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CHAPTER 11 The Basics of Capital Budgeting

Competition in the Aircraft Industry: Airbus vs. Boeing

In early 2008, Boeing was involved in a titanic struggle with European consortium Airbus SAS for dominance of the commercial aircraft industry.¹ Several years ago Airbus committed to spend \$16 billion to develop the A380, the largest plane ever built. Boeing countered by announcing that it would spend \$6 billion on a super-efficient new plane, the 7E7 Dreamliner. Airbus then announced plans to spend another \$6 billion on the A350, a competitor to the 7E7. Many detailed calculations went into these multibillion-dollar investment decisions—development costs were estimated, the cost of each plane was forecasted, a sales price per plane was established, and the number of planes that would be sold through 2025 was predicted.

Both companies projected negative cash flows for 5 or 6 years, then positive cash flows for

the following 20 years. Given their forecasted cash flows, both managements decided that taking on the projects would increase each company's intrinsic value. Because the planes will compete with one another, either Boeing's or Airbus's forecast is probably incorrect. One will probably be a winner and the other a loser, and one set of stockholders will likely be happy and the other unhappy. As of the winter of 2008, both companies received orders for their planes, but both have encountered problems that have delayed the actual introduction of the aircraft. The winner is still undecided.

Projects such as the A350, A380, and 7E7 receive a great deal of attention; but Boeing, Airbus, and other companies make a great many routine investment decisions every year, ranging from buying new trucks or machinery

¹ Airbus SAS is owned by European Aeronautics Defense & Space Company (EADS), which is owned by the French government and several large European companies. Airbus was formed because the Europeans wanted to create an organization large enough to compete with Boeing.

to purchasing computers and software to optimize inventory management. The techniques described in this chapter are required to analyze projects of all types and sizes.

Sources: John Newhouse, *Boeing Versus Airbus: The Inside Story of the Greatest International Competition in Business* (New York: Random House, 2007).

PUTTING THINGS IN PERSPECTIVE

Capital Budgeting

The process of planning expenditures on assets with cash flows that are expected to extend beyond one year.

In the last chapter, we discussed the cost of capital. Now we turn to investment decisions involving fixed assets, or *capital budgeting*. Here *capital* refers to long-term assets used in production, while a *budget* is a plan that outlines projected expenditures during some future period. Thus, the *capital budget* is a summary of planned investments in long-term assets, and *capital budgeting* is the whole process of analyzing projects and deciding which ones to include in the capital budget. Boeing, Airbus, and other companies use the techniques in this chapter when deciding to accept or reject proposed capital expenditures.

When you finish this chapter, you should be able to:

- Discuss capital budgeting.
- Calculate and use the major capital budgeting decision criteria, which are NPV, IRR, MIRR, and payback.
- Explain why NPV is the best criterion and how it overcomes problems inherent in the other methods.

With an understanding of the theory of capital budgeting developed in this chapter, which uses simplified examples, you will be ready for the next chapter, where we discuss how cash flows are estimated, how risk is measured, and how capital budgeting decisions are made.

11-1 AN OVERVIEW OF CAPITAL BUDGETING

The same concepts used in security valuation are also used in capital budgeting, but there are two major differences. First, stocks and bonds exist in the security markets, and investors select from the available set; firms, however, create capital budgeting projects. Second, for most securities, investors have no influence on the cash flows produced by their investments, whereas corporations have a major influence on projects' results. Still, in both security valuation and capital budgeting, we forecast a set of cash flows, find the present value of those flows, and make the investment only if the PV of the inflows exceeds the investment's cost.

A firm's growth, and even its ability to remain competitive and to survive, depends on a constant flow of ideas relating to new products, to improvements in existing products, and to ways of operating more efficiently. Accordingly, well-managed firms go to great lengths to develop good capital budgeting proposals. For example, the executive vice president of one successful corporation said that his company takes the following steps to generate projects:

Our R&D department constantly searches for new products and ways to improve existing products. In addition, our Executive Committee, which consists of senior executives in marketing, production, and finance, identifies the

products and markets in which our company should compete, and the Committee sets long-run targets for each division. These targets, which are spelled out in the corporation's **strategic business plan**, provide a general guide to the operating executives who must meet them. The operating executives then seek new products, set expansion plans for existing products, and look for ways to reduce production and distribution costs. Since bonuses and promotions are based on each unit's ability to meet or exceed its targets, these economic incentives encourage our operating executives to seek out profitable investment opportunities.

While our senior executives are judged and rewarded on the basis of how well their units perform, people further down the line are given bonuses and stock options for suggestions that lead to profitable investments. Additionally, a percentage of our corporate profit is set aside for distribution to nonexecutive employees, and we have an Employees' Stock Ownership Plan (ESOP) to provide further incentives. Our objective is to encourage employees at all levels to keep an eye out for good ideas, especially those that lead to capital investments.

Analyzing capital expenditure proposals is not costless—benefits can be gained, but analysis does have a cost. For certain types of projects, an extremely detailed analysis may be warranted, while for other projects, simpler procedures are adequate. Accordingly, firms generally categorize projects and then analyze them in each category somewhat differently:

1. *Replacement: needed to continue current operations.* One category consists of expenditures to replace worn-out or damaged equipment required in the production of profitable products. The only questions here are should the operation be continued and if so, should the firm continue to use the same production processes? If the answers are yes, the project will be approved without going through an elaborate decision process.
2. *Replacement: cost reduction.* This category includes expenditures to replace serviceable but obsolete equipment and thereby to lower costs. These decisions are discretionary, and a fairly detailed analysis is generally required.
3. *Expansion of existing products or markets.* These are expenditures to increase output of existing products or to expand retail outlets or distribution facilities in markets now being served. Expansion decisions are more complex because they require an explicit forecast of growth in demand, so a more detailed analysis is required. The go/no-go decision is generally made at a higher level within the firm.
4. *Expansion into new products or markets.* These investments relate to new products or geographic areas, and they involve strategic decisions that could change the fundamental nature of the business. Invariably, a detailed analysis is required, and the final decision is generally made at the top level of management.
5. *Safety and/or environmental projects.* Expenditures necessary to comply with government orders, labor agreements, or insurance policy terms fall into this category. How these projects are handled depends on their size, with small ones being treated much like the Category 1 projects.
6. *Other projects.* This catch-all includes items such as office buildings, parking lots, and executive aircraft. How they are handled varies among companies.
7. *Mergers.* In a merger, one firm buys another one. Buying a whole firm is different from buying an asset such as a machine or investing in a new airplane, but the same principles are involved. The concepts of capital budgeting underlie merger analysis.

In general, relatively simple calculations, and only a few supporting documents, are required for replacement decisions, especially maintenance investments in

Strategic Business Plan

A long-run plan that outlines in broad terms the firm's basic strategy for the next 5 to 10 years.

profitable plants. More detailed analyses are required for cost-reduction projects, for expansion of existing product lines, and especially for investments in new products or areas. Also, within each category, projects are grouped by their dollar costs: Larger investments require increasingly detailed analysis and approval at higher levels. Thus, a plant manager might be authorized to approve maintenance expenditures up to \$10,000 using a relatively unsophisticated analysis, but the full board of directors might have to approve decisions that involve amounts greater than \$1 million or expansions into new products or markets.

If a firm has capable and imaginative executives and employees and if its incentive system is working properly, many ideas for capital investment will be advanced. Some ideas will be good ones, but others will not. Therefore, procedures must be established for screening projects. Companies use, and we discuss, the following criteria for deciding to accept or reject projects:²

1. Net Present Value (NPV)
2. Internal Rate of Return (IRR)
3. Modified Internal Rate of Return (MIRR)
4. Regular Payback
5. Discounted Payback

The NPV is the best method, primarily because it addresses directly the central goal of financial management—maximizing shareholder wealth. However, all of the methods provide useful information, and all are used in practice at least to some extent.



How is capital budgeting similar to security valuation? How is it different?

What are some ways that firms generate ideas for capital projects?

Identify the major project classification categories and explain how and why they are used.

What is the single best capital budgeting decision criterion?

11-2 NET PRESENT VALUE (NPV)

Net Present Value (NPV)

A method of ranking investment proposals using the NPV, which is equal to the present value of future net cash flows, discounted at the cost of capital.

The **net present value (NPV)** tells us how much a project contributes to shareholder wealth—the larger the NPV, the more value the project adds; and added value means a higher stock price.³ Thus, NPV is the best selection criterion. We use the data for Projects S and L shown in Table 11-1 to illustrate the calculation. The S stands for *Short*; the L, for *Long*. Project S is a short-term project in the sense that its cash inflows come in relatively soon, while L has more total cash inflows but they come in later in its life. The projects are equally risky, and they both have a 10% cost of capital. Furthermore, the cash flows have been adjusted to reflect

²Two other rarely used criteria, the Profitability Index and the Accounting Rate of Return, are covered in Chapter 12 and its Web Extension of Eugene F. Brigham and Phillip R. Daves, *Intermediate Financial Management*, 9th ed. (Mason, OH: Thomson/South-Western, 2007).

³We could divide the NPV by the number of shares outstanding to estimate a project's effect on the stock price. However, given the lag between project acceptance and visible effects on earnings, this is rarely done for routine projects. However, for major projects, this procedure is useful.

Table 11-1 Data on Projects S and L

	A	B	C	D	E	F	G
1							
2							
3	WACC for both projects:		10%				
4							
5		Initial Cost:	After-Tax, End of Year Net Cash Inflows, CF_t:				Total Inflows
6	Years:	0	1	2	3	4	
7	Project S:	-\$1,000	\$500	\$400	\$300	\$100	\$1,300
8	Project L:	-\$1,000	\$100	\$300	\$400	\$675	\$1,475

depreciation, taxes, and salvage values.⁴ The investment outlays shown as CF₀ include fixed assets and any necessary investments in working capital, and cash flows come in at the end of the year. Finally, we show the table with an “Excel look,” which simply means adding row and column headings to a “regular” table. All of the calculations can be done easily with a financial calculator; but since some students may want to work with Excel, we show how problems would be set up in Excel. Do keep in mind, though, that Excel is not necessary.

We find the NPVs as follows:

1. The present value of each cash flow is calculated, discounted at the project’s risk-adjusted cost of capital, $r = 10\%$ in our example.
2. The sum of the discounted cash flows is defined as the project’s NPV.

