

# CAPITAL BUDGETING TECHNIQUES

## LEARNING GOALS

LG1

Understand the role of capital budgeting techniques in the capital budgeting process.

LG2

Calculate, interpret, and evaluate the payback period.

LG3

Calculate, interpret, and evaluate the net present value (NPV).

LG4

Calculate, interpret, and evaluate the internal rate of return (IRR).

LG5

Use net present value profiles to compare NPV and IRR techniques.

LG6

Discuss NPV and IRR in terms of conflicting rankings and the theoretical and practical strengths of each approach.

## *Across the Disciplines* WHY THIS CHAPTER MATTERS TO YOU

**Accounting:** You need to understand capital budgeting techniques in order to help determine the after-tax cash flows associated with proposed capital expenditures.

**Information systems:** You need to understand capital budgeting techniques in order to design decision modules that help reduce the amount of work required to analyze proposed capital projects.

**Management:** You need to understand capital budgeting techniques in order to understand the decision criteria used to accept or reject proposed projects.

**Marketing:** You need to understand capital budgeting techniques in order to understand how proposals for new marketing programs for new products, and for the expansion of existing product lines will be evaluated by the firm's decision makers.

**Operations:** You need to understand capital budgeting techniques in order to understand how proposals for the acquisition of new equipment and plants will be evaluated by the firm's decision makers.

# DELTA

## DELTA CUTS THE WIRES

Have you ever been stuck at an airport because your flight was late and you missed your connection? You were frustrated by the long lines at customer service counters and pay phones, and when you called on your cell phone, you were placed on hold for what seemed like forever. Wouldn't it be nice to use your Internet-capable cell phone or personal digital assistant (PDA) to pull up flight information and timetables and reschedule your flight? Since 2000, **Delta Airlines** passengers have been able to do just that.

The airline was one of the first to recognize that it could increase customer loyalty by giving business travelers better flight information more quickly. Before Delta's e-business unit added this feature, however, the project had to be justified on the basis of its economic value. Unlike making capital budgeting decisions about whether to buy new aircraft or build maintenance facilities, decisions that managers had been making for years, this project was moving them into uncharted skies—literally.

Delta's capital budgeting methodology for this Internet project used traditional net present value (NPV) analysis to develop relevant cash flows, discount them at the company's cost of capital, and subtract the project's initial investment. Anticipated cost savings were a major factor in developing projected cash flows. Wireless Web access enables customers to obtain information and conduct transactions without calling Delta's customer service representatives, so the airline doesn't have to add employees to handle a larger customer base. Another potential savings: lower paper costs, because more tickets will be issued electronically, even when last-minute changes are involved. The system is more cost-effective, thereby resulting in better resource utilization and a higher ROI.

Improved productivity is another benefit to be derived from this wireless project. Delta hopes to add self-service features so that passengers can choose seats, check in, and handle other routine transactions online. This will free reservations agents to handle more calls placed to purchase tickets, thus generating more revenue. Building on its initial success, Delta is ready to expand its wireless applications. A joint project with American Airlines, United Airlines, and Boeing Corporation will equip planes with broadband Internet connections so that the airlines can sell in-flight wireless services. Delta's innovative technology initiatives have made it one of five finalists for Computerworld's 21st Century Achievement Award.

Delta based its decision to accept the wireless-communication project on the project's positive NPV, which indicated that the project would earn a return above its cost of capital. This chapter focuses on the capital budgeting techniques, including NPV, that companies use to accept or reject and to rank proposed projects.



## LG1 9.1 Overview of Capital Budgeting Techniques

When firms have developed relevant cash flows, as demonstrated in Chapter 8, they analyze them to assess whether a project is acceptable or to rank projects. A number of techniques are available for performing such analyses. The preferred approaches integrate time value procedures, risk and return considerations, and valuation concepts to select capital expenditures that are consistent with the firm's goal of maximizing owners' wealth. This chapter focuses on the use of these techniques in an environment of certainty. Chapter 10 covers risk and other refinements in capital budgeting.

We will use one basic problem to illustrate all the techniques described in this chapter. The problem concerns Bennett Company, a medium-sized metal fabricator that is currently contemplating two projects: Project A requires an initial investment of \$42,000, project B an initial investment of \$45,000. The projected relevant operating cash inflows for the two projects are presented in Table 9.1 and depicted on the time lines in Figure 9.1.<sup>1</sup> The projects exhibit *conventional cash flow patterns*, which are assumed throughout the text. In addition, we initially assume that all projects' cash flows have the same level of risk, that projects being compared have equal usable lives, and that the firm has unlimited funds. (The risk assumption will be relaxed in Chapter 10.) We begin with a look at the three most popular capital budgeting techniques: payback period, net present value, and internal rate of return.<sup>2</sup>

**Hint** Remember that the initial investment is an *outflow* occurring at time zero.

**TABLE 9.1** Capital Expenditure Data for Bennett Company

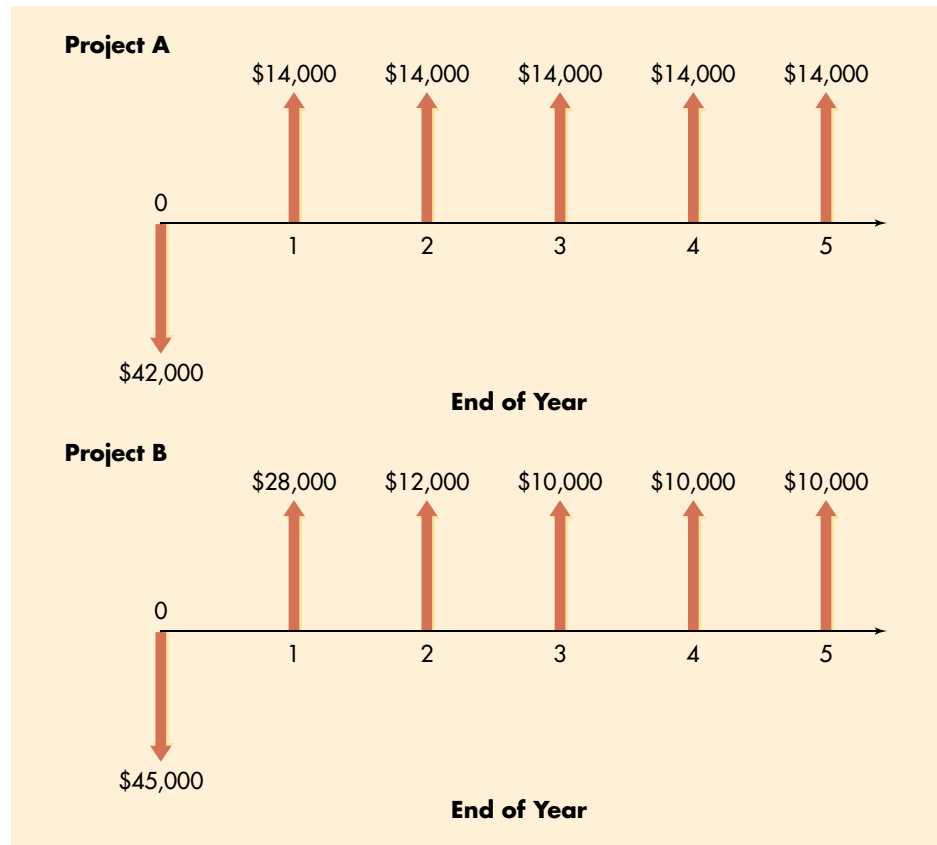
	Project A	Project B
Initial investment	\$42,000	\$45,000
Year	Operating cash inflows	
1	\$14,000	\$28,000
2	14,000	12,000
3	14,000	10,000
4	14,000	10,000
5	14,000	10,000

1. For simplification, these 5-year-lived projects with 5 years of cash inflows are used throughout this chapter. Projects with usable lives equal to the number of years of cash inflows are also included in the end-of-chapter problems. Recall from Chapter 8 that under current tax law, MACRS depreciation results in  $n + 1$  years of depreciation for an  $n$ -year class asset. This means that projects will commonly have at least 1 year of cash flow beyond their recovery period. In actual practice, the usable lives of projects (and the associated cash inflows) may differ significantly from their depreciable lives. Generally, under MACRS, usable lives are longer than depreciable lives.

