greater than the cost of the funds used to purchase the project*. We also know that a project is acceptable if its IRR is greater than the firm’s required rate of return. When a project has an IRR greater than the required rate of return, then it *generates a return that is greater than the cost of the funds used to purchase the project*. As you can see by the italicized phrases, accepting a project using the NPV technique provides the same benefit as accepting a project using the IRR technique. As a result, both the NPV technique and the IRR technique should always give the same accept/reject decision—that is, if a project is acceptable using the NPV method, it also is acceptable using the IRR method, and vice versa. As we will discover shortly, however, when comparing two or more projects, the two techniques do not always agree as to which project is best.
 - NPV profiles—an NPV profile is a graph that shows the NPVs of a project at various required rates of return. To construct an NPV profile, compute the NPV of a project at different discount rates and then plot the results. For our example, the following table shows the results of computing the NPV of the project at different discounts rates, or required rates if return:

<u>Discount rate</u>	<u>NPV</u>
0.0%	2,600.00
5.0	1,368.51
8.0	763.00
10.0	404.61
12.0	77.82
15.0	(360.47)
18.0	(745.03)
20.0	(975.57)

If these values are plotted, the NPV profile for this project is:



As you can see, the point where the curve intersects the horizontal axis represents the project's IRR.

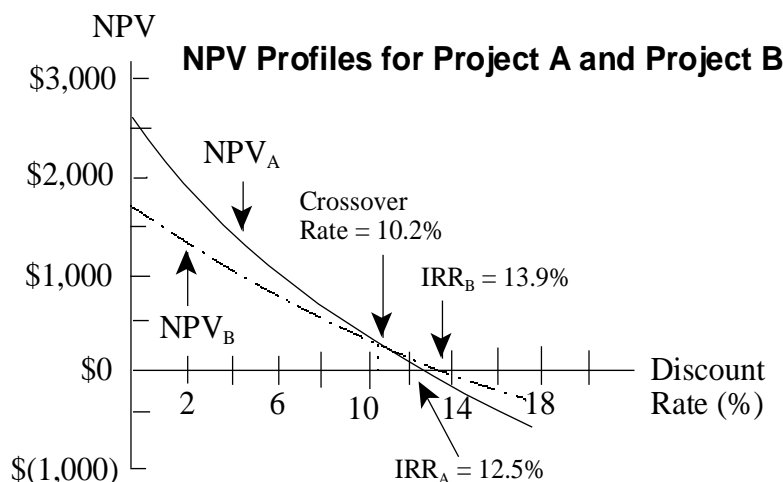
Let's assume the firm in our example is considering another project with the following characteristics:

<u>Year</u>	<u>Cash Flow</u>	<u>PV of CF</u>
0	\$(5,000)	\$(5,000.00)
1	2,400	2,142.86
2	1,800	1,434.95
3	900	640.60
4	900	571.97
5	700	397.20
		<u>\$ 187.57 = NPV</u>

The NPVs for this project, which we will call Project B, at various discount rates would be:

<u>Discount rate</u>	<u>NPV</u>
0.0%	\$1,700.00
5.0	984.72
8.0	617.82
10.0	394.96
12.0	187.57
15.0	(97.62)
18.0	(355.42)
20.0	(513.82)

Plotting these NPVs with the NPVs of the first project, which we call Project A, produces the following NPV profile graph:



In examining the graph you should notice a few points: (1) At lower discount rates Project A has a higher NPV, while Project B has the higher NPV at higher rates. The reason for this is that, although Project B generates less total cash flow over its life (that is, \$1,700 compared to \$2,600 for Project A), the cash flows are received sooner than for Project A. As a result, the cash flows can be reinvested to produce a higher rate of return, which is evidenced by the fact that $IRR_B > IRR_A$. (2) The slope of the curve for Project A is steeper than for Project B, which indicates that the NPV of Project A is more sensitive to changes in the discount rate than Project B—that is, the NPV change is greater for Project A than for Project B when the discount rate changes. (3) There is a point, which we refer to as the *crossover point*, where $NPV_A = NPV_B$. In this case the crossover point is where the discount rate equals 10.2 percent. This rate was computed by taking the difference between the cash flows for both projects and then determining the IRR of the results. In other words,