The equation for the NPV, set up with input data for Project S, is as follows:

$$\begin{aligned}
 \text{NPV} &= \text{CF}_0 + \frac{\text{CF}_1}{(1+r)^1} + \frac{\text{CF}_2}{(1+r)^2} + \cdots + \frac{\text{CF}_N}{(1+r)^N} \\
 &= \sum_{t=0}^N \frac{\text{CF}_t}{(1+r)^t} \quad \text{11-1} \\
 \text{NPV}_S &= -\$1,000 + \frac{\$500}{(1.10)^1} + \frac{\$400}{(1.10)^2} + \frac{\$300}{(1.10)^3} + \frac{\$100}{(1.10)^4}
 \end{aligned}$$

Here CF_t is the expected net cash flow at Time t, r is the project’s risk-adjusted cost of capital (or WACC), and N is its life. Projects generally require an initial investment—for example, developing the product, buying the equipment needed to make it, building a factory, and stocking inventory. The initial investment is a negative cash flow. For Projects S and L, only CF₀ is negative; but for a large project such as Boeing’s 7E7, outflows occur for several years before cash inflows begin.

Figure 11-1 shows the cash flow time line for Project S; the PV of each cash flow; and the sum of the PVs, which is by definition the NPV.

The cost, at $t = 0$, is $-\$1,000$. The first positive cash flow is $\$500$; and with a regular calculator, you could find its PV as $\$500/(1.10)^1 = \454.55 . You could also find the PV of the $\$500$ with a financial calculator. Other PVs could be found similarly, and the end result would be the numbers in the left column of the diagram. When we sum those numbers, the result is $\$78.82$, which is NPV_S. Note that the initial cost, the $-\$1,000$, is not discounted because it occurs at Time 0. The NPV for Project L, $\$100.40$, could be found similarly.

⁴The most difficult aspect of capital budgeting is estimating the relevant cash flows. For simplicity, the net cash flows are treated as a given in this chapter, which allows us to focus on the rules for making capital budgeting decisions. However, in Chapter 12, we discuss cash flow estimation in detail. Also note that *net working capital* is defined as the increase in current assets required for a project minus the associated increases in payables and accruals. Thus, in capital budgeting, investment in working capital means the *net amount* that must be financed by investors.

FIGURE 11-1

Finding the NPV for Projects S and L

	A	B	C	D	E	F	G	H
11		0	1	2	3	4		
12	Project S							
13		-1,000.00	500	400	300	100		
14		454.55						
15		330.58						
16		225.39						
17		68.30						
18	NPV _S =	78.82	Sum = NPV for Project S					
19								
20	NPV _L =	100.40	NPV _L found with the cash flow register of a calculator or Excel					

The step-by-step procedure shown in Figure 11-1 is useful for illustrating how the NPV is calculated; but in practice (and on exams), it is far more efficient to use a financial calculator or Excel. Different calculators are set up somewhat differently; but as we discussed in Chapter 5, they all have a “cash flow register” that can be used to evaluate uneven cash flows such as those for Projects S and L. Equation 11-1 is programmed into these calculators, and all you must do is enter the cash flows (with the correct signs) along with $r = I/YR = 10$. Once the data have been entered and you press the NPV key, the answer, 78.82, appears on the screen.⁵

If you are familiar with Excel, you can use it to find the NPVs for S and L:

$$NPV_S = \$78.82$$

$$NPV_L = \$100.40$$

The model used to obtain these values is provided in the chapter’s Excel model. If you want to know something about Excel, you should look at the model, as this is the way most people in practice find NPVs.

Before using these NPVs in the decision process, we need to know whether Projects S and L are **independent** or **mutually exclusive**. Independent projects are projects whose cash flows are not affected by one another. If Wal-Mart was considering a new store in Boise and another in Atlanta, the projects would be independent; and if both had positive NPVs, Wal-Mart should accept both. Mutually exclusive projects, on the other hand, are projects where if one project is accepted, the other must be rejected. A conveyor belt system to move goods in a warehouse and a fleet of forklifts used for the same purpose would be mutually exclusive—accepting one implies rejecting the other.

What should be the decision if Projects S and L are independent? In this case, both should be accepted because both have positive NPVs and thus add value to the firm. However, if they are mutually exclusive, Project L should be chosen because it has the higher NPV and thus adds more value than S. Here is a summary of the NPV decision rules:

Independent projects: If NPV exceeds zero, accept the project.

Mutually exclusive projects: Accept the project with the highest positive NPV. If no project has a positive NPV, reject them all.

Independent Projects

Projects with cash flows that are not affected by the acceptance or nonacceptance of other projects.

Mutually Exclusive Projects

A set of projects where only one can be accepted.

⁵The keystrokes for finding the NPV are shown for several calculators in the calculator tutorials provided on the text’s web site.

Since projects must be either independent or mutually exclusive, one or the other of these rules applies to every project.

SELF TEST



Why is the NPV the primary capital budgeting decision criterion?

What is the difference between independent and mutually exclusive projects?

Projects SS and LL have the following cash flows:

	END-OF-YEAR CASH FLOWS				WACC = r = 10%
	0	1	2	3	
SS	-\$700	\$500	\$300	\$100	
LL	-\$700	\$100	\$300	\$600	

If a 10% cost of capital is appropriate for both projects, what are their NPVs? (**NPV_{SS} = \$77.61; NPV_{LL} = \$89.63**)

Which project(s) would you accept if SS and LL were (a) independent? (b) mutually exclusive?

11-3 INTERNAL RATE OF RETURN (IRR)

In Chapter 7, we discussed the yield to maturity on a bond and we explained that if you hold it to maturity, you will earn the YTM on your investment. The YTM is found as the discount rate that forces the PV of the cash inflows to equal the price of the bond. This same concept is involved in capital budgeting when we calculate a project's **internal rate of return (IRR)**:

A project's IRR is the discount rate that forces the PV of the inflows to equal the cost. This is equivalent to forcing the NPV to equal zero. The IRR is an estimate of the project's rate of return, and it is comparable to the YTM on a bond.

To calculate the IRR, we begin with Equation 11-1 for the NPV, replace r in the denominator with the term IRR, and set the NPV equal to zero. This transforms Equation 11-1 into Equation 11-2, the one used to find the IRR. The rate that forces NPV to equal zero is the IRR.⁶

$$\text{NPV} = \text{CF}_0 + \frac{\text{CF}_1}{(1 + \text{IRR})^1} + \frac{\text{CF}_2}{(1 + \text{IRR})^2} + \cdots + \frac{\text{CF}_N}{(1 + \text{IRR})^N} = 0$$

$$0 = \sum_{t=0}^N \frac{\text{CF}_t}{(1 + \text{IRR})^t} \quad \text{11-2}$$

$$\text{NPV}_S = 0 = -\$1,000 + \frac{\$500}{(1 + \text{IRR})^1} + \frac{\$400}{(1 + \text{IRR})^2} + \frac{\$300}{(1 + \text{IRR})^3} + \frac{\$100}{(1 + \text{IRR})^4}$$

Figure 11-2 illustrates the process of finding the IRR for Project S.

Three procedures can be used:

1. *Trial and Error.* We could use a trial-and-error procedure—try a discount rate; see if the equation solves to zero; and if it doesn't, try a different rate. We could

Internal Rate of Return (IRR)

The discount rate that forces a project's NPV to equal zero.

⁶For a large, complex project like Boeing's 7E7 jetliner, costs are incurred for several years before cash inflows begin. That means that we have a number of negative cash flows before the positive cash flows begin.

FIGURE 11-2

Finding the IRR for Project S

	A	B	C	D	E	F	G	H	
24		0	1	2	3	4			
25	Project S	IRR = 14.489%							
26		-1,000.00	500	400	300	100			
27		436.72							
28		305.16							
29		199.91							
30		58.20							
31		0.00	= NPV at a discount rate of 14.489%. Since the NPV is zero, 14.489% must be the IRR.						
32									

then continue until we found the rate that forces the NPV to zero; that rate would be the IRR. For Project S, the IRR is 14.489%. Note, though, that the trial-and-error procedure is so time-consuming that before computers and financial calculators were available, the IRR was rarely used. It's useful to think about the trial-and-error procedure, but it's far better to use a calculator or Excel to do the actual calculations.

2. *Calculator Solution.* Enter the cash flows in the calculator's cash flow register just as we did to find the NPV; then press the button labeled "IRR." Instantly, you get the IRR. Here are the values for Projects S and L:⁷

$$IRR_S = 14.489\%$$

$$IRR_L = 13.549\%$$

3. *Excel Solution.* It is even easier to find IRR_S using Excel, as we demonstrate in the chapter model.

Why is the discount rate that causes a project's NPV to equal zero so special? The reason is that the IRR is an estimate of the project's rate of return. If this return exceeds the cost of the funds used to finance the project, the difference will be a bonus that goes to the firm's stockholders and causes the stock price to rise. Project S has an estimated return of 14.489% versus a 10% cost of capital, so its bonus is 4.489%. On the other hand, if the IRR is less than the cost of capital, stockholders must make up the shortfall, which will hurt the stock price.

Note again that the IRR formula, Equation 11-2, is simply the NPV formula, Equation 11-1, solved for the particular discount rate that forces the NPV to zero. Thus, the same basic equation is used for both methods. The only difference is that with the NPV method, the discount rate is given and we find the NPV; with the IRR method, however, the NPV is set equal to zero and we find the interest rate that produces this equality.

As we noted earlier, projects should be accepted or rejected depending on whether their NPVs are positive. However, the IRR is sometimes used (improperly

⁷See the calculator tutorials on the text's web site. Note that once the cash flows have been entered in the cash flow register, you can find the NPV and the IRR. To find the NPV, enter the interest rate (I/YR) and then press the NPV key. Then with no further entries, press the IRR key to find the IRR. Thus, once you set up the calculator to find the NPV, it is trivially easy to find the IRR. This is one reason most firms calculate the NPV and the IRR. If you calculate one, it is easy to calculate the other; and both provide information that decision makers find useful. The same is true with Excel.

WHY NPV IS BETTER THAN IRR

Buffett University recently hosted a seminar on business methods for managers. A finance professor covered capital budgeting, explaining how to calculate the NPV and stating that it should be used to screen potential projects. In the Q&A session, Ed Wilson, the treasurer of an electronics firm, said that his firm used the IRR primarily because the CFO and the directors understood the selection of projects based on their rates of return but didn't understand the NPV. Ed had tried to explain why the NPV was better, but he simply confused everyone; so the company stuck with the IRR. Now a meeting on the firm's capital budget is coming up, and Ed asked the professor for a simple, easy-to-understand explanation of why the NPV was better.