2. Two other, closely related techniques that are sometimes used to evaluate capital budgeting projects are the *average (or accounting) rate of return (ARR)* and the *profitability index (PI)*. The ARR is an unsophisticated technique that is calculated by dividing a project's average profits after taxes by its average investment. Because it fails to con-

**FIGURE 9.1****Bennett Company's projects A and B**

Time lines depicting the conventional cash flows of projects A and B



## Review Question

- 9-1 Once the firm has determined its projects' relevant cash flows, what must it do next? What is its goal in selecting projects?



## 9.2 Payback Period

### payback period

The amount of time required for a firm to recover its initial investment in a project, as calculated from cash inflows.

Payback periods are commonly used to evaluate proposed investments. The **payback period** is the amount of time required for the firm to recover its initial investment in a project, as calculated from *cash inflows*. In the case of an *annuity*, the payback period can be found by dividing the initial investment by the annual

cash flows and the time value of money, it is ignored here. The PI, sometimes called the *benefit-cost ratio*, is calculated by dividing the present value of cash inflows by the initial investment. This technique, which does consider the time value of money, is sometimes used as a starting point in the selection of projects under capital rationing; the more popular NPV and IRR methods are discussed here.

cash inflow. For a *mixed stream* of cash inflows, the yearly cash inflows must be accumulated until the initial investment is recovered. Although popular, the payback period is generally viewed as an *unsophisticated capital budgeting technique*, because it does not *explicitly* consider the time value of money.

## The Decision Criteria

When the payback period is used to make accept–reject decisions, the decision criteria are as follows:

- If the payback period is *less than* the maximum acceptable payback period, *accept* the project.
- If the payback period is *greater than* the maximum acceptable payback period, *reject* the project.

The length of the maximum acceptable payback period is determined by management. This value is set *subjectively* on the basis of a number of factors, including the type of project (expansion, replacement, renewal), the perceived risk of the project, and the perceived relationship between the payback period and the share value. It is simply a value that management feels, on average, will result in value-creating investment decisions.

### EXAMPLE ▼

We can calculate the payback period for Bennett Company’s projects A and B using the data in Table 9.1. For project A, which is an annuity, the payback period is 3.0 years ( $\$42,000$  initial investment  $\div$   $\$14,000$  annual cash inflow). Because project B generates a mixed stream of cash inflows, the calculation of its payback period is not as clear-cut. In year 1, the firm will recover  $\$28,000$  of its  $\$45,000$  initial investment. By the end of year 2,  $\$40,000$  ( $\$28,000$  from year 1 +  $\$12,000$  from year 2) will have been recovered. At the end of year 3,  $\$50,000$  will have been recovered. Only 50% of the year 3 cash inflow of  $\$10,000$  is needed to complete the payback of the initial  $\$45,000$ . The payback period for project B is therefore 2.5 years (2 years + 50% of year 3).

If Bennett’s maximum acceptable payback period were 2.75 years, project A would be rejected and project B would be accepted. If the maximum payback were 2.25 years, both projects would be rejected. If the projects were being ranked, B would be preferred over A, because it has a shorter payback period.

**Hint** In all three of the decision methods presented in this text, the relevant data are *after-tax cash flows*. Accounting profit is used only to help determine the after-tax cash flow.

**Hint** The payback period indicates to firms taking on projects of high risk how quickly they can recover their investment. In addition, it tells firms with limited sources of capital how quickly the funds invested in a given project will become available for future projects.

## Pros and Cons of Payback Periods

The payback period is widely used by large firms to evaluate small projects and by small firms to evaluate most projects. Its popularity results from its computational simplicity and intuitive appeal. It is also appealing in that it considers cash flows rather than accounting profits. By measuring how quickly the firm recovers its initial investment, the payback period also gives *implicit* consideration to the timing of cash flows and therefore to the time value of money. Because it can be viewed as a measure of *risk exposure*, many firms use the payback period as a decision criterion or as a supplement to other decision techniques. The longer the firm must wait to recover its invested funds, the greater the possibility of a calamity. Therefore, the shorter the payback period, the lower the firm’s exposure to such risk.

The major weakness of the payback period is that the appropriate payback period is merely a subjectively determined number. It cannot be specified in light of the wealth maximization goal because it is not based on discounting cash flows to determine whether they add to the firm's value. Instead, the appropriate payback period is simply the maximum acceptable period of time over which management decides that a project's cash flows must break even (that is, just equal the initial investment). A second weakness is that this approach fails to take *fully* into account the time factor in the value of money.<sup>3</sup> This weakness can be illustrated by an example.

**EXAMPLE** ▼ DeYarman Enterprises, a small medical appliance manufacturer, is considering two mutually exclusive projects, which it has named projects Gold and Silver. The firm uses only the payback period to choose projects. The relevant cash flows and payback period for each project are given in Table 9.2. Both projects have 3-year payback periods, which would suggest that they are equally desirable. But comparison of the pattern of cash inflows over the first 3 years shows that more of the \$50,000 initial investment in project Silver is recovered sooner than is recovered for project Gold. For example, in year 1, \$40,000 of the \$50,000 invested in project Silver is recovered, whereas only \$5,000 of the \$50,000 investment in project Gold is recovered. Given the time value of money, project Silver would clearly be preferred over project Gold, in spite of the fact that they both have identical 3-year payback periods. The payback approach does not fully account for the time value of money, which, if recognized, would cause project Silver to be preferred over project Gold. ▲

A third weakness of payback is its failure to recognize cash flows that occur *after* the payback period.

**TABLE 9.2** Relevant Cash Flows and Payback Periods for DeYarman Enterprises' Projects

	Project Gold	Project Silver
Initial investment	\$50,000	\$50,000
Year	Operating cash inflows	
1	\$ 5,000	\$40,000
2	5,000	2,000
3	40,000	8,000
4	10,000	10,000
5	10,000	10,000
Payback period	3 years	3 years

3. To consider differences in timing *explicitly* in applying the payback method, the *present value payback period* is sometimes used. It is found by first calculating the present value of the cash inflows at the appropriate discount rate and then finding the payback period by using the present value of the cash inflows.

## In Practice

## FOCUS ON PRACTICE Limits of Payback Analysis

The high labor component of U.S. textile manufacturers creates a cost disadvantage that makes it hard for them to compete in global markets. They lag behind other U.S. industries and foreign textile producers in terms of plant automation. One key hurdle is payback period. The industry standard for capital expenditure projects for machinery is 3 years. Because few major automation projects have such a short payback period, the

pace of automation has been very slow. For example, the payback period for materials transport automation—moving material from one point to another with minimum labor—averages 5 to 6 years.

This situation underscores a major limitation of payback period analysis. Companies that rely only on the payback period may not give fair consideration to technology that can greatly improve their long-term

manufacturing effectiveness. Whereas Japanese managers will invest \$1 million to replace one job, U.S. managers invest about \$250,000. At prevailing wage rates, the Japanese accept a 5- to 6-year payback, compared to a period of 3 to 4 years in the United States. These differences underscore the linkages that exist between a firm's operations and finance.