Year	Cash Flows		Difference
	Project A	Project B	
0	\$(5,000)	\$(5,000)	\$0
1	800	2,400	(1,600)
2	900	1,800	(900)
3	1,500	900	600
4	1,200	900	300
5	3,200	700	2,500

Treat the values in the last column as a separate cash flow stream and then compute the IRR just like you would for either Project A or Project B—that is, $CF_0 = \$0$, $CF_1 = -\$1,600$, $CF_2 = -\$900$, $CF_3 = \$600$, $CF_4 = \$300$, and $CF_5 = \$2,500$. You should find $IRR = 10.2\%$, which is the crossover point. As the graph shows, if the discount rate is below 10.2 percent, the NPV of Project A is greater than the NPV of Project B and, if the discount rate is above 10.2 percent the NPV of Project A is less than the NPV of Project B. If the discount rate equals 10.2 percent, then $NPV_A = NPV_B$.

- Independent projects—if projects are independent, the simple rule is to invest in all projects that have positive NPVs (IRRs greater than the firm's required rate of return). Remember, that if a project has a positive NPV, then its IRR is greater than the firm's required rate of return.
- Mutually exclusive projects—the firm cannot invest in all projects that have positive NPVs if they are mutually exclusive, because, by definition, only one project can be purchased. Even though we know that when $NPV > 0$, $IRR > r$ in every case, there are instances when we evaluate two projects and find the following:

$$NPV_1 > NPV_2 > 0 \quad \text{and} \quad r < IRR_1 < IRR_2$$

According to our decision rules, both projects are acceptable. But, if the projects are mutually exclusive, which should be chosen? The NPV of Project 1 is greater than the NPV of Project 2, but the IRR of Project 2 is greater than the IRR of Project 1. This poses a problem, because one project is more acceptable using NPV while the other project is more acceptable using IRR. The reason this conflict occurs is because the two techniques have different reinvestment assumptions. NPV assumes the cash flows received in the future can be reinvested at the firm's required rate of return, while IRR assumes that the cash flows can be reinvested at the project's IRR. Which is a more appropriate assumption? Most people generally agree that the firm can reinvest at its required rate of return, but not always at the project's IRR. Thus, we conclude that the NPV method should be used to determine which project should be purchased when such a conflict occurs when evaluating mutually exclusive projects. In this case, then, Project 1 is more acceptable than Project 2 because $NPV_1 > NPV_2$.

- Multiple IRRs—if a project has an unconventional cash flow pattern such that net cash outflows alternate with net cash inflows more than once, then it could have more than one IRR. Each time the sign of the net cash flow changes (that is, from positive to negative, or vice versa) the project will have another IRR. In our examples to this point, the projects have had only one sign change—from negative in Year 0 to positive in Year 1—so they only have one IRR. If we introduced a project with a similar cash flow pattern as the previously mentioned projects except there was a net cash outflow at some point during the life of the project (in addition to the initial investment at Year 0), say, in Year 3, then the new project would have two IRRs. If you would like to see how we correct for multiple IRRs, see the appendix to the capital budgeting chapter in the text.
- Modified Internal Rate of Return (MIRR)—represents the rate of return that equates the present value of a project's cash outflows with the present value of its cash inflows, which are stated in terms of dollars at the end of the project's life. MIRR is computed as follows:

$$\sum_{t=0}^n \frac{COF_t}{(1+r)^t} = \frac{\sum_{t=0}^n CIF_t (1+r)^{n-t}}{(1+MIRR)^n}$$

Here COF represents cash outflows, CIF represent cash inflows, r is the firm's required rate of return, and n is the life of the project.

The MIRR can be used to solve ranking problems and multiple IRRs.

Example:

<u>Year</u>	<u>Cash Flows</u>	
	<u>Project A</u>	<u>Project B</u>
0	(7,000)	(8,000)
1	2,000	6,000
2	1,000	3,000
3	5,000	1,000
4	3,000	500

Following are the results of solving for NPV, IRR, and discounted payback:

	<u>Asset A</u>	<u>Asset B</u>
Traditional PB	2.80 yrs	1.67 yrs
Discounted PB	3.71 yrs	<u>2.78 yrs</u>
NPV	<u>\$498.12</u>	\$429.22
IRR	18.02%	<u>19.03%</u>

Underlines represent the asset with the better results. A ranking conflict exists.