The professor recommended the following extreme example. A firm with adequate access to capital and a 10% WACC is choosing between two equally risky, mutually exclusive projects. Project Large calls for investing \$100,000 and then receiving \$50,000 per year for 10 years, while Project Small calls for investing \$1 and receiving \$0.60 per year for 10 years. Here is each project's NPV and IRR:

Project Large (L)	Project Small (S)
NPV _L : \$207,228.36	NPV _S : \$2.69
IRR _L : 49.1%	IRR _S : 59.4%

The IRR says choose S, but the NPV says take L. Intuitively, it's obvious that the firm would be better off choosing the large project in spite of its lower IRR. With a cost of capital of only 10%, a 49% rate of return on a \$100,000 investment is more profitable than a 59% return on a \$1 investment.

When Ed gave this example in his firm's executive meeting on the capital budget, the CFO argued that this example was extreme and unrealistic and that no one would choose S in spite of its higher IRR. Ed agreed, but he asked the CFO where the line should be drawn between realistic and unrealistic examples. When Ed received no answer, he went on to say that (1) it's hard to draw this line and (2) the NPV is always better because it tells us how much value each project will add, which is what the firm should maximize. The president was listening, and he declared Ed the winner. The company switched from IRR to NPV, and Ed is now the CFO.

we believe) to rank projects and make capital budgeting decisions. When this is done, here are the decision rules:

Independent projects: If IRR exceeds the project's WACC, accept the project. If IRR is less than the project's WACC, reject it.

Mutually exclusive projects. Accept the project with the highest IRR, provided that IRR is greater than WACC. Reject all projects if the best IRR does not exceed WACC.

The IRR is logically appealing—it is useful to know the rates of return on proposed investments. However, as we demonstrate in a later section, NPV and IRR can produce conflicting conclusions when a choice is being made between mutually exclusive projects; and when conflicts occur, the NPV is generally better.

SELF TEST



In what sense is a project's IRR similar to the YTM on a bond?

The cash flows for projects SS and LL are as follows:

	END-OF-YEAR CASH FLOWS				WACC = r = 10%
	0	1	2	3	
SS	-\$700	\$500	\$300	\$100	
LL	-\$700	\$100	\$300	\$600	

What are the projects' IRRs, and which one would the IRR method select if the firm had a 10% cost of capital and the projects were (a) independent or (b) mutually exclusive? ($IRR_{SS} = 18.0\%$; $IRR_{LL} = 15.6\%$)

11-4 MULTIPLE INTERNAL RATES OF RETURN⁸

A problem with the IRR is that under certain conditions, a project may have more than one IRR. First, note that a project is said to have *normal* cash flows if it has one or more cash outflows (costs) followed by a series of cash inflows. If, however, a cash *outflow* occurs sometime after the inflows have commenced, meaning that the signs of the cash flows change *more than once*, the project is said to have *nonnormal* cash flows.

Examples:

Normal: - + + + + + or - - - + + + + +
Nonnormal: - + + + + - or - + + + - + + +

An example of nonnormal flows would be a strip coal mine where the company spends money to buy the property and prepare the site for mining, has positive inflows for several years, and spends more money to return the land to its original condition. In such a case, the project might have two IRRs, that is, **multiple IRRs**.⁹

To illustrate multiple IRRs, suppose a firm is considering a potential strip mine (Project M) that has a cost of \$1.6 million and will produce a cash flow of \$10 million at the end of Year 1. Then at the end of Year 2, the firm must spend \$10 million to restore the land to its original condition. Therefore, the project's expected net cash flows are as follows (in millions):

Cash flows	Year 0	End of Year 1	End of Year 2
	-\$1.6	+\$10	-\$10

We can substitute these values into Equation 11-2 and solve for the IRR:

$$NPV = \frac{-\$1.6 \text{ million}}{(1 + IRR)^0} + \frac{\$10 \text{ million}}{(1 + IRR)^1} + \frac{-\$10 \text{ million}}{(1 + IRR)^2} = 0$$

NPV equals 0 when $IRR = 25\%$, but it also equals 0 when $IRR = 400\%$.¹⁰ Therefore, Project M has an IRR of 25% and another of 400%, and we don't know which one to use. This relationship is depicted graphically in Figure 11-3.¹¹ The graph is constructed by plotting the project's NPV at different discount rates.

Note that no dilemma regarding Project M would arise if the NPV method was used; we would simply find the NPV and use it to evaluate the project.

⁸This section is relatively technical, but it can be omitted without loss of continuity.

⁹Equation 11-2 is a polynomial of degree n ; so it has n different roots, or solutions. All except one of the roots is an imaginary number when investments have normal cash flows (one or more cash outflows followed by cash inflows). So in the normal case, only one value of IRR appears. However, the possibility of multiple real roots (hence multiple IRRs) arises when negative net cash flows occur after the project has been placed in operation.

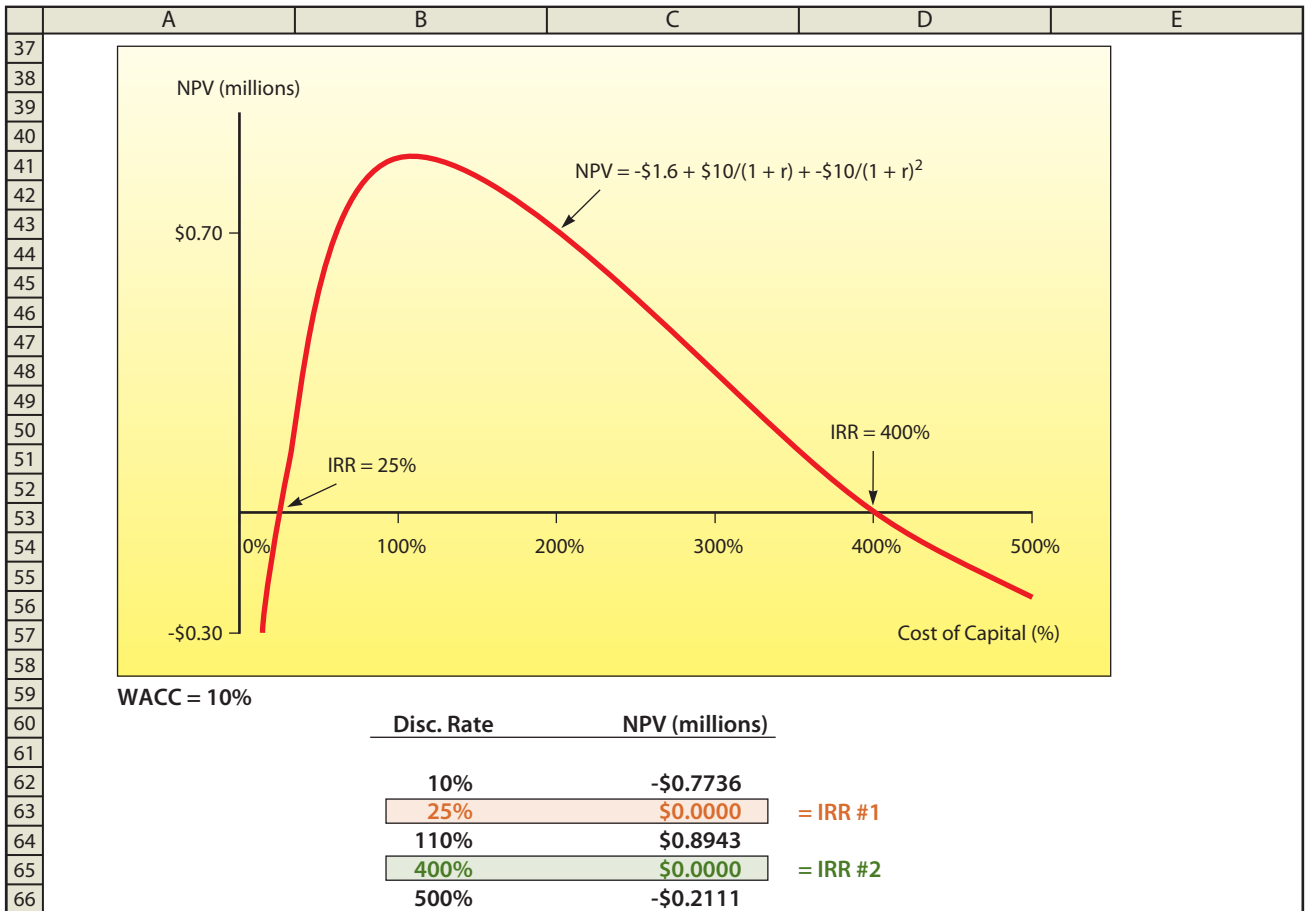
¹⁰If you attempt to find Project M's IRR with an HP calculator, you will get an error message, while TI calculators give only the IRR that's closest to zero. When you encounter either situation, you can find the approximate IRRs by calculating NPVs using several different values for $r = I/YR$, plotting NPV on the vertical axis with the corresponding discount rate on the horizontal axis of a graph, and seeing about where $NPV = 0$. The intersection with the x-axis provides a rough idea of the IRRs' values. With some calculators and with Excel, you can find both IRRs by entering guesses, as explained in the calculator and Excel tutorials.

¹¹Figure 11-3 is called an NPV profile. Profiles are discussed in more detail in Section 11-7.

Multiple IRRs
 The situation where a project has two or more IRRs.

FIGURE 11-3

Graph for Multiple IRRs: Project M



We would see that if Project M's cost of capital was 10%, its NPV would be -\$0.7736 million and the project should be rejected. However, if r was between 25% and 400%, NPV would be positive, but those numbers would not be realistic or useful for anything.

SELF TEST



What condition regarding cash flows would cause more than one IRR to exist?

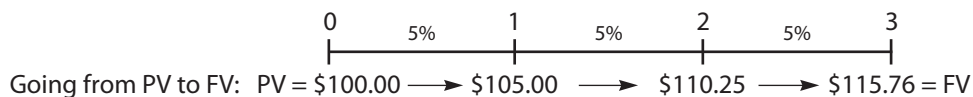
Project MM has the following cash flows:

END-OF-YEAR CASH FLOWS			
0	1	2	3
-\$1,000	\$2,000	\$2,000	-\$3,350

Calculate MM's NPV at discount rates of 0%, 10%, 12.2258%, 25%, 122.1470%, and 150%. What are MM's IRRs? If the cost of capital is 10%, should the project be accepted or rejected? (NPVs range from -\$350 to +\$164 and then back down to -\$94; the IRRs are 12.23% and 122.15%.)