**EXAMPLE** ▼ Rashid Company, a software developer, has two investment opportunities, X and Y. Data for X and Y are given in Table 9.3. The payback period for project X is 2 years; for project Y it is 3 years. Strict adherence to the payback approach suggests that project X is preferable to project Y. However, if we look beyond the payback period, we see that project X returns only an additional \$1,200 (\$1,000 in year 3 + \$100 in year 4 + \$100 in year 5), whereas project Y returns an additional \$7,000 (\$4,000 in year 4 + \$3,000 in year 5). On the basis of this information, project Y appears preferable to X. The payback approach ignored the cash inflows occurring after the end of the payback period.<sup>4</sup>

**TABLE 9.3** Calculation of the Payback Period for Rashid Company's Two Alternative Investment Projects

	Project X	Project Y
Initial investment	\$10,000	\$10,000
Year	Operating cash inflows	
1	\$5,000	\$3,000
2	5,000	4,000
3	1,000	3,000
4	100	4,000
5	100	3,000
Payback period	2 years	3 years

4. To get around this weakness, some analysts add a desired dollar return to the initial investment and then calculate the payback period for the increased amount. For example, if the analyst wished to pay back the initial investment plus 20% for projects X and Y in Table 9.3, the amount to be recovered would be \$12,000 [ $\$10,000 + (0.20 \times \$10,000)$ ]. For project X, the payback period would be infinite because the \$12,000 would never be recovered; for project Y, the payback period would be 3.50 years [3 years +  $(\$2,000 \div \$4,000)$  years]. Clearly, project Y would be preferred.

## Review Questions

- 9-2 What is the *payback period*? How is it calculated?
- 9-3 What weaknesses are commonly associated with the use of the payback period to evaluate a proposed investment?



### 9.3 Net Present Value (NPV)

Because *net present value (NPV)* gives explicit consideration to the time value of money, it is considered a *sophisticated capital budgeting technique*. All such techniques in one way or another discount the firm's cash flows at a specified rate. This rate—often called the *discount rate*, *required return*, *cost of capital*, or *opportunity cost*—is the minimum return that must be earned on a project to leave the firm's market value unchanged. In this chapter, we take this rate as a “given.” In Chapter 11 we will explore how it is calculated.

The **net present value (NPV)** is found by subtracting a project's initial investment ( $CF_0$ ) from the present value of its cash inflows ( $CF_t$ ) discounted at a rate equal to the firm's cost of capital ( $k$ ).

NPV = Present value of cash inflows – Initial investment

$$\text{NPV} = \sum_{t=1}^n \frac{CF_t}{(1+k)^t} - CF_0 \quad (9.1)$$

$$= \sum_{t=1}^n (CF_t \times PVIF_{k,t}) - CF_0 \quad (9.1a)$$

When NPV is used, both inflows and outflows are measured in terms of present dollars. Because we are dealing only with investments that have *conventional cash flow patterns*, the initial investment is automatically stated in terms of today's dollars. If it were not, the present value of a project would be found by subtracting the present value of outflows from the present value of inflows.

### The Decision Criteria

When NPV is used to make accept–reject decisions, the decision criteria are as follows:

- If the NPV is *greater than* \$0, *accept* the project.
- If the NPV is *less than* \$0, *reject* the project.

If the NPV is greater than \$0, the firm will earn a return greater than its cost of capital. Such action should enhance the market value of the firm and therefore the wealth of its owners.

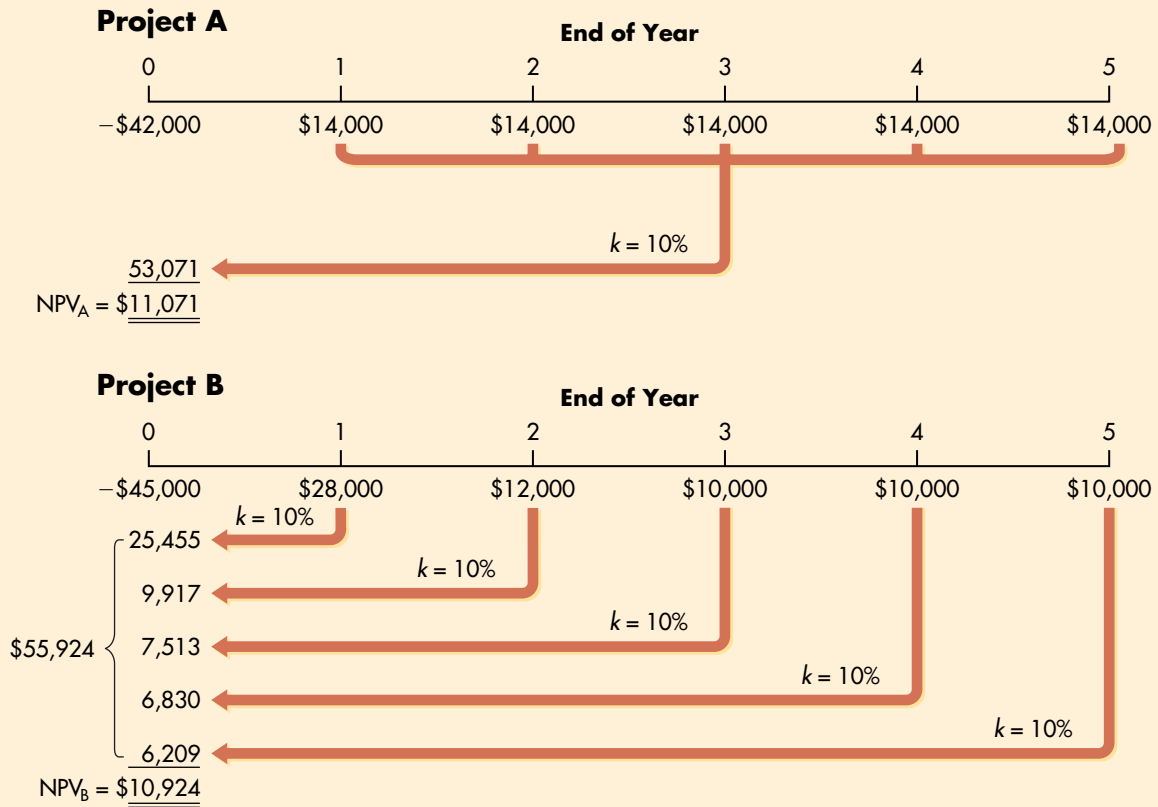
**EXAMPLE** ▼ We can illustrate the net present value (NPV) approach by using Bennett Company data presented in Table 9.1. If the firm has a 10% cost of capital, the net present values for projects A (an annuity) and B (a mixed stream) can be calculated as shown on the time lines in Figure 9.2. These calculations result in net present

#### net present value (NPV)

A sophisticated capital budgeting technique; found by subtracting a project's initial investment from the present value of its cash inflows discounted at a rate equal to the firm's cost of capital.



**FIGURE 9.2** Calculation of NPVs for Bennett Company's Capital Expenditure Alternatives  
Time lines depicting the cash flows and NPV calculations for projects A and B



values for projects A and B of \$11,071 and \$10,924, respectively. Both projects are acceptable, because the net present value of each is greater than \$0. If the projects were being ranked, however, project A would be considered superior to B, because it has a higher net present value than that of B (\$11,071 versus \$10,924).

**Calculator Use** The preprogrammed NPV function in a financial calculator can be used to simplify the NPV calculation. The keystrokes for project A—the annuity—typically are as shown at left. Note that because project A is an annuity, only its first cash inflow,  $CF_1 = 14000$ , is input, followed by its frequency,  $N = 5$ .