Computing the MIRRs, we have

$$7,000 = \frac{2,000(1.15)^3 + 1,000(1.15)^2 + 5,000(1.15)^1 + 3,000(1.15)^0}{(1 + \text{MIRR}_A)} = \frac{13,114.25}{(1 + \text{MIRR}_A)}$$

Calculator solution: $N = 4$, $PV = -7,000$, $PMT = 0$, $FV = 13,114.25$; $I/Y = 16.99 = \text{MIRR}_A$

$$8,000 = \frac{6,000(1.15)^3 + 3,000(1.15)^2 + 1,000(1.15)^1 + 500(1.15)^0}{(1 + \text{MIRR}_B)} = \frac{14,742.75}{(1 + \text{MIRR}_B)}$$

Calculator solution: $N = 4$, $PV = -8,000$, $PMT = 0$, $FV = 14,742.75$; $I/Y = 16.51 = \text{MIRR}_B$

$\text{MIRR}_A > \text{MIRR}_B$, which indicates that Project A is preferable.

Project Cash Flows and Risk

- Cash Flow Estimation—when evaluating a capital budgeting project, we must estimate the after-tax cash flows the asset is expected to generate in the future. (Remember that the value of an asset is the present value of the future cash flows the asset is expected to generate.) Estimating future cash flows is not easy because the future cannot be predicted with perfect certainty. Some cash flows can

be predicted more accurately than others. For example, the cash flows associated with a project that has existed for a long time—a utility power plant—might be *fairly* easy to predict, while the cash flows associated with a project that was introduced recently—a dot.com company—might be extremely difficult to predict. Accurate cash flow forecasts are important because incorrect forecasts could cause the firm to either accept projects that actually are unacceptable or reject projects that actually are acceptable.

- Relevant Cash Flows—cash flows that must be evaluated in capital budgeting decisions.
 - Cash flow versus accounting income—we are concerned with cash flows rather than income because cash flows pay the bills and cash flows can be invested to earn positive returns; income cannot. Always use cash flows after taxes—that is, after-tax cash flows—because cash must be used to pay taxes. The computation of accounting income often includes noncash items, such as depreciation. Thus, in simple terms, we can use the following relationship to estimate operating cash flows:

$$\begin{aligned}\text{Net cash flow} &= \text{Net income} && + && \text{Depreciation} \\ &= \text{Return on capital} && + && \text{Return of capital}\end{aligned}$$

- Incremental cash flows—when conducting a capital budgeting analysis, we are concerned with the marginal, or incremental, cash flows associated with the asset. In other words, we should examine only those cash flows that are affected, or change, if the asset is purchased. When examining incremental cash flows keep the following in mind:
 - Sunk costs—if a cash outflow associated with the project has already occurred and will not be affected by the decision to purchase the asset, it is considered a sunk cost. For example, a firm might pay \$250,000 for a feasibility study to determine whether a new product should be introduced. The \$250,000 will be paid whether the firm decides to pursue the idea further—that is, conduct a capital budgeting analysis—or drops the idea after examining the completed feasibility study. Thus, the cost of the feasibility study is a sunk cost. This cost should not be included in the capital budgeting analysis because it is not an *incremental* future cash flow associated with the decision to manufacture the product—that is, we should only evaluate the cash flows that change in the future as a result of the capital budgeting decision.
 - Opportunity costs—the return that can be earned by investing funds in assets similar to those the firm already owns—that is, the next best return the firm can earn if the funds are not invested in the proposed capital budgeting project. For example, if a company owns an empty warehouse with a market value of \$3.5 million that it is considering converting into office space for the firm, the \$3.5 million is considered an opportunity cost associated with the decision to turn the warehouse into an office building.
 - Externalities: effects on other parts of the firm—any effect a project is expected to have on another part of the firm’s operations must be included in a capital budgeting analysis. For example, many firms that have traditionally sold their products in stores are now selling merchandise on the Internet. If a company decides to examine viability of selling on the Internet, the capital budgeting analysis must take into consideration the fact that some of the cash flows generated by Internet sales will be derived from customers who previously purchased at the stores. These “transfer” cash flows should not be included as part of the

incremental cash flows for the purposes of evaluating this project because this portion of sales is not new, or incremental.