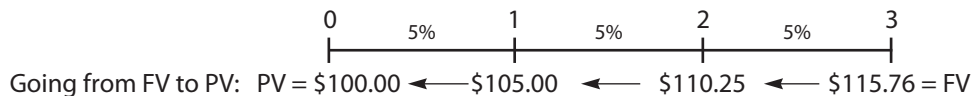
11-5 REINVESTMENT RATE ASSUMPTIONS¹²

The NPV calculation is based on the assumption that cash inflows can be reinvested at the project's risk-adjusted WACC, whereas the IRR calculation is based on the assumption that cash flows can be reinvested at the IRR. To see why this is so, consider the following diagram, which was first used in Chapter 5 to illustrate the future value of \$100 when the interest rate was 5%.



Observe that the FV calculation assumes that the interest earned during each year can be reinvested to earn the same 5% in each succeeding year.

Now recall that when we found the PV, we reversed the process, discounting rather than compounding at the 5% rate. This diagram was used to demonstrate this point:



This led to the following conclusion: *When we calculate a present value, we are implicitly assuming that cash flows can be reinvested at a specified interest rate, 5% in our example.* This applies to Projects S and L: When we calculated their NPVs, we discounted at the WACC, 10%, which means that we were assuming that their cash flows could be reinvested at 10%.

Now consider the IRR. In Section 11-3 we presented a cash flow diagram set up to show the PVs of the cash flows when discounted at the IRR. We saw that the sum of the PVs is equal to the cost at a discount rate of 14.489%; so by definition, 14.489% is the IRR. Now we can ask this question: What reinvestment rate is built into the IRR?

Since discounting at a given rate assumes that cash flows can be reinvested at that same rate, the IRR assumes that cash flows are reinvested at the IRR.

The NPV assumes reinvestment at the WACC, while the IRR assumes reinvestment at the IRR. Which assumption is more reasonable? For most firms, assuming reinvestment at the WACC is more reasonable for the following reasons:

- If a firm has reasonably good access to the capital markets, it can raise all the capital it needs at the going rate, which in our example is 10%.
- Since the firm can obtain capital at 10%, if it has investment opportunities with positive NPVs, it should take them on and it can finance them at a 10% cost.
- If the firm uses internally generated cash flows from past projects rather than external capital, this will save it the 10% cost of capital. Thus, 10% is the *opportunity cost* of the cash flows, and that is the effective return on reinvested funds.

To illustrate all this, suppose a project's IRR is 50%, the firm's WACC is 10%, and the firm has adequate access to the capital markets. Thus, the firm can raise all the capital it needs at the 10% rate. Unless the firm is a monopoly, the 50% return would attract competition, which would make it hard to find new projects with a similar high return, which is what the IRR assumes. Moreover, even if the firm

¹²This section gives a theoretical explanation of the key difference between NPV and IRR. However, it is relatively technical; so if time is a constraint, professors may decide to have students skip it and just read the box titled, "Why NPV Is Better Than IRR," which appears earlier in the chapter.

does find such projects, it could take them on with external capital that costs 10%. The logical conclusion is that the original project's cash flows will save the 10% cost of the external capital, and that is the effective return on those flows.

If a firm does not have good access to external capital and if it has many potential projects with high IRRs, it might be reasonable to assume that a project's cash flows could be reinvested at rates close to their IRRs. However, that situation rarely exists: Firms with good investment opportunities generally *do* have good access to debt and equity markets.

Our conclusion is that the assumption built into the IRR—that cash flows can be reinvested at the IRR—is flawed, whereas the assumption built into the NPV—that cash flows can be reinvested at the WACC—is generally correct. Moreover, if the true reinvestment rate is less than the IRR, the true rate of return on the investment must be less than the calculated IRR; thus, the IRR is misleading as a measure of projects' profitability. This point is discussed further in the next section.

SELF TEST



Why is it true that a reinvestment rate is implicitly assumed whenever we find the present value of a future cash flow? Would it be possible to find the PV of a FV without specifying an implicit reinvestment rate? **(PVs are the reverse of FVs. We need r to find FV; hence, we need r to find the PV.)**

What reinvestment rate is built into the NPV calculation? the IRR calculation? **(WACC, IRR)**

For a firm that has adequate access to capital markets, is it more reasonable to assume reinvestment at the WACC or the IRR? **(WACC)**

11-6 MODIFIED INTERNAL RATE OF RETURN (MIRR)¹³

It is logical for managers to want to know the expected rate of return on investments, and this is what the IRR is supposed to tell them. However, the IRR is based on the assumption that projects' cash flows can be reinvested at the IRR. *This assumption is generally incorrect, and this causes the IRR to overstate the project's true return.*¹⁴ Given this fundamental flaw, is there a percentage evaluator that is better than the regular IRR? The answer is yes—we can modify the IRR to make it a better measure of profitability.

This new measure, the **Modified IRR (MIRR)**, is illustrated for Project S in Figure 11-4. It is similar to the regular IRR except that it is based on the assumption that cash flows are reinvested at the WACC (or some other explicit rate if that is a more reasonable assumption). Refer to Figure 11-4 as you read about its construction.

1. Project S has just one outflow, the minus \$1,000 at $t = 0$. Since it occurs at Time 0, it is not discounted and its PV is $-\$1,000$. If the project had additional outflows, we would find the PV at $t = 0$ for each one and sum them for use in the MIRR calculation.
2. Next, we find the future value of each *inflow* compounded at the WACC out to the "terminal year," which is the year the last inflow is received. We assume that cash flows are reinvested at the WACC. For Project S, the first cash flow,

Modified IRR (MIRR)

The discount rate at which the present value of a project's cost is equal to the present value of its terminal value, where the terminal value is found as the sum of the future values of the cash inflows, compounded at the firm's cost of capital.

¹³Again, this section is relatively technical, but it too can be omitted without loss of continuity.

¹⁴The IRR overstates the expected return for accepted projects because cash flows cannot generally be reinvested at the IRR. Therefore, the average IRR for accepted projects is greater than the true expected rate of return. This imparts an upward bias on corporate projections based on IRRs.

FIGURE 11-4

Finding the MIRR for Projects S and L, WACC = 10%

	A	B	C	D	E	F	G	H
69					WACC =	10%		
70	Project S	0	1	2	3	4		
71		-\$1,000.00	\$500	\$400	\$300	\$100.00		
72						\$330.00		
73						\$484.00		
74						\$665.50		
75		-\$1,000.00				Terminal Value (TV) =	\$1,579.50	
76	\$1,000 = TV/(1 + MIRR) ^N = \$1,579.50/(1 + MIRR) ⁴ . Solve for MIRR with calculator or Excel.							
77	Calculator: N = 4, PV = -1000, PMT = 0, FV = 1579.5. Press I/YR to get:						12.11%	
78	Excel: =RATE(F70,0,B71,F75)						Rate = MIRR	12.11%
79	Direct Excel calculation, MIRR function: =MIRR(B71:F71,F69,F69)						12.11%	

\$500, is compounded at WACC = 10% for 3 years and it grows to \$665.50. The second inflow, \$400, grows to \$484.00; the third, to \$330.00. The last inflow is received at the end, so it is not compounded at all. The sum of the future values, \$1,579.50, is called the “terminal value,” or TV.

3. We now have the cost at t = 0, -\$1,000, and the TV at Year 4, \$1,579.50. There is some discount rate that will cause the PV of the terminal value to equal the cost. *That interest rate is defined as the MIRR.* In a calculator, enter N = 4, PV = -1000, PMT = 0, and FV = 1579.50. Then when you press the I/YR key, you get the MIRR, 12.11%.
4. The MIRR can be found in a number of ways. Figure 11-4 illustrates how the MIRR is calculated: We compound each cash inflow, sum them to determine the TV, and then find the rate that causes the PV of the TV to equal the cost. That rate is 12.11%. However, some of the better calculators have a built-in MIRR function that streamlines the process, as does Excel. We explain how to use the calculator function in the calculator tutorials, and we explain how to find MIRR with Excel in the chapter Excel model.¹⁵

The MIRR has two significant advantages over the regular IRR. First, whereas the regular IRR assumes that the cash flows from each project are reinvested at the

¹⁵Equation 11-2a summarizes these steps.

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

11-2a

$$PV \text{ costs} = \frac{TV}{(1+MIRR)^N}$$

COF_t is the cash outflow at time t, and CIF_t is the cash inflow at time t. The left term is the PV of the investment outlays when discounted at the cost of capital; the numerator of the second term is the compounded value of the inflows, assuming the inflows are reinvested at the cost of capital. The MIRR is the discount rate that forces the PV of the TV to equal the PV of the costs.

Also note that there are alternative definitions for the MIRR. One difference relates to whether negative cash flows, after the positive cash flows begin, should be compounded and treated as part of the TV or discounted and treated as a cost. A related issue is whether negative and positive flows in a given year should be netted or treated separately. For a complete discussion, see William R. McDaniel, Daniel E. McCarty, and Kenneth A. Jessell, “Discounted Cash Flow with Explicit Reinvestment Rates: Tutorial and Extension,” *The Financial Review*, August 1988, pp. 369–385 and David M. Shull, “Interpreting Rates of Return: A Modified Rate of Return Approach,” *Financial Practice and Education*, Fall 1993, pp. 67–71.

IRR, the MIRR assumes that cash flows are reinvested at the cost of capital (or some other explicit rate). Since reinvestment at the IRR is generally not correct, the MIRR is generally a better indicator of a project's true profitability. Second, the MIRR eliminates the multiple IRR problem—there can never be more than one MIRR, and it can be compared with the cost of capital when deciding to accept or reject projects.

Our conclusion is that the MIRR is better than the regular IRR; however, this question remains: Is MIRR as good as the NPV? Here are our conclusions:

- For *independent* projects, the NPV, IRR, and MIRR always reach the same accept/reject conclusion; so the three criteria are equally good when evaluating independent projects.
- However, if projects are *mutually exclusive* and they differ in size, conflicts can arise. In such cases, the NPV is best because it selects the project that maximizes value.¹⁶
- Our overall conclusions are that (1) the MIRR is superior to the regular IRR as an indicator of a project's "true" rate of return but that (2) NPV is better than IRR and MIRR when choosing among competing projects.

SELF TEST



What's the primary difference between the MIRR and the regular IRR? (**reinvestment rate**)

Which provides a better estimate of a project's "true" rate of return, the MIRR or the regular IRR? Explain.