The keystrokes for project B—the mixed stream—are as shown on page 403. Because the last three cash inflows for project B are the same ( $CF_3 = CF_4 = CF_5 = 10000$ ), after inputting the first of these cash inflows,  $CF_3$ , we merely input its frequency,  $N = 3$ .

The calculated NPVs for projects A and B of \$11,071 and \$10,924, respectively, agree with the NPVs cited above.

**Spreadsheet Use** The NPVs can be calculated as shown on the following Excel spreadsheet.

**Project A**

Input	Function
-42000	CF <sub>0</sub>
14000	CF <sub>1</sub>
5	N
10	I
	NPV
Solution	
11071.01	

**Project B**

Input	Function
-45000	CF <sub>0</sub>
28000	CF <sub>1</sub>
12000	CF <sub>2</sub>
10000	CF <sub>3</sub>
3	N
10	I
	NPV
Solution	
10924.40	

	A	B	C
<b>DETERMINING THE NET PRESENT VALUE</b>			
1	Firm's cost of capital		10%
3	Year-End Cash Flow		
4	Year	Project A	Project B
5	0	\$ (42,000)	\$ (45,000)
6	1	\$ 14,000	\$ 28,000
7	2	\$ 14,000	\$ 12,000
8	3	\$ 14,000	\$ 10,000
9	4	\$ 14,000	\$ 10,000
10	5	\$ 14,000	\$ 10,000
11	NPV	\$ 11,071	\$ 10,924
12	<b>Choice of project</b>		<b>Project A</b>
Entry in Cell B11 is =NPV(\$C\$2,B6:B10)+B5 Copy the entry in Cell B11 to Cell C11. Entry in Cell C12 is IF(B11>C11,B4,C4).			

## Review Questions

- 9-4 How is the *net present value (NPV)* calculated for a project with a *conventional cash flow pattern*?
- 9-5 What are the acceptance criteria for NPV? How are they related to the firm's market value?



## 9.4 Internal Rate of Return (IRR)

### internal rate of return (IRR)

A sophisticated capital budgeting technique; the discount rate that equates the NPV of an investment opportunity with \$0 (because the present value of cash inflows equals the initial investment); it is the compound annual rate of return that the firm will earn if it invests in the project and receives the given cash inflows.

The *internal rate of return (IRR)* is probably the most widely used *sophisticated capital budgeting technique*. However, it is considerably more difficult than NPV to calculate by hand. The **internal rate of return (IRR)** is the discount rate that equates the NPV of an investment opportunity with \$0 (because the present value of cash inflows equals the initial investment). It is the compound annual rate of return that the firm will earn if it invests in the project and receives the given cash inflows. Mathematically, the IRR is the value of  $k$  in Equation 9.1 that causes NPV to equal \$0.

$$\$0 = \sum_{t=1}^n \frac{CF_t}{(1 + IRR)^t} - CF_0 \quad (9.2)$$

$$\sum_{t=1}^n \frac{CF_t}{(1 + IRR)^t} = CF_0 \quad (9.2a)$$

### The Decision Criteria

When IRR is used to make accept–reject decisions, the decision criteria are as follows:

- If the IRR is *greater than* the cost of capital, *accept* the project.
- If the IRR is *less than* the cost of capital, *reject* the project.

These criteria guarantee that the firm earns at least its required return. Such an outcome should enhance the market value of the firm and therefore the wealth of its owners.

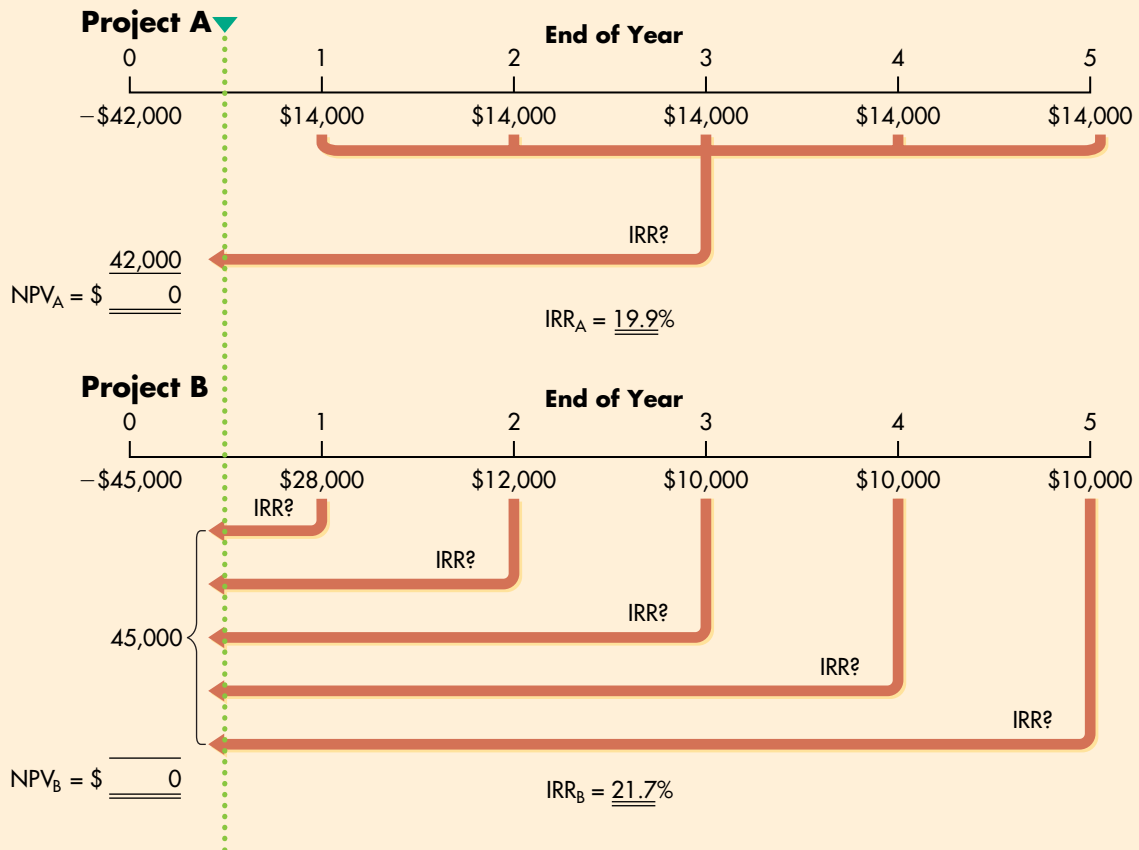
### Calculating the IRR



The actual calculation by hand of the IRR from Equation 9.2a is no easy chore. It involves a complex trial-and-error technique that is described and demonstrated on this text's Web site: [www.aw.com/gitman](http://www.aw.com/gitman). Fortunately, many financial calculators have a preprogrammed IRR function that can be used to simplify the IRR calculation. With these calculators, you merely punch in all cash flows just as if to calculate NPV and then depress IRR to find the internal rate of return. Computer software, including spreadsheets, is also available for simplifying these calculations. All NPV and IRR values presented in this and subsequent chapters are obtained by using these functions on a popular financial calculator.

**FIGURE 9.3** Calculation of IRRs for Bennett Company's Capital Expenditure Alternatives

Time lines depicting the cash flows and IRR calculations for projects A and B



**EXAMPLE**

We can demonstrate the internal rate of return (IRR) approach using Bennett Company data presented in Table 9.1. Figure 9.3 (page 404) uses time lines to depict the framework for finding the IRRs for Bennett's projects A and B, both of which have conventional cash flow patterns. It can be seen in the figure that the IRR is the unknown discount rate that causes the NPV just to equal \$0.