- Shipping and installation costs—these costs generally are not included in the quoted purchase price of an asset, but they are effectively part of the purchase price because the firm cannot use the asset until it is received and put in operating condition. Also, the depreciable basis of an asset—that is, the amount that can be depreciated over the life of the asset—includes the purchase price plus whatever it costs to make the asset operational, which includes shipping and installation.
- Inflation—inflation expectations should be built into the forecasts of the future cash flows associated with a project; otherwise, the analysis could produce incorrect results.

- Identifying Incremental Cash Flows—we generally identify three types of incremental cash flows:
 - Initial investment outlay—includes cash flows that occur only at the beginning of the project's life. Cash flows included in this category are the purchase price of the asset, shipping and installation costs, the cash flows associated with disposal of the old asset if that asset is being replaced (this could be the cash received from selling the asset), taxes, changes in net working capital, and any other “up-front” cash flows associated with a capital budgeting project. The item “changes in net working capital” refers to the fact that in many cases inventory or other working capital accounts are affected when a new machine is purchased and added to the firm or when an old machine is replaced by a new, more technologically advanced machine. In some cases inventory will increase, which means there will be an additional cash outflow associated with purchasing the additional inventory, and in other cases inventory will decrease, which means there will be a cash inflow associated with purchasing the asset because inventory can be sold until the new, lower level of inventory is attained.
 - Incremental operating cash flows—changes in cash flows that are sustained throughout the life of the asset—that is, the cash flow effects are ongoing. Cash flows included in this category are permanent changes in cash sales, salaries, costs of raw materials, and other cash operating revenues and expenses that change because the asset is purchased. One item that must be included in incremental cash flows is the effect of taxes—if revenues and expenses change, then there is a good chance the tax liability of the firm changes also. In most cases, incremental operating cash flows can be computed using the following equation:

Incremental

$$\begin{aligned}
 \text{operating cash flow}_t &= \Delta \text{Cash revenues}_t - \Delta \text{Cash expenses}_t - \Delta \text{Taxes}_t \\
 &= \Delta \text{NI}_t + \Delta \text{Depr}_t \\
 &= \Delta \text{EBT}_t \times (1 - T) + \Delta \text{Depr}_t \\
 &= (\Delta S_t - \Delta \text{OC}_t - \Delta \text{Depr}_t) \times (1 - T) + \Delta \text{Depr}_t \\
 &= (\Delta S_t - \Delta \text{OC}_t) \times (1 - T) + T(\Delta \text{Depr}_t)
 \end{aligned}$$

where Δ represents a change, thus ΔNI_t is the change in net income associated with the project. The other variables are defined as follows: S represents sales, OC is operating costs, T is taxes, and Depr is depreciation.

- Terminal cash flow—the cash flows that occur only at the end of the life of the asset. Cash flows included in this category are the salvage value of the asset, which could be positive if the asset is sold for cash or negative if the firm has to pay to have the asset taken away, any taxes associated with salvage, changes in net working capital, and any other cash flows that occur at the end of the life of the asset only. The item “changes in net working capital” included here is the opposite of the change in net working capital that is included in the initial investment outlay. The rationale for this adjustment is that the firm will return to the same operating position it was in before the asset was purchased so that inventories and other working capital accounts return to their “normal” levels. As a result, if an increase in inventory is required when the asset is purchased, the inventory should decrease to its “normal” level when the firm disposes of the asset, which would represent a cash inflow at the end of the asset’s life.
- Capital Budgeting Project Evaluation
 - Expansion projects—evaluation of expansion projects is relatively simple because identifying the incremental cash flows associated with such projects generally is straightforward. The initial investment outlay includes the asset’s purchase price, shipping and installation costs, and any changes in net working capital; the incremental operating cash flows include increases in cash sales and the cash expenses associated with incremental sales and the impact of such changes on taxes; and the terminal cash flow includes the salvage value of the asset after taxes and the reversal of the changes in net working capital that occurred when the asset was purchased. Once the cash flows are identified, we can apply either NPV or IRR to determine whether the asset should be purchased.
 - Replacement analysis—evaluation of replacement projects is slightly more involved compared to expansion projects because an existing asset is being replaced. When identifying the cash flows for replacement projects, keep in mind that the cash flows associated with the existing (replaced) asset will no longer exist if the new asset is purchased. Therefore, we must not only determine the cash flows that the new asset will generate, but we must also determine the effect of eliminating the cash flows generated by the replaced asset. For example, if a new asset that will produce cash sales equal to \$100,000 per year is purchased to replace an existing asset that is generating cash sales equal to \$75,000, then the incremental, or marginal, cash flow related to sales is \$25,000. Likewise, if the asset that is replaced can be sold for \$350,000, then the purchase price of the new asset effectively is \$350,000 less than its invoice price. In other words, for replacement decisions, we must determine the overall net effect of purchasing a new asset to replace an existing asset—the cash flows associated with the old asset will be replaced with the cash flows associated with the new asset. Two items that you must remember to include when determining the incremental cash flows are depreciation—not because it is a cash flow, but because it affects cash flows through taxes—and taxes, both of which generally change when an older asset is replaced with a newer asset.
- Incorporating Risk in Capital Budgeting Analysis—when evaluating a capital budgeting project, we need to examine the risk associated with the project and how the existing assets of the firm will be affected if the project is purchased. The reason we need to evaluate the risk of a project is to determine if the appropriate required rate of return is used to compute the project’s NPV (or to compare to its IRR). If a firm is considering a project that is much riskier than the existing assets,