Projects A and B have the following cash flows:

	0	1	2
A	−\$1,000	\$1,150	\$ 100
B	−\$1,000	\$ 100	\$1,300

Their cost of capital is 10%. What are the projects' IRRs, MIRRs, and NPVs? Which project would each method select? (**IRR_A = 23.1%, IRR_B = 19.1%; MIRR_A = 16.8%, MIRR_B = 18.7%; NPV_A = \$128.10, NPV_B = \$165.29**)

11-7 NPV PROFILES

Figure 11-5 presents the **net present value profile** for Project S. To make the profile, we find the project's NPV at a number of different discount rates and then plot those values to create a graph. Note that at a zero cost of capital, the NPV is simply the net total of the undiscounted cash flows, $\$1,300 - \$1,000 = \$300$. This value is plotted as the vertical axis intercept. Also recall that the IRR is the discount rate that causes the NPV to equal zero, so the discount rate at which the profile line crosses the horizontal axis is the project's IRR. When we connect the data points, we have the NPV profile.¹⁷

Net Present Value Profile

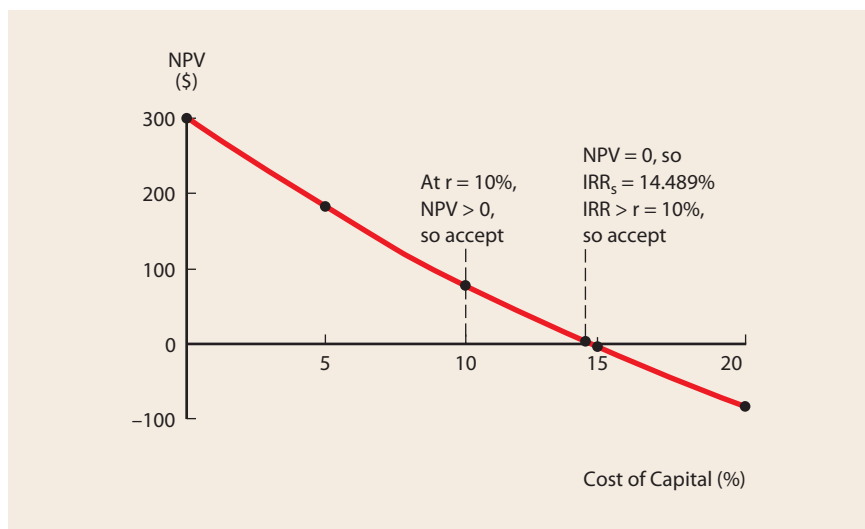
A graph showing the relationship between a project's NPV and the firm's cost of capital.

¹⁶See Brigham and Daves, *Intermediate Financial Management*, 9th ed. (Mason, OH: South-Western, 2007), pp. 412–413.

¹⁷Notice that the NPV profile is curved—it is *not* a straight line. NPV approaches CF_0 , which is the $-\$1,000$ project cost, as the discount rate increases toward infinity. The reason is that at an infinitely high cost of capital, all the PVs of the inflows would be zero; so NPV at $r = \infty$ must be CF_0 . We should also note that under certain conditions, the NPV profiles can cross the horizontal axis several times or never cross it. This point was discussed in Section 11-4.

FIGURE 11-5

NPV Profile for Project S



	Cost of Capital	NPV _S
	0%	\$300.00
	5	180.00
	10	78.82
IRR _S =	14.489	0.00
	15	-8.33
	20	-83.72

Now consider Figure 11-6, which shows two NPV profiles—one for Project S and one for L—and note the following points:

- The IRRs are fixed, and S has the higher IRR regardless of the cost of capital.
- However, the NPVs vary depending on the actual cost of capital.
- The two NPV profile lines cross at a cost of capital of 11.975%, which is called the **crossover rate**. The crossover rate can be found by calculating the IRR of the differences in the projects' cash flows, as demonstrated:

Crossover Rate

The cost of capital at which the NPV profiles of two projects cross and, thus, at which the projects' NPVs are equal.

	0	1	2	3	4
Project S	-\$1,000	\$500	\$400	\$300	\$100
Project L	-\$1,000	\$100	\$300	\$400	\$675
ΔCF _S - CF _L	\$ 0	\$400	\$100	-\$100	-\$575
IRR Δ =	<u>11.975%</u> = Crossover Rate				

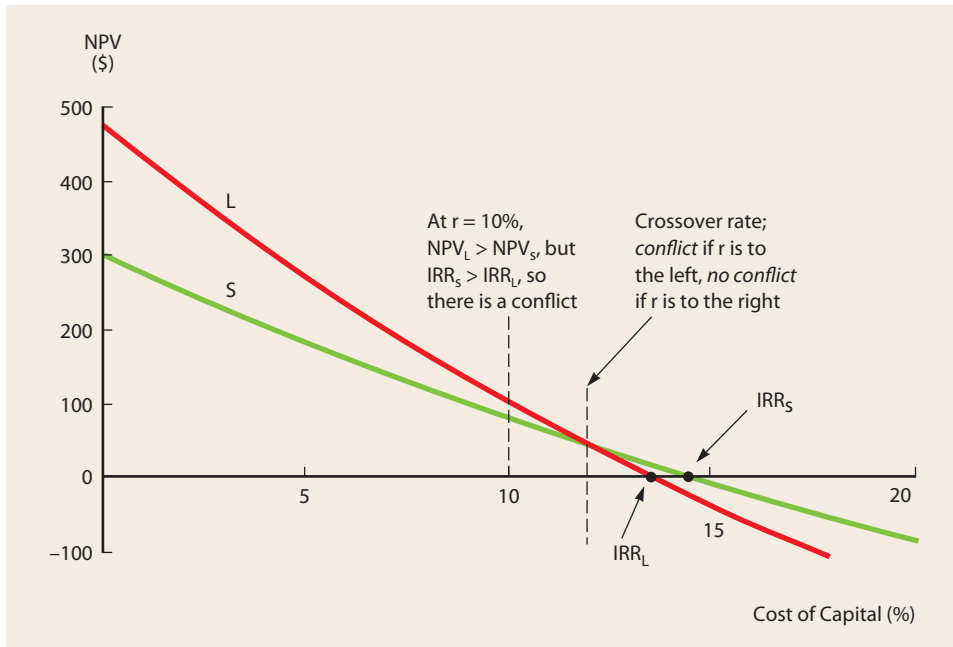
- Project L has the higher NPV if the cost of capital is less than the crossover rate, but S has the higher NPV if the cost of capital is greater than that rate.

Notice that Project L has the steeper slope, indicating that a given increase in the cost of capital causes a larger decline in NPV_L than in NPV_S. To see why this is so, recall that L's cash flows come in later than those of S. Therefore, L is a long-term project and S is a short-term project. Next, recall the equation for the NPV:

$$NPV = CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \dots + \frac{CF_N}{(1+r)^N}$$

FIGURE 11-6

NPV Profiles for Projects S and L



	Cost of Capital	NPV _S	NPV _L
	0%	\$300.00	\$475.00
	5	180.42	268.21
	10	78.82	100.40
Crossover =	11.975	42.84	42.84
IRR _L =	13.549	15.64	0.00
IRR _S =	14.489	0.00	-24.37
	15	-8.33	-37.26
	20	-83.72	-151.33

Now recognize that the impact of an increase in the cost of capital is much greater on distant than near-term cash flows, as we demonstrate here:

Effect of doubling r on a Year 1 cash flow:

$$\text{PV of \$100 due in 1 year @ } r = 5\%: \frac{\$100}{(1.05)^1} = \$95.24$$

$$\text{PV of \$100 due in 1 year @ } r = 10\%: \frac{\$100}{(1.10)^1} = \$90.91$$

$$\text{Percentage decline due to higher } r = \frac{\$95.24 - \$90.91}{\$95.24} = 4.5\%$$

Effect of doubling r on a Year 20 cash flow:

$$\text{PV of \$100 due in 20 years @ } r = 5\%: \frac{\$100}{(1.05)^{20}} = \$37.69$$

$$\text{PV of \$100 due in 20 years @ } r = 10\%: \frac{\$100}{(1.10)^{20}} = \$14.86$$

$$\text{Percentage decline due to higher } r = \frac{\$37.69 - \$14.86}{\$37.69} = 60.6\%$$

Thus, a doubling of the discount rate results in only a 4.5% decline in the PV of a Year 1 cash flow, but the same discount rate increase causes the PV of a Year 20 cash flow to fall by more than 60%. *Therefore, if a project has most of its cash flows coming in the later years, its NPV will decline sharply if the cost of capital increases; but a project whose cash flows come earlier will not be severely penalized by high capital costs.* Most of Project L's cash flows come in its later years; so if the cost of capital is high, L is hurt much worse than Project S. Therefore, Project L's NPV profile has the steeper slope.

Sometimes the NPV and IRR methods produce conflicting results. We can use NPV profiles to see when conflicts can and cannot arise.

Independent Projects. If an independent project with normal cash flows is being evaluated, the NPV and IRR criteria always lead to the same accept/reject decision: If NPV says accept, IRR also says accept, and vice versa. To see why this is so, look at Figure 11-5 and notice that (1) the IRR says accept if the project's cost of capital is less than (or to the left of) the IRR and (2) if the cost of capital is less than the IRR, the NPV will be positive. Thus, at any cost of capital less than 14.489%, Project S will be recommended by both the NPV and IRR criteria; but both methods reject the project if the cost of capital is greater than 14.489%. A similar graph could be used for Project L or any other normal project, and we would always reach the same conclusion: *For normal, independent projects, if the IRR says accept, so will the NPV.*

Mutually Exclusive Projects. Assume that Projects S and L are mutually exclusive rather than independent. Therefore, we can choose either S or L, or we can reject both; but we can't accept both. Now look at Figure 11-6 and note these points:

- As long as the cost of capital is *greater than* the crossover rate, 11.975%, both methods agree that Project S is better: $NPV_S > NPV_L$ and $IRR_S > IRR_L$. Therefore, if r is *greater* than the crossover rate, no conflict occurs.
- However, if the cost of capital is *less than* the crossover rate, a conflict arises: NPV ranks L higher, but IRR ranks S higher.

Two basic conditions cause NPV profiles to cross and thus lead to conflicts:¹⁸

1. **Timing differences.** If most of the cash flows from one project come in early while most of those from the other project come in later, as occurred with Projects S and L, the NPV profiles may cross and result in a conflict.
2. **Project size (or scale) differences.** If the amount invested in one project is larger than the other, this too can lead to profiles crossing and a resulting conflict.

When size or timing differences occur, the firm will have different amounts of funds to invest in the various years depending on which of the two mutually exclusive projects it chooses. If it chooses S, it will have more funds to invest in Year 1 because S has a higher inflow that year. Similarly, if one project costs more than the other, the firm will have more money to invest at $t = 0$ if it selects the smaller project.