**Calculator Use** To find the IRR using the preprogrammed function in a financial calculator, the keystrokes for each project are the same as those shown on page 403 for the NPV calculation, except that the last two NPV keystrokes (punching I and then NPV) are replaced by a single IRR keystroke.

Comparing the IRRs of projects A and B given in Figure 9.3 to Bennett Company's 10% cost of capital, we can see that both projects are acceptable because

$$IRR_A = 19.9\% > 10.0\% \text{ cost of capital}$$

$$IRR_B = 21.7\% > 10.0\% \text{ cost of capital}$$

Comparing the two projects' IRRs, we would prefer project B over project A because  $IRR_B = 21.7\% > IRR_A = 19.9\%$ . If these projects are mutually exclusive, the IRR decision technique would recommend project B.

**Spreadsheet Use** The internal rate of return also can be calculated as shown on the Excel spreadsheet on page 405.

	A	B	C
1	<b>DETERMINING THE INTERNAL RATE OF RETURN</b>		
2		Year-End Cash Flow	
3	Year	Project A	Project B
4	0	\$ (42,000)	\$ (45,000)
5	1	\$ 14,000	\$ 28,000
6	2	\$ 14,000	\$ 12,000
7	3	\$ 14,000	\$ 10,000
8	4	\$ 14,000	\$ 10,000
9	5	\$ 14,000	\$ 10,000
10	IRR	19.9%	21.7%
11	<b>Choice of Project</b>		<b>Project B</b>
	Entry in Cell B10 is =IRR(B4:B9).		
	Copy the entry in Cell B10 to Cell C10.		
	Entry in Cell C11 is =IF(B10>C10,B3,C3).		

It is interesting to note in the preceding example that the IRR suggests that project B, which has an IRR of 21.7%, is preferable to project A, which has an IRR of 19.9%. This conflicts with the NPV rankings obtained in an earlier example. Such conflicts are not unusual. *There is no guarantee that NPV and IRR will rank projects in the same order. However, both methods should reach the same conclusion about the acceptability or nonacceptability of projects.*

## In Practice

### FOCUS ON PRACTICE EVA<sup>®</sup> Creation

Answering the question “Does the company use investors’ money wisely?” is one of the financial manager’s chief responsibilities and greatest challenges. At many firms—from Fortune 500 companies and investment firms to community hospitals—economic value added (EVA<sup>®</sup>) is the measurement tool of choice for making investment decisions, measuring overall financial performance, and motivating management.

Developed in 1983 by financial consultants Stern Stewart and protected by trademark, EVA<sup>®</sup> is the difference between an investment’s net operating profits after taxes and the cost of funds used to finance the investment (the amount of capital times the company’s cost of capital). An investment with a positive EVA<sup>®</sup> exceeds the firm’s cost of capital and therefore creates wealth. The EVA<sup>®</sup> calculation is similar to calculating internal rate of return (IRR), except that the result is stated *in dollars* rather than percentages. It can be applied to the company as a whole as well as to specific long-term investments such as new facilities or equipment and acquisitions.

According to its proponents, EVA<sup>®</sup> represents “real” profits and provides a more accurate measure than accounting profits. Over

time, it also has better correlation with stock prices than does earnings per share (EPS). Income calculations include only the cost of debt (interest expense), whereas EVA<sup>®</sup> uses the total cost of capital—both debt and equity (an expensive form of capital). In addition, EVA<sup>®</sup> treats research and development (R&D) outlays as investments in future products or processes and capitalizes rather than expenses them. A growing EVA<sup>®</sup> can signal future increases in stock prices.

Companies that use EVA<sup>®</sup> believe doing so leads to better overall performance. Managers who apply it focus on allocating and managing assets, not just accounting profits. They will accelerate the development of a hot new product even if it reduces earnings in the near term. Likewise, EVA<sup>®</sup>-driven companies will expense rather than capitalize the cost of a new venture. Although earnings will drop for a few quarters, so will taxes—and cash flow actually increases.

EVA<sup>®</sup> is not a panacea, however. Its critics say it’s just another accounting measure and may not be the right one for many companies. They claim that because it favors big projects in big companies, it doesn’t do a good job on capital allocation.

Each year *Fortune* and Stern Stewart publish a “wealth creators” list that answers a critical question: Is the company creating or destroying wealth for its shareholders? This list uses both EVA<sup>®</sup> and market value added (MVA<sup>®</sup>)—the difference between what investors can now take out of a company and what they put in—to rank companies. In 2001 the list also included another measure, *future growth value*, an estimate of the value of the companies’ future growth today, based on current net operating profits after taxes.

**General Electric** again topped the 2001 list, followed by **Microsoft**, **Wal-Mart**, **IBM**, and **Pfizer**.

EVA<sup>®</sup> is gaining acceptance worldwide as well. At the French corporation **Danone**, chief executive Franck Riboud uses an EVA<sup>®</sup> formula to measure performance. “It’s a question of tools and language,” says Riboud. “If I talk EVA<sup>®</sup>, I will be understood all over the world.”

*Sources:* Geoffrey Colvin, “Earnings Aren’t Everything,” *Fortune* (September 17, 2001), p. 58; Janet Guyon, “Companies Around the World Are Going the America Way,” *Fortune* (November 26, 2001), pp. 114–120; Randy Myers, “Measure for Measure,” *CFD* (November 1997), downloaded from [www.cfnet.com](http://www.cfnet.com); Stern Stewart Web site, [www.sternstewart.com](http://www.sternstewart.com); and David Stires, “America’s Best and Worst Wealth Creators,” *Fortune* (December 10, 2001), pp. 137–142.

## Review Questions

- 9–6 What is the *internal rate of return (IRR)* on an investment? How is it determined?
- 9–7 What are the acceptance criteria for IRR? How are they related to the firm’s market value?
- 9–8 Do the net present value (NPV) and internal rate of return (IRR) always agree with respect to accept–reject decisions? With respect to ranking decisions? Explain.



## 9.5 Comparing NPV and IRR Techniques

To understand the differences between the NPV and IRR techniques and decision makers' preferences in their use, we need to look at net present value profiles, conflicting rankings, and the question of which approach is better.

### Net Present Value Profiles

**net present value profile**  
Graph that depicts a project's NPVs for various discount rates.

Projects can be compared graphically by constructing **net present value profiles** that depict the projects' NPVs for various discount rates. These profiles are useful in evaluating and comparing projects, especially when conflicting rankings exist. They are best demonstrated via an example.

#### EXAMPLE

To prepare net present value profiles for Bennett Company's two projects, A and B, the first step is to develop a number of "discount rate–net present value" coordinates. Three coordinates can be easily obtained for each project; they are at discount rates of 0%, 10% (the cost of capital,  $k$ ), and the IRR. The net present value at a 0% discount rate is found by merely adding all the cash inflows and subtracting the initial investment. Using the data in Table 9.1 and Figure 9.1, we get

**For project A:**

$$(\$14,000 + \$14,000 + \$14,000 + \$14,000 + \$14,000) - \$42,000 = \$28,000$$

**For project B:**

$$(\$28,000 + \$12,000 + \$10,000 + \$10,000 + \$10,000) - \$45,000 = \$25,000$$

The net present values for projects A and B at the 10% cost of capital are \$11,071 and \$10,924, respectively (from Figure 9.2). Because the IRR is the discount rate for which net present value equals zero, the IRRs (from Figure 9.3) of 19.9% for project A and 21.7% for project B result in \$0 NPVs. The three sets of coordinates for each of the projects are summarized in Table 9.4.