then it makes sense that the firm should expect to earn a higher return on the project than on its existing assets.

There are three risks that we generally identify when evaluating a project: (1) *stand-alone risk*, which is the risk of the asset when it is held in isolation—that is, when it stands alone; (2) *corporate, or within-firm, risk*, which is measured by the impact an asset is expected to have on the operations of the firm—that is, how an asset will affect the firm’s total risk if it is purchased and added to existing assets; and (3) *beta, or market, risk*, which is the portion of an asset’s risk that cannot be eliminated through diversification—that is, how an asset will affect the firm’s market risk, or beta, if it is purchased and added to existing assets. For a more detailed discussion of how each of these types of risks is measured, see the notes for the “Risk and Return” section.

- **Stand-Alone Risk**—generally this is the risk that we compute when evaluating capital budgeting projects because it is easier to determine than the other two types of risk and it is usually very highly correlated to the other types of risk. To examine stand-alone risk, we need to determine how uncertain a project’s cash flows are. To do this, we often apply the following techniques:
 - Sensitivity analysis—determine by how much the final result of a computation, such as NPV, changes when the values (inputs) needed for the computation are changed. For example, if we examine the NPV of a project at various levels of sales and find that the result changes very little, then sales would be considered a fairly insensitive variable in the computation. Generally, if the final results are very sensitive to the value of a variable (the variable is said to be sensitive), greater care is taken to ensure an accurate forecast of the variable is attained so that the final results are more accurate. Sensitivity analysis is easy to perform using a spreadsheet because you can input numerous values for the variable being evaluated.
 - Scenario analysis—compute outcomes using various circumstances, or scenarios. Often firms will compute the NPVs of a project using the normal, or most likely, situation, a conservative, or worst-case, situation, and an optimistic, or best-case, situation. After determining the NPVs, a probability is assigned to each scenario, and the expected NPV and standard deviation of the NPV are computed. For example, consider the following:

Scenario	Probability, Pr_i	NPV	$NPV \times Pr_i$
Best case	0.30	\$75,100	22,530
Most likely case	0.50	34,500	17,250
Worst case	0.20	(5,200)	(1,040)
			E(NPV) = \$38,740

$$\sigma = \sqrt{0.3(75,100 - 38,740)^2 + 0.5(34,500 - 38,740)^2 + 0.2(-5,200 - 38,740)^2} = \$28,138$$

$$\text{Coefficient of variation} = CV = \frac{\$28,138}{\$38,740} = 0.73$$

In this case, if the company’s assets have an average CV = 1.0, this project probably would be desirable. Remember that a lower CV is better than a higher CV when we are measuring risk relative to return.