Given this situation, the rate of return at which differential cash flows can be reinvested is a critical issue. We saw earlier that the NPV assumes reinvestment at the cost of capital and that this is generally the best assumption. Therefore, *when conflicts exist between mutually exclusive projects, use the NPV method.*

¹⁸Of course, mutually exclusive projects can differ with respect to both scale and timing. Also, if mutually exclusive projects have different lives (as opposed to different cash flow patterns over a common life), this introduces further complications; and for meaningful comparisons, some mutually exclusive projects must be evaluated over a common life. This point is discussed later in the text and in an appendix on the text's web site.

SELF TEST



Describe in words how an NPV profile is constructed. How are the intercepts of the x- and y-axes determined?

What is the crossover rate, and how does its value relative to the cost of capital determine whether a conflict exists between NPV and IRR?

What two characteristics can lead to conflicts between the NPV and the IRR when evaluating mutually exclusive projects?

11-8 PAYBACK PERIOD

NPV is the most commonly used method today; but historically, the first selection criterion was the **payback period**, defined as the number of years required to recover the funds invested in a project from its operating cash flows. Equation 11-3 is used for the calculation, and the process is diagrammed in Figure 11-7. We start with the project's cost, a negative, and then add the cash inflow for each year until the cumulative cash flow turns positive. The payback year is the year prior to full recovery plus a fraction equal to the shortfall at the end of that year divided by the cash flow during the full recovery year.¹⁹

Payback Period

The length of time required for an investment's net revenues to cover its cost.

$$\text{Payback} = \text{Number of years prior to full recovery} + \frac{\text{Unrecovered cost at start of year}}{\text{Cash flow during full recovery year}}$$

11-3

The shorter the payback, the better the project. Therefore, if the firm requires a payback of three years or less, S would be accepted, but L would be rejected. If the projects were mutually exclusive, S would be ranked over L because of its shorter payback.

FIGURE 11-7

Payback Calculations

Project S	Years	0	1	2	3	4
	Cash flow	-1,000	500	400	300	100
	Cumulative cash flow	-1,000	-500	-100	200	300
Payback S = 2 + 100/300 =		2.33				
Project L	Years	0	1	2	3	4
	Cash flow	-1,000	100	300	400	675
	Cumulative cash flow	-1,000	-900	-600	-200	475
Payback L = 3 + 200/675 =		3.30				

¹⁹Equation 11-3 assumes that cash flows come in uniformly during the full recovery year.

The payback has three flaws: (1) All dollars received in different years are given the same weight (i.e., the time value of money is ignored). (2) Cash flows beyond the payback year are given no consideration regardless of how large they might be. (3) Unlike the NPV, which tells us how much wealth a project adds, and the IRR, which tells us how much a project yields over the cost of capital, the payback merely tells us when we recover our investment. There is no necessary relationship between a given payback and investor wealth maximization, so we do not know what an acceptable payback is. The firm might use 2 years, 3 years, or any other number as the minimum acceptable payback; but the choice is purely arbitrary.

Discounted Payback

The length of time required for an investment's cash flows, discounted at the investment's cost of capital, to cover its cost.

To counter the first criticism, analysts developed the **discounted payback**. Here cash flows are discounted at the WACC; then those discounted cash flows are used to find the payback. In Figure 11-8, we calculate the discounted paybacks for S and L assuming that both have a 10% cost of capital. Each inflow is divided by $(1 + r)^t = (1.10)^t$, where t is the year in which the cash flow occurs and r is the project's cost of capital; and those PVs are used to find the payback. Project S's discounted payback is 2.95, while L's is 3.78.

Note that the payback is a "break-even" calculation in the sense that if cash flows come in at the expected rate, the project will break even. However, since the regular payback doesn't consider the cost of capital, it doesn't specify the true break-even year. The discounted payback does consider capital costs; but it still disregards cash flows beyond the payback year, which is a serious flaw. Further, if mutually exclusive projects vary in size, both payback methods can conflict with the NPV, which might lead to a poor choice. Finally, there is no way of telling how low the paybacks must be to justify project acceptance.

Although the payback methods have faults as ranking criteria, they do provide information about *liquidity* and *risk*. The shorter the payback, other things held constant, the greater the project's liquidity. This factor is often important for smaller firms that don't have ready access to the capital markets. Also, cash flows expected in the distant future are generally riskier than near-term cash flows, so the payback is used as one *risk indicator*.

FIGURE 11-8

Discounted Payback Calculations at 10% Cost of Capital

Project S	Years	0	1	2	3	4
Cash flow		-1,000	500	400	300	100
Discounted cash flow		-1,000	455	331	225	68
Cumulative discounted CF		-1,000	-545	-215	11	79

$$\text{Discounted payback S} = 2 + 215/225 = 2.95$$

Project L	Years	0	1	2	3	4
Cash flow		-1,000	100	300	400	675
Discounted cash flow		-1,000	91	248	301	461
Cumulative discounted CF		-1,000	-909	-661	-361	100

$$\text{Discounted payback L} = 3 + 361/461 = 3.78$$

SELF TEST



What information does the payback convey that is absent from the other capital budgeting decision methods?

What three flaws does the regular payback have? Does the discounted payback correct all of these flaws? Explain.

Project P has a cost of \$1,000 and cash flows of \$300 per year for three years plus another \$1,000 in Year 4. The project's cost of capital is 15%. What are P's regular and discounted paybacks? **(3.10, 3.55)** If the company requires a payback of three years or less, would the project be accepted? Would this be a good accept/reject decision considering the NPV and/or the IRR? **(NPV = \$256.72, IRR = 24.78%)**

11-9 CONCLUSIONS ON CAPITAL BUDGETING METHODS

We have discussed five capital budgeting decision criteria—NPV, IRR, MIRR, payback, and discounted payback. We compared these methods with one another and highlighted their strengths and weaknesses. In the process, we may have created the impression that “sophisticated” firms should use only one method, the NPV. However, virtually all capital budgeting decisions are analyzed by computer, so it is easy to calculate all five decision criteria. In making the accept/reject decision, large, sophisticated firms such as GE, Boeing, and Airbus generally calculate and consider all five measures because each provides a somewhat different piece of information about the decision.

NPV is the single best criterion because it provides a direct measure of value the project adds to shareholder wealth. IRR and MIRR measure profitability expressed as a percentage rate of return, which is interesting to decision makers. Further, IRR and MIRR contain information concerning a project's “safety margin.” To illustrate, consider a firm whose WACC is 10% that must choose between these two mutually exclusive projects: SS (for small), which costs \$10,000 and is expected to return \$16,500 at the end of one year, and LL (for large), which costs \$100,000 and has an expected payoff of \$115,550 after one year. SS has a huge IRR, 65%, while LL's IRR is a more modest 15.6%. The NPV paints a somewhat different picture—at the 10% cost of capital, SS's NPV is \$5,000 while LL's is \$5,045. By the NPV rule, we would choose LL. However, SS's IRR indicates that it has a much larger margin for error: Even if its cash flow was 39% below the \$16,500 forecast, the firm would still recover its \$10,000 investment. On the other hand, if LL's inflows fell by only 13.5% from its forecasted \$115,550, the firm would not recover its investment. Further, if neither project generated any cash flows, the firm would lose only \$10,000 on SS but \$100,000 if it accepted LL.

The Modified IRR has all the virtues of the IRR, but it incorporates a better reinvestment rate assumption and avoids the multiple rate of return problem. So if decision makers want to know projects' rates of return, the MIRR is a better indicator than the regular IRR.

Payback and discounted payback provide indications of a project's *liquidity* and *risk*. A long payback means that investment dollars will be locked up for a long time; hence, the project is relatively illiquid. In addition, a long payback means that cash flows must be forecasted far out into the future, and that probably makes the project riskier than one with a shorter payback. A good analogy for this is bond valuation. An investor should never compare the yields to maturity on two bonds without also considering their terms to maturity because a bond's risk is significantly influenced by its maturity. The same holds true for capital projects.

In summary, the different measures provide different types of information. Since it is easy to calculate all of them, all should be considered when capital budgeting decisions are being made. For most decisions, the greatest weight should be given to the NPV, but it would be foolish to ignore the information provided by the other criteria.



Describe the advantages and disadvantages of the five capital budgeting methods discussed in this chapter.

Should capital budgeting decisions be made solely on the basis of a project's NPV? Explain.

11-10 DECISION CRITERIA USED IN PRACTICE

Surveys designed to find out which of the criteria managers actually use have been taken over the years. Surveys prior to 1999 asked companies to indicate which method they gave the most weight, while the most recent survey, in 1999, asked what method(s) managers actually calculated and used. A summary of all these surveys is shown in Table 11-2, and it reveals some interesting trends.

First, the NPV criterion was not used significantly before 1980; but by 1999, it was close to the top in usage. Moreover, informal discussions with companies suggest that if a survey were to be taken in 2008, NPV would be at the top of this list. Second, the IRR method is widely used, but its recent growth is less dramatic than that of NPV. Third, payback was the most important criterion years ago, but its use as the primary criterion had fallen drastically by 1980. Companies still use payback because it is easy to calculate and it does provide some information, but it is rarely used today as the primary criterion. Fourth, "other methods," primarily the accounting rate of return and the profitability index, have been fading due to the increased use of IRR and especially NPV.

These trends are consistent with our evaluation of the various methods. NPV is the best single criterion, but all of the methods provide useful information and all are easy to calculate; thus, all are used, along with judgment and common sense. We will have more to say about all this in the next chapter.

Table 11-2

Capital Budgeting Methods Used in Practice

	PRIMARY CRITERION			CALCULATE AND USE
	1960	1970	1980	1999
NPV	0%	0%	15%	75%
IRR	20	60	65	76
Payback	35	15	5	57
Discounted Payback	NA	NA	NA	29
Other	45	25	15	NA
Totals	<u>100%</u>	<u>100%</u>	<u>100%</u>	

Source: The 1999 data are from John R. Graham and Campbell R. Harvey, "The Theory and Practice of Corporate Finance: Evidence from the Field," *Journal of Financial Economics*, 2001, pp. 187–244. Data from prior years are our estimates based on averaging data from these studies: J. S. Moore and A. K. Reichert, "An Analysis of the Financial Management Techniques Currently Employed by Large U.S. Corporations," *Journal of Business Finance and Accounting*, Winter 1983, pp. 623–645; and M. T. Stanley and S. R. Block, "A Survey of Multinational Capital Budgeting," *The Financial Review*, March 1984, pp. 36–51.

SELF TEST



What trends in capital budgeting methodology can be seen from Table 11-2?