Plotting the data from Table 9.4 results in the net present value profiles for projects A and B shown in Figure 9.4. The figure indicates that for any discount

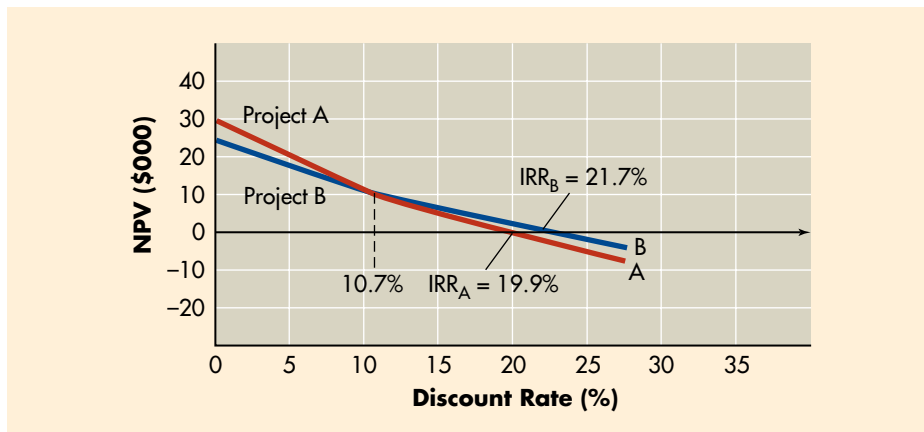
**TABLE 9.4** Discount-Rate–NPV Coordinates for Projects A and B

Net present value		
Discount rate	Project A	Project B
0 %	\$28,000	\$25,000
10	11,071	10,924
19.9	0	—
21.7	—	0

FIGURE 9.4

**NPV Profiles**

Net present value profiles for Bennett Company's projects A and B



- rate less than approximately 10.7%, the NPV for project A is greater than the
- NPV for project B. Beyond this point, the NPV for project B is greater. Because
- the net present value profiles for projects A and B cross at a positive NPV, the
- IRRs for the projects cause conflicting rankings whenever they are compared to
- ▲ NPVs calculated at discount rates below 10.7%.

## Conflicting Rankings

Ranking is an important consideration when projects are mutually exclusive or when capital rationing is necessary. When projects are mutually exclusive, ranking enables the firm to determine which project is best from a financial standpoint. When capital rationing is necessary, ranking projects will provide a logical starting point for determining what group of projects to accept. As we'll see, **conflicting rankings** using NPV and IRR result from *differences in the magnitude and timing of cash flows*.

The underlying cause of conflicting rankings is different implicit assumptions about the *reinvestment of intermediate cash inflows*—cash inflows received prior to the termination of a project. NPV assumes that intermediate cash inflows are reinvested at the cost of capital, whereas IRR assumes that intermediate cash inflows are invested at a rate equal to the project's IRR.<sup>5</sup> These differing assumptions can be demonstrated with an example.

### conflicting rankings

Conflicts in the ranking given a project by NPV and IRR, resulting from differences in the magnitude and timing of cash flows.

### intermediate cash inflows

Cash inflows received prior to the termination of a project.

5. To eliminate the reinvestment rate assumption of the IRR, some practitioners calculate the *modified internal rate of return (MIRR)*. The MIRR is found by converting each operating cash inflow to its future value measured at the end of the project's life and then summing the future values of all inflows to get the project's *terminal value*. Each future value is found by using the cost of capital, thereby eliminating the reinvestment rate criticism of the traditional IRR. The MIRR represents the discount rate that causes the terminal value just to equal the initial investment. Because it uses the cost of capital as the reinvestment rate, the MIRR is generally viewed as a better measure of a project's true profitability than the IRR. Although this technique is frequently used in commercial real estate valuation and is a preprogrammed function on some sophisticated financial calculators, its failure to resolve the issue of conflicting rankings and its theoretical inferiority to NPV have resulted in the MIRR receiving only limited attention and acceptance in the financial literature. For a thorough analysis of the arguments surrounding IRR and MIRR, see D. Anthony Plath and William F. Kennedy, "Teaching Return-Based Measures of Project Evaluation," *Financial Practice and Education* (Spring/Summer 1994), pp. 77–86.

**TABLE 9.5** Reinvestment Rate Comparisons for a Project<sup>a</sup>

Year (1)	Cash inflows (2)	Number of years earning interest ( <i>t</i> ) [3 - (1)] (3)	Reinvestment rate			
			10%		15%	
			<i>FVIF</i> <sub>10%,<i>t</i></sub> (4)	Future value [(2) × (4)] (5)	<i>FVIF</i> <sub>15%,<i>t</i></sub> (6)	Future value [(2) × (6)] (7)
1	\$ 52,000	2	1.210	\$ 62,920	1.323	\$ 68,796
2	78,000	1	1.100	85,800	1.150	89,700
3	100,000	0	1.000	<u>100,000</u>	1.000	<u>100,000</u>
Future value end of year 3				<u>\$248,720</u>		<u>\$258,496</u>

NPV @ 10% = \$16,867

IRR = 15%

<sup>a</sup>Initial investment in this project is \$170,000.**EXAMPLE**

A project requiring a \$170,000 initial investment is expected to provide operating cash inflows of \$52,000, \$78,000, and \$100,000 at the end of each of the next 3 years. The NPV of the project (at the firm's 10% cost of capital) is \$16,867 and its IRR is 15%. Clearly, the project is acceptable (NPV = \$16,867 > \$0 and IRR = 15% > 10% cost of capital). Table 9.5 demonstrates calculation of the project's future value at the end of its 3-year life, assuming both a 10% (its cost of capital) and a 15% (its IRR) rate of return. A future value of \$248,720 results from reinvestment at the 10% cost of capital (total in column 5), and a future value of \$258,496 results from reinvestment at the 15% IRR (total in column 7).

If the future value in each case in Table 9.5 were viewed as the return received 3 years from today from the \$170,000 initial investment, the cash flows would be those given in Table 9.6. The NPVs and IRRs in each case are shown below the cash flows in Table 9.6. You can see that at the 10% reinvestment rate, the NPV remains at \$16,867; reinvestment at the 15% IRR produces an NPV of \$24,213.

From this result, it should be clear that the NPV technique assumes reinvestment at the cost of capital (10% in this example). (Note that with reinvestment at 10%, the IRR would be 13.5%.) On the other hand, the IRR technique assumes an ability to reinvest intermediate cash inflows at the IRR. If reinvestment does not occur at this rate, the IRR will differ from 15%. Reinvestment at a rate below the IRR would result in an IRR below that calculated (at 13.5%, for example, if the reinvestment rate were only 10%). Reinvestment at a rate above the IRR would result in an IRR above that calculated.

In general, projects with similar-size investments and lower cash inflows in the early years tend to be preferred at lower discount rates.<sup>6</sup> Projects that have

6. Because differences in the relative sizes of initial investments can also affect conflicts in rankings, the initial investments are assumed to be similar. This permits isolation of the effect of differences in the magnitude and timing of cash inflows on project rankings.



**TABLE 9.6** Project Cash Flows After Reinvestment

	Reinvestment Rate	
	10%	15%
Initial investment	\$170,000	
Year	Operating cash inflows	
1	\$ 0	\$ 0
2	0	0
3	248,720	258,496
NPV @ 10%	\$ 16,867	\$ 24,213
IRR	13.5%	15.0%

higher cash inflows in the early years tend to be preferred at higher discount rates. Why? Because at high discount rates, later-year cash inflows tend to be severely penalized in present value terms. For example, at a high discount rate, say 20 percent, the present value of \$1 received at the end of 5 years is about 40 cents, whereas for \$1 received at the end of 15 years it is less than 7 cents. Clearly, at high discount rates a project's early-year cash inflows count most in terms of its NPV. Table 9.7 summarizes the preferences associated with extreme discount rates and dissimilar cash inflow patterns.