- Monte Carlo simulation—we try to simulate the real world by identifying all the possible outcomes for all the situations, or variables, that are associated with a capital budgeting project. For example, one variable that generally needs to be forecast is the change in sales that will occur if a project is implemented. When using simulation, you must predict every sales level that is feasible under various circumstances—for example, sales if projections are met during good economic times, sales if projections are not met during good economic times, sales if projections are met during normal economic times, and so forth. After identifying all the possible sales outcomes, you must determine the possibility (probability) that such outcomes will occur. This process is completed for each variable included in the final outcome (e.g., NPV) and then all the information is input into a computer program that determines a final outcome value based on the various values and the probabilities that were provided. The computation is completed numerous times such that the final product is a distribution of values for the final outcome. If the NPV of a project is the final result, then the computer program produces values for the NPV under various circumstances. This helps us determine the most likely outcome for NPV, the range within which NPV is likely to fall, and the riskiness of the project.
- Corporate (within-Firm) Risk—determine how a capital budgeting project is related to the existing assets of the firm. If the firm wants to diversify its risk, it will try to invest in projects that are negatively related (or have little relationship) to the existing assets. If a firm can reduce its overall risk, then it generally becomes more stable and its required rate of return decreases.
- Beta (Market) Risk—at least theoretically, any asset has a beta, β , or some way to measure its systematic risk (see the notes for “Risk and Rates of Return” for a detailed discussion).
 - If we can determine the beta of an asset, then we can use the capital asset pricing model, CAPM, to compute its required rate of return as follows:

$$r_{\text{proj}} = r_{\text{RF}} + (r_{\text{M}} - r_{\text{RF}})\beta_{\text{proj}}$$

According to the CAPM, the greater a project’s systematic risk as measured by β , the greater the return the firm should require to invest in the project. For example, if a firm uses the CAPM and determines $r_{\text{proj}} = 16\%$, then the IRR for the project must be greater than 16 percent for it to be acceptable.

The concept of beta can also be used to determine the impact of adding a project to existing assets. Remember that the beta of a portfolio is the weighted average of the betas of the individual investments. The beta for a firm can be thought of as the weighted average of the betas of the individual assets it possesses. For example, if the firm’s beta equals 1.5, then the weighted average of the betas of all the assets in the firm is 1.5. Suppose the firm adds a new project. If the new project has a beta equal to 3.0 and it will constitute 20 percent of the firm’s operations once it is added, then the beta of the firm after the project is added, β_{new} , will be:

$$\beta_{\text{new}} = (0.20 \times \beta_{\text{project}}) + (0.80 \times \beta_{\text{old}}) = (0.20 \times 3.0) + (0.80 \times 1.5) = 1.8$$

- Measuring beta risk for a project—it is difficult to determine the beta for a project. One method we use to determine a project's beta is to examine a firm that sells only one product, the product that is identical to the project, and then use the beta of that firm as the beta of the project. When a single-product company is used to identify characteristics of a like capital budgeting project, it is called the *pure play method*.
- How Project Risk Is Considered in Capital Budgeting Decisions—in reality, risk generally is incorporated into capital budgeting decisions somewhat arbitrarily. The firm generally uses its “normal,” or average, required rate of return to evaluate projects that have average risk, a few percentage points are added to the average required rate of return to evaluate projects that have above-average risk, and a few percentage points are subtracted from the average required rate of return to evaluate projects that have below-average risk. It is important that a project's risk be considered in capital budgeting analysis, because incorrect decisions might be made if risk is not considered. For example, if the firm's average rate of return is used to evaluate all capital budgeting projects, regardless of their risk, then projects with little (great) risk might be rejected (accepted) when they should be accepted (rejected).
- Capital Rationing—in most cases firms do not have access to unlimited amounts of funds or financial managers do not want to access additional funds, which might mean that some acceptable capital budgeting projects are not purchased. If the amount of funds that is invested in capital budgeting projects is constrained, then *capital rationing* exists. In such situations, the firm should invest in the combination of projects that provides the highest combined NPV—that is, that increases the firm's value by the most.
- Multinational Capital Budgeting—for the most part, the capital budgeting projects of multinational firms should be evaluated the same as for domestic firms. However, the multinational firm must be aware that many countries have restrictions on how much cash can be sent back to the parent company from its foreign subsidiaries (repatriation of cash). Restrictions on the *repatriation of cash (earnings)* can often be very severe, thus the cash flows that are relevant to the parent company are those that can be repatriated, not those that must stay in the foreign country. Also, capital budgeting projects associated with foreign operations generally are considered riskier than those associated with domestic operations because (1) movements in exchange rates—that is, exchange rate risk—affect the translation of foreign currency into domestic currency, and (2) there is a risk that foreign governments will takeover or severely restrict operations of foreign subsidiaries—that is, political risk exists. Such risks must be considered when evaluating capital budgeting projects of foreign subsidiaries.