TYING IT ALL TOGETHER

In this chapter, we described five techniques—NPV, IRR, MIRR, payback, and discounted payback—that are used to evaluate proposed capital budgeting projects. NPV is the best single measure as it tells us how much value each project contributes to shareholder wealth. Therefore, NPV is the method that should be given the greatest weight in decisions. However, the other approaches provide useful information; and in this age of computers, it is easy to calculate all of them. Therefore, managers generally look at all five criteria when deciding to accept or reject projects and when choosing among mutually exclusive projects.

In this chapter, we took the cash flows given and used them to illustrate the different capital budgeting methods. As you will see in the next chapter, estimating cash flows is a major task. Still, the framework established in this chapter is critically important for sound capital budgeting analyses; and at this point, you should:

- Understand capital budgeting.
- Know how to calculate and use the major capital budgeting decision criteria, which are NPV, IRR, MIRR, and payback.
- Understand why NPV is the best criterion and how it overcomes problems inherent in the other methods.
- Recognize that while NPV is the best method, the other methods do provide information that decision makers find useful.

SELF-TEST QUESTIONS AND PROBLEMS (Solutions Appear in Appendix A)

ST-1 KEY TERMS Define the following terms:

- a. Capital budgeting; strategic business plan
- b. Net present value (NPV)
- c. Internal rate of return (IRR)
- d. NPV profile; crossover rate
- e. Mutually exclusive projects; independent projects
- f. Nonnormal cash flows; normal cash flows; multiple IRRs
- g. Modified internal rate of return (MIRR)
- h. Payback period; discounted payback

ST-2 CAPITAL BUDGETING CRITERIA You must analyze two projects, X and Y. Each project costs \$10,000, and the firm's WACC is 12%. The expected net cash flows are as follows:

	0	1	2	3	4
Project X	−\$10,000	\$6,500	\$3,000	\$3,000	\$1,000
Project Y	−\$10,000	\$3,500	\$3,500	\$3,500	\$3,500

- a. Calculate each project's NPV, IRR, MIRR, payback, and discounted payback.
- b. Which project(s) should be accepted if they are independent?
- c. Which project(s) should be accepted if they are mutually exclusive?
- d. How might a change in the WACC produce a conflict between the NPV and IRR rankings of the two projects? Would there be a conflict if WACC were 5%? (Hint: Plot the NPV profiles. The crossover rate is 6.21875%.)
- e. Why does the conflict exist?

QUESTIONS

- 11-1 How are project classifications used in the capital budgeting process?
- 11-2 What are three potential flaws with the regular payback method? Does the discounted payback method correct all three flaws? Explain.
- 11-3 Why is the NPV of a relatively long-term project (one for which a high percentage of its cash flows occurs in the distant future) more sensitive to changes in the WACC than that of a short-term project?
- 11-4 What is a mutually exclusive project? How should managers rank mutually exclusive projects?
- 11-5 If two mutually exclusive projects were being compared, would a high cost of capital favor the longer-term or the shorter-term project? Why? If the cost of capital declined, would that lead firms to invest more in longer-term projects or shorter-term projects? Would a decline (or an increase) in the WACC cause changes in the IRR ranking of mutually exclusive projects?
- 11-6 Discuss the following statement: If a firm has only independent projects, a constant WACC, and projects with normal cash flows, the NPV and IRR methods will always lead to identical capital budgeting decisions. What does this imply about the choice between IRR and NPV? If each of the assumptions were changed (one by one), how would your answer change?
- 11-7 Why might it be rational for a small firm that does not have access to the capital markets to use the payback method rather than the NPV method?
- 11-8 Project X is very risky and has an NPV of \$3 million. Project Y is very safe and has an NPV of \$2.5 million. They are mutually exclusive, and project risk has been properly considered in the NPV analyses. Which project should be chosen? Explain.
- 11-9 What reinvestment rate assumptions are built into the NPV, IRR, and MIRR methods? Give an explanation (other than "because the text says so") for your answer.
- 11-10 A firm has a \$100 million capital budget. It is considering two projects, each costing \$100 million. Project A has an IRR of 20%; has an NPV of \$9 million; and will be terminated after 1 year at a profit of \$20 million, resulting in an immediate increase in EPS. Project B, which cannot be postponed, has an IRR of 30% and an NPV of \$50 million. However, the firm's short-run EPS will be reduced if it accepts Project B because no revenues will be generated for several years.
 - a. Should the short-run effects on EPS influence the choice between the two projects?
 - b. How might situations like this influence a firm's decision to use payback?

PROBLEMS

Easy Problems 1–6

- 11-1 NPV** Project K costs \$52,125, its expected net cash inflows are \$12,000 per year for 8 years, and its WACC is 12%. What is the project's NPV?
- 11-2 IRR** Refer to Problem 11-1. What is the project's IRR?
- 11-3 MIRR** Refer to Problem 11-1. What is the project's MIRR?
- 11-4 PAYBACK PERIOD** Refer to Problem 11-1. What is the project's payback?
- 11-5 DISCOUNTED PAYBACK** Refer to Problem 11-1. What is the project's discounted payback?
- 11-6 NPV** Your division is considering two projects with the following net cash flows (in millions):

	0	1	2	3
Project A	−\$25	\$5	\$10	\$17
Project B	−\$20	\$10	\$9	\$6

- What are the projects' NPVs assuming the WACC is 5%? 10%? 15%?
- What are the projects' IRRs at each of these WACCs?
- If the WACC was 5% and A and B were mutually exclusive, which project would you choose? What if the WACC was 10%? 15%? (Hint: The crossover rate is 7.81%.)

Intermediate Problems 7–13

- 11-7 CAPITAL BUDGETING CRITERIA** A firm with a 14% WACC is evaluating two projects for this year's capital budget. After-tax cash flows, including depreciation, are as follows:

	0	1	2	3	4	5
Project A	−\$6,000	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000
Project B	−\$18,000	\$5,600	\$5,600	\$5,600	\$5,600	\$5,600

- Calculate NPV, IRR, MIRR, payback, and discounted payback for each project.
 - Assuming the projects are independent, which one(s) would you recommend?
 - If the projects are mutually exclusive, which would you recommend?
 - Notice that the projects have the same cash flow timing pattern. Why is there a conflict between NPV and IRR?
- 11-8 CAPITAL BUDGETING CRITERIA: ETHICAL CONSIDERATIONS** A mining company is considering a new project. Because the mine has received a permit, the project would be legal; but it would cause significant harm to a nearby river. The firm could spend an additional \$10 million at Year 0 to mitigate the environmental problem, but it would not be required to do so. Developing the mine (without mitigation) would cost \$60 million, and the expected net cash inflows would be \$20 million per year for 5 years. If the firm does invest in mitigation, the annual inflows would be \$21 million. The risk-adjusted WACC is 12%.
- Calculate the NPV and IRR with and without mitigation.
 - How should the environmental effects be dealt with when this project is evaluated?
 - Should this project be undertaken? If so, should the firm do the mitigation?
- 11-9 CAPITAL BUDGETING CRITERIA: ETHICAL CONSIDERATIONS** An electric utility is considering a new power plant in northern Arizona. Power from the plant would be sold in the Phoenix area, where it is badly needed. Because the firm has received a permit, the plant would be legal; but it would cause some air pollution. The company could spend an additional \$40 million at Year 0 to mitigate the environmental problem, but it would not be required to do so. The plant without mitigation would cost \$240 million, and the expected net cash inflows would be \$80 million per year for 5 years. If the firm does invest in mitigation, the annual inflows would be \$84 million. Unemployment in the area where the plant would be built is high, and the plant would provide about 350 good jobs. The risk-adjusted WACC is 17%.
- Calculate the NPV and IRR with and without mitigation.
 - How should the environmental effects be dealt with when evaluating this project?
 - Should this project be undertaken? If so, should the firm do the mitigation?

- 11-10 CAPITAL BUDGETING CRITERIA: MUTUALLY EXCLUSIVE PROJECTS** A firm with a WACC of 10% is considering the following mutually exclusive projects:

	0	1	2	3	4	5
	----- ----- ----- ----- ----- -----					
Project A	-\$400	\$55	\$55	\$55	\$225	\$225
Project B	-\$600	\$300	\$300	\$50	\$50	\$49

Which project would you recommend? Explain.

- 11-11 CAPITAL BUDGETING CRITERIA: MUTUALLY EXCLUSIVE PROJECTS** Project S costs \$15,000, and its expected cash flows would be \$4,500 per year for 5 years. Mutually exclusive Project L costs \$37,500, and its expected cash flows would be \$11,100 per year for 5 years. If both projects have a WACC of 14%, which project would you recommend? Explain.

- 11-12 IRR AND NPV** A company is analyzing two mutually exclusive projects, S and L, with the following cash flows:

	0	1	2	3	4
	----- ----- ----- ----- -----				
Project S	-\$1,000	\$900	\$250	\$10	\$10
Project L	-\$1,000	\$0	\$250	\$400	\$800

The company's WACC is 10%. What is the IRR of the *better* project? (Hint: The better project may or may not be the one with the higher IRR.)

- 11-13 MIRR** A firm is considering two mutually exclusive projects, X and Y, with the following cash flows:

	0	1	2	3	4
	----- ----- ----- ----- -----				
Project X	-\$1,000	\$100	\$300	\$400	\$700
Project Y	-\$1,000	\$1,000	\$100	\$50	\$50

The projects are equally risky, and their WACC is 12%. What is the MIRR of the project that maximizes shareholder value?

Challenging Problems
14–22

- 11-14 CHOOSING MANDATORY PROJECTS ON THE BASIS OF LEAST COST** K. Kim Inc. must install a new air conditioning unit in its main plant. Kim must install one or the other of the units; otherwise, the highly profitable plant would have to shut down. Two units are available, HCC and LCC (for high and low capital costs, respectively). HCC has a high capital cost but relatively low operating costs, while LCC has a low capital cost but higher operating costs because it uses more electricity. The costs of the units are shown here. Kim's WACC is 7%.