**EXAMPLE** ▼ Bennett Company's projects A and B were found to have conflicting rankings at the firm's 10% cost of capital (as depicted in Figure 9.4). If we review each project's cash inflow pattern as presented in Table 9.1 and Figure 9.1, we see that although the projects require similar initial investments, they have dissimilar cash inflow patterns. Table 9.7 indicates that project B, which has higher early-year cash inflows than project A, would be preferred over project A at higher discount rates. Figure 9.4 shows that this is in fact the case. At any discount rate in excess

**TABLE 9.7** Preferences Associated with Extreme Discount Rates and Dissimilar Cash Inflow Patterns

Discount rate	Cash inflow pattern	
	Lower early-year cash inflows	Higher early-year cash inflows
Low	Preferred	Not preferred
High	Not preferred	Preferred

of 10.7%, project B's NPV is above that of project A. Clearly, the magnitude and timing of the projects' cash inflows do affect their rankings.

Although the classification of cash inflow patterns in Table 9.7 is useful in explaining conflicting rankings, differences in the magnitude and timing of cash inflows do not guarantee conflicts in ranking. In general, the greater the difference between the magnitude and timing of cash inflows, the greater the likelihood of conflicting rankings. Conflicts based on NPV and IRR can be reconciled computationally; to do so, one creates and analyzes an incremental project reflecting the difference in cash flows between the two mutually exclusive projects. Because a detailed description of this procedure is beyond the scope of an introductory text, suffice it to say that IRR techniques can be used to generate consistently the same project rankings as those obtained by using NPV.

### Which Approach Is Better?

It is difficult to choose one approach over the other, because the theoretical and practical strengths of the approaches differ. It is therefore wise to view both NPV and IRR techniques in each of those dimensions.

#### Theoretical View

*On a purely theoretical basis, NPV is the better approach to capital budgeting as a result of several factors. Most important is that the use of NPV implicitly assumes that any intermediate cash inflows generated by an investment are reinvested at the firm's cost of capital. The use of IRR assumes reinvestment at the often high rate specified by the IRR. Because the cost of capital tends to be a reasonable estimate of the rate at which the firm could actually reinvest intermediate cash inflows, the use of NPV, with its more conservative and realistic reinvestment rate, is in theory preferable.*

In addition, certain mathematical properties may cause a project with a non-conventional cash flow pattern to have zero or more than one *real* IRR; this problem does not occur with the NPV approach.

#### Practical View

Evidence suggests that in spite of the theoretical superiority of NPV, *financial managers prefer to use IRR.*<sup>7</sup> The preference for IRR is due to the general disposition of businesspeople toward *rates of return* rather than actual *dollar returns*. Because interest rates, profitability, and so on are most often expressed as annual rates of return, the use of IRR makes sense to financial decision makers. They tend to find NPV less intuitive because it does not measure benefits *relative to the*

7. For example, see Harold Bierman, Jr., "Capital Budgeting in 1992: A Survey," *Financial Management* (Autumn 1993), p. 24, and Lawrence J. Gitman and Charles E. Maxwell, "A Longitudinal Comparison of Capital Budgeting Techniques Used by Major U.S. Firms: 1986 versus 1976," *Journal of Applied Business Research* (Fall 1987), pp. 41–50, for discussions of evidence with respect to capital budgeting decision-making practices in major U.S. firms.

*amount invested.* Because a variety of techniques are available for avoiding the pitfalls of the IRR, its widespread use does not imply a lack of sophistication on the part of financial decision makers.

## Review Questions

- 9–9 How is a *net present value profile* used to compare projects? What causes conflicts in the ranking of projects via net present value and internal rate of return?
- 9–10 Does the assumption concerning the reinvestment of intermediate cash inflow tend to favor NPV or IRR? In practice, which technique is preferred and why?

# SUMMARY

## FOCUS ON VALUE

After estimating the relevant cash flows, the financial manager must apply appropriate decision techniques to assess whether the project creates value for shareholders. Net present value (NPV) and internal rate of return (IRR) are the generally preferred capital budgeting techniques. Both use the cost of capital as the required return needed to compensate shareholders for undertaking projects with the same risk as that of the firm. The appeal of NPV and IRR stems from the fact that both indicate whether a proposed investment creates or destroys shareholder value.

NPV clearly indicates the expected dollar amount of wealth creation from a proposed project, whereas IRR provides the same accept-or-reject decision as NPV. As a consequence of some fundamental differences, NPV and IRR do not necessarily rank projects the same. Although the potential conflicting rankings can be reconciled, NPV is the theoretically preferred approach. In practice, however, IRR is preferred because of its intuitive appeal. Regardless, the application of NPV and IRR to good estimates of relevant cash flows should enable the financial manager to recommend projects that are consistent with the firm's goals of **maximizing stock price**.

## REVIEW OF LEARNING GOALS

**LG1** Understand the role of capital budgeting techniques in the capital budgeting process. Capital budgeting techniques are used to analyze and assess project acceptability and ranking. They are applied to each project's relevant cash flows to select capital expenditures that are consistent with the firm's goal of maximizing owners' wealth.

**LG2** Calculate, interpret, and evaluate the payback period. The payback period is the amount of time required for the firm to recover its initial investment, as calculated from cash inflows. The formula and decision criteria for the payback period are summarized in Table 9.8. Shorter payback periods are preferred. The payback period's strengths

include ease of calculation, simple intuitive appeal, its consideration of cash flows, its implicit consideration of timing, and its ability to measure risk exposure. Its weaknesses include its lack of linkage to the wealth maximization goal, its failure to consider time value explicitly, and the fact that it ignores cash flows that occur after the payback period.

**LG3** Calculate, interpret, and evaluate the net present value (NPV). Because it gives explicit consideration to the time value of money, NPV is considered a sophisticated capital budgeting technique. The key formula and decision criteria for NPV are summarized in Table 9.8. In calculating NPV, the rate at which cash flows are discounted is often called the discount rate, required return, cost of capital, or opportunity cost. By whatever name, this rate represents the minimum return that must be earned on a project to leave the firm's market value unchanged.

**LG4** Calculate, interpret, and evaluate the internal rate of return (IRR). Like NPV, IRR is a sophisticated capital budgeting technique because it explicitly considers the time value of money. The key formula and decision criteria for IRR are summarized in Table 9.8. IRR can be viewed as the

compound annual rate of return that the firm will earn if it invests in a project and receives the given cash inflows. By accepting only those projects with IRRs in excess of the firm's cost of capital, the firm should enhance its market value and the wealth of its owners. Both NPV and IRR yield the same accept–reject decisions, but they often provide conflicting ranks.

**LG5** Use net present value profiles to compare NPV and IRR techniques. A net present value profile is a graph that depicts the projects' NPVs for various discount rates. It is useful in comparing projects, especially when NPV and IRR yield conflicting rankings. The NPV profile is prepared by developing a number of “discount rate–net present value” coordinates, often using discount rates of 0 percent, the cost of capital, and the IRR for each project, and then plotting them on the same set of discount-rate–NPV axes.