	0	1	2	3	4	5
	----- ----- ----- ----- ----- -----					
HCC	-\$600,000	-\$50,000	-\$50,000	-\$50,000	-\$50,000	-\$50,000
LCC	-\$100,000	-\$175,000	-\$175,000	-\$175,000	-\$175,000	-\$175,000

- Which unit would you recommend? Explain.
 - If Kim's controller wanted to know the IRRs of the two projects, what would you tell him?
 - If the WACC rose to 15% would this affect your recommendation? Explain your answer and the reason this result occurred.
- 11-15 NPV PROFILES: TIMING DIFFERENCES** An oil drilling company must choose between two mutually exclusive extraction projects, and each costs \$12 million. Under Plan A, all the oil would be extracted in 1 year, producing a cash flow at $t = 1$ of \$14.4 million. Under Plan B, cash flows would be \$2.1 million per year for 20 years. The firm's WACC is 12%.
- Construct NPV profiles for Plans A and B, identify each project's IRR, and show the approximate crossover rate.
 - Is it logical to assume that the firm would take on all available independent, average-risk projects with returns greater than 12%? If all available projects with returns greater than 12% have been undertaken, does this mean that cash flows from past investments have an opportunity cost of only 12% because all the company can do with these cash flows is to replace money that has a cost of 12%? Does this imply that the WACC is the correct reinvestment rate assumption for a project's cash flows?

11-16 NPV PROFILES: SCALE DIFFERENCES A company is considering two mutually exclusive expansion plans. Plan A requires a \$40 million expenditure on a large-scale integrated plant that would provide expected cash flows of \$6.4 million per year for 20 years. Plan B requires a \$12 million expenditure to build a somewhat less efficient, more labor-intensive plant with expected cash flows of \$2.72 million per year for 20 years. The firm's WACC is 10%.

- Calculate each project's NPV and IRR.
- Graph the NPV profiles for Plan A and Plan B and approximate the crossover rate.
- Why is NPV better than IRR for making capital budgeting decisions that add to shareholder value?

11-17 CAPITAL BUDGETING CRITERIA A company has a 12% WACC and is considering two mutually exclusive investments (that cannot be repeated) with the following net cash flows:

	0	1	2	3	4	5	6	7
Project A	-\$300	-\$387	-\$193	-\$100	\$600	\$600	\$850	-\$180
Project B	-\$405	\$134	\$134	\$134	\$134	\$134	\$134	\$0

- What is each project's NPV?
- What is each project's IRR?
- What is each project's MIRR? (Hint: Consider Period 7 as the end of Project B's life.)
- From your answers to Parts a, b, and c, which project would be selected? If the WACC was 18%, which project would be selected?
- Construct NPV profiles for Projects A and B.
- What is each project's MIRR at a WACC of 18%?

11-18 NPV AND IRR A store has 5 years remaining on its lease in a mall. Rent is \$2,000 per month, 60 payments remain, and the next payment is due in 1 month. The mall's owner plans to sell the property in a year and wants rent at that time to be high so that the property will appear more valuable. Therefore, the store has been offered a "great deal" (owner's words) on a new 5-year lease. The new lease calls for no rent for 9 months, then payments of \$2,600 per month for the next 51 months. The lease cannot be broken, and the store's WACC is 12% (or 1% per month).

- Should the new lease be accepted? (Hint: Make sure you use 1% per month.)
- If the store owner decided to bargain with the mall's owner over the new lease payment, what new lease payment would make the store owner indifferent between the new and old leases? (Hint: Find FV of the old lease's original cost at $t = 9$; then treat this as the PV of a 51-period annuity whose payments represent the rent during months 10 to 60.)
- The store owner is not sure of the 12% WACC—it could be higher or lower. At what *nominal* WACC would the store owner be indifferent between the two leases? (Hint: Calculate the differences between the two payment streams; then find its IRR.)

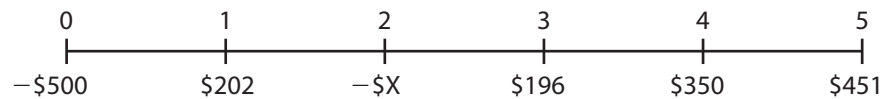
11-19 MULTIPLE IRRS AND MIRR A mining company is deciding whether to open a strip mine, which costs \$2 million. Net cash inflows of \$13 million would occur at the end of Year 1. The land must be returned to its natural state at a cost of \$12 million, payable at the end of Year 2.

- Plot the project's NPV profile.
- Should the project be accepted if $WACC = 10\%$? if $WACC = 20\%$? Explain your reasoning.
- Think of some other capital budgeting situations in which negative cash flows during or at the end of the project's life might lead to multiple IRRs.
- What is the project's MIRR at $WACC = 10\%$? at $WACC = 20\%$? Does MIRR lead to the same accept/reject decision for this project as the NPV method? Does the MIRR method *always* lead to the same accept/reject decision as NPV? (Hint: Consider mutually exclusive projects that differ in size.)

11-20 NPV A project has annual cash flows of \$7,500 for the next 10 years and then \$10,000 each year for the following 10 years. The IRR of this 20-year project is 10.98%. If the firm's WACC is 9%, what is the project's NPV?

11-21 MIRR Project X costs \$1,000, and its cash flows are the same in Years 1 through 10. Its IRR is 12%, and its WACC is 10%. What is the project's MIRR?

11-22 MIRR A project has the following cash flows:



This project requires two outflows at Years 0 and 2, but the remaining cash flows are positive. Its WACC is 10%, and its MIRR is 14.14%. What is the Year 2 cash outflow?

COMPREHENSIVE/SPREADSHEET PROBLEM

11-23 CAPITAL BUDGETING CRITERIA Your division is considering two projects. Its WACC is 10%, and the projects' after-tax cash flows (in millions of dollars) would be as follows:

	0	1	2	3	4
	—	—	—	—	—
Project A	-\$30	\$5	\$10	\$15	\$20
Project B	-\$30	\$20	\$10	\$8	\$6

- a. Calculate the projects' NPVs, IRRs, MIRRs, regular paybacks, and discounted paybacks.
- b. If the two projects are independent, which project(s) should be chosen?
- c. If the two projects are mutually exclusive and the WACC is 10%, which project(s) should be chosen?
- d. Plot NPV profiles for the two projects. Identify the projects' IRRs on the graph.
- e. If the WACC was 5%, would this change your recommendation if the projects were mutually exclusive? If the WACC was 15%, would this change your recommendation? Explain your answers.
- f. The crossover rate is 13.5252%. Explain what this rate is and how it affects the choice between mutually exclusive projects.
- g. Is it possible for conflicts to exist between the NPV and the IRR when *independent* projects are being evaluated? Explain your answer.
- h. Now look at the regular and discounted paybacks. Which project looks better when judged by the paybacks?
- i. If the payback was the only method a firm used to accept or reject projects, what pay-back should it choose as the cutoff point, that is, reject projects if their payouts are not below the chosen cutoff? Is your selected cutoff based on some economic criteria, or is it more or less arbitrary? Are the cutoff criteria equally arbitrary when firms use the NPV and/or the IRR as the criteria? Explain.
- j. Define the MIRR. What's the difference between the IRR and the MIRR, and which generally gives a better idea of the rate of return on the investment in a project?
- k. Why do most academics and financial executives regard the NPV as being the single best criterion and better than the IRR? Why do companies still calculate IRRs?

INTEGRATED CASE

ALLIED COMPONENTS COMPANY

11-24 BASICS OF CAPITAL BUDGETING You recently went to work for Allied Components Company, a supplier of auto repair parts used in the after-market with products from Daimler, Chrysler, Ford, and other automakers. Your boss, the chief financial officer (CFO), has just handed you the estimated cash flows for two proposed projects. Project L involves adding a new item to the firm's ignition system line; it would take some time to build up the market for this product, so the cash inflows would increase over time. Project S involves an add-on to an existing line, and its cash flows would decrease over time. Both projects have 3-year lives because Allied is planning to introduce entirely new models after 3 years.

Here are the projects' net cash flows (in thousands of dollars):

	0	1	2	3
	----- ----- ----- -----			
Project L	-\$100	\$10	\$60	\$80
Project S	-\$100	\$70	\$50	\$20

Depreciation, salvage values, net working capital requirements, and tax effects are all included in these cash flows.

The CFO also made subjective risk assessments of each project, and he concluded that both projects have risk characteristics that are similar to the firm's average project. Allied's WACC is 10%. You must determine whether one or both of the projects should be accepted.

- a. What is capital budgeting? Are there any similarities between a firm's capital budgeting decisions and an individual's investment decisions?
- b. What is the difference between independent and mutually exclusive projects? Between projects with normal and nonnormal cash flows?
- c. (1) Define the term *net present value (NPV)*. What is each project's NPV?
 (2) What is the rationale behind the NPV method? According to NPV, which project(s) should be accepted if they are independent? mutually exclusive?
 (3) Would the NPVs change if the WACC changed? Explain.
- d. (1) Define the term *internal rate of return (IRR)*. What is each project's IRR?
 (2) How is the IRR on a project related to the YTM on a bond?
 (3) What is the logic behind the IRR method? According to IRR, which project(s) should be accepted if they are independent? mutually exclusive?
 (4) Would the projects' IRRs change if the WACC changed?
- e. (1) Draw NPV profiles for Projects L and S. At what discount rate do the profiles cross?
 (2) Look at your NPV profile graph without referring to the actual NPVs and IRRs. Which project(s) should be accepted if they are independent? mutually exclusive? Explain. Are your answers correct at any WACC less than 23.6%?
- f. (1) What is the underlying cause of ranking conflicts between NPV and IRR?
 (2) What is the reinvestment rate assumption, and how does it affect the NPV versus IRR conflict?
 (3) Which method is best? Why?
- g. (1) Define the term *modified IRR (MIRR)*. Find the MIRRs for Projects L and S.
 (2) What are the MIRR's advantages and disadvantages vis-à-vis the NPV?
- h. (1) What is the payback period? Find the paybacks for Projects L and S.
 (2) What is the rationale for the payback method? According to the payback criterion, which project(s) should be accepted if the firm's maximum acceptable payback is 2 years, if Projects L and S are independent, if Projects L and S are mutually exclusive?
 (3) What is the difference between the regular and discounted payback methods?
 (4) What are the two main disadvantages of discounted payback? Is the payback method of any real usefulness in capital budgeting decisions? Explain.
- i. As a separate project (Project P), the firm is considering sponsoring a pavilion at the upcoming World's Fair. The pavilion would cost \$800,000, and it is expected to result in \$5 million of incremental cash inflows during its 1 year of operation. However, it would then take another year, and \$5 million of costs, to demolish the site and return it to its original condition. Thus, Project P's expected net cash flows look like this (in millions of dollars):

	0	1	2
	----- -----		
	-\$0.8	\$5.0	-\$5.0

The project is estimated to be of average risk, so its WACC is 10%.

- (1) What is Project P's NPV? What is its IRR? its MIRR?
- (2) Draw Project P's NPV profile. Does Project P have normal or nonnormal cash flows? Should this project be accepted? Explain.