**LG6** Discuss NPV and IRR in terms of conflicting rankings and the theoretical and practical strengths of each approach. Conflicting rankings of projects frequently emerge from NPV and IRR, as a result of differences in the magnitude and timing of each project's cash flows. The underlying cause is the differing implicit assumptions of NPV and IRR

**TABLE 9.8** Summary of Key Formulas/Definitions and Decision Criteria for Capital Budgeting Techniques

Technique	Formula/definition	Decision criteria
Payback period <sup>a</sup>	<p><i>For annuity:</i></p> $\frac{\text{Initial investment}}{\text{Annual cash inflow}}$ <p><i>For mixed stream:</i> Calculate cumulative cash inflows on year-to-year basis until the initial investment is recovered.</p>	<p><i>Accept if</i> &lt; maximum acceptable payback period.</p> <p><i>Reject if</i> &gt; maximum acceptable payback period.</p>
Net present value (NPV) <sup>b</sup>	Present value of cash inflows – Initial investment.	<p><i>Accept if</i> &gt; \$0.</p> <p><i>Reject if</i> &lt; \$0.</p>
Internal rate of return (IRR) <sup>b</sup>	The discount rate that causes NPV = \$0 (present value of cash inflows equals the initial investment).	<p><i>Accept if</i> &gt; the cost of capital.</p> <p><i>Reject if</i> &lt; the cost of capital.</p>

<sup>a</sup>Unsophisticated technique, because it does not give explicit consideration to the time value of money.

<sup>b</sup>Sophisticated technique, because it gives explicit consideration to the time value of money.

with regard to the reinvestment of intermediate cash inflows—cash inflows received prior to termination of a project. NPV assumes reinvestment of intermediate cash inflows at the more conservative cost of capital, whereas IRR assumes reinvestment at the project's IRR. On a purely theoretical basis, NPV is preferred over IRR, because NPV assumes the more

conservative reinvestment rate and does not exhibit the mathematical problems that often occur when IRRs are calculated for nonconventional cash flows. In practice, however, the IRR is more commonly used because it is consistent with the general preference for rates of return.

## SELF-TEST PROBLEM (Solution in Appendix B)



**ST 9-1 All techniques with NPV profile—Mutually exclusive projects** Fitch Industries is in the process of choosing the better of two equal-risk, mutually exclusive capital expenditure projects—M and N. The relevant cash flows for each project are shown in the following table. The firm's cost of capital is 14%.

	Project M	Project N
Initial investment ( $CF_0$ )	\$28,500	\$27,000
Year ( $t$ )	Cash inflows ( $CF_t$ )	
1	\$10,000	\$11,000
2	10,000	10,000
3	10,000	9,000
4	10,000	8,000

- Calculate each project's payback period.
- Calculate the net present value (NPV) for each project.
- Calculate the internal rate of return (IRR) for each project.
- Summarize the preferences dictated by each measure you calculated, and indicate which project you would recommend. Explain why.
- Draw the net present value profiles for these projects on the same set of axes, and explain the circumstances under which a conflict in rankings might exist.

## PROBLEMS



**9-1 Payback period** Jordan Enterprises is considering a capital expenditure that requires an initial investment of \$42,000 and returns after-tax cash inflows of \$7,000 per year for 10 years. The firm has a maximum acceptable payback period of 8 years.

- Determine the payback period for this project.
- Should the company accept the project? Why or why not?



**9-2 Payback comparisons** Nova Products has a 5-year maximum acceptable payback period. The firm is considering the purchase of a new machine and must

choose between two alternative ones. The first machine requires an initial investment of \$14,000 and generates annual after-tax cash inflows of \$3,000 for each of the next 7 years. The second machine requires an initial investment of \$21,000 and provides an annual cash inflow after taxes of \$4,000 for 20 years.

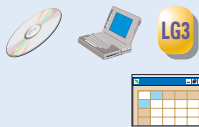
- Determine the payback period for each machine.
- Comment on the acceptability of the machines, assuming that they are independent projects.
- Which machine should the firm accept? Why?
- Do the machines in this problem illustrate any of the weaknesses of using payback? Discuss.



- 9-3 Choosing between two projects with acceptable payback periods** Shell Camping Gear, Inc., is considering two mutually exclusive projects. Each requires an initial investment of \$100,000. John Shell, president of the company, has set a maximum payback period of 4 years. The after-tax cash inflows associated with each project are as follows:

Year	Cash inflows ( $CF_t$ )	
	Project A	Project B
1	\$10,000	\$40,000
2	20,000	30,000
3	30,000	20,000
4	40,000	10,000
5	20,000	20,000

- Determine the payback period of each project.
- Because they are mutually exclusive, Shell must choose one. Which should the company invest in?
- Explain why one of the projects is a better choice than the other.



- 9-4 NPV** Calculate the net present value (NPV) for the following 20-year projects. Comment on the acceptability of each. Assume that the firm has an opportunity cost of 14%.

- Initial investment is \$10,000; cash inflows are \$2,000 per year.
- Initial investment is \$25,000; cash inflows are \$3,000 per year.
- Initial investment is \$30,000; cash inflows are \$5,000 per year.



- 9-5 NPV for varying costs of capital** Dane Cosmetics is evaluating a new fragrance-mixing machine. The machine requires an initial investment of \$24,000 and will generate after-tax cash inflows of \$5,000 per year for 8 years. For each of the costs of capital listed, (1) calculate the net present value (NPV), (2) indicate whether to accept or reject the machine, and (3) explain your decision.

- The cost of capital is 10%.
- The cost of capital is 12%.
- The cost of capital is 14%.



- 9-6 **Net present value—Independent projects** Using a 14% cost of capital, calculate the net present value for each of the independent projects shown in the following table, and indicate whether each is acceptable.

	Project A	Project B	Project C	Project D	Project E
Initial investment ( $CF_0$ )	\$26,000	\$500,000	\$170,000	\$950,000	\$80,000
Year ( $t$ )	Cash inflows ( $CF_t$ )				
1	\$4,000	\$100,000	\$20,000	\$230,000	\$ 0
2	4,000	120,000	19,000	230,000	0
3	4,000	140,000	18,000	230,000	0
4	4,000	160,000	17,000	230,000	20,000
5	4,000	180,000	16,000	230,000	30,000
6	4,000	200,000	15,000	230,000	0
7	4,000		14,000	230,000	50,000
8	4,000		13,000	230,000	60,000
9	4,000		12,000		70,000
10	4,000		11,000		

- 9-7 **NPV** Simes Innovations, Inc., is negotiating to purchase exclusive rights to manufacture and market a solar-powered toy car. The car's inventor has offered Simes the choice of either a one-time payment of \$1,500,000 today or a series of 5 year-end payments of \$385,000.
- If Simes has a cost of capital of 9%, which form of payment should the company choose?
  - What yearly payment would make the two offers identical in value at a cost of capital of 9%?
  - Would your answer to part a of this problem be different if the yearly payments were made at the beginning of each year? Show what difference, if any, that change in timing would make to the present value calculation.
  - The after-tax cash inflows associated with this purchase are projected to amount to \$250,000 per year for 15 years. Will this factor change the firm's decision about how to fund the initial investment?



- 9-8 **NPV and maximum return** A firm can purchase a fixed asset for a \$13,000 initial investment. The asset generates an annual after-tax cash inflow of \$4,000 for 4 years.
- Determine the net present value (NPV) of the asset, assuming that the firm has a 10% cost of capital. Is the project acceptable?
  - Determine the maximum required rate of return (closest whole-percentage rate) that the firm can have and still accept the asset. Discuss this finding in light of your response in part a.

- 9-9 **NPV—Mutually exclusive projects** Hook Industries is considering the replacement of one of its old drill presses. Three alternative replacement presses are

under consideration. The relevant cash flows associated with each are shown in the following table. The firm's cost of capital is 15%.

	Press A	Press B	Press C
Initial investment ( $CF_0$ )	\$85,000	\$60,000	\$130,000
Year ( $t$ )	Cash inflows ( $CF_t$ )		
1	\$18,000	\$12,000	\$50,000
2	18,000	14,000	30,000
3	18,000	16,000	20,000
4	18,000	18,000	20,000
5	18,000	20,000	20,000
6	18,000	25,000	30,000
7	18,000	—	40,000
8	18,000	—	50,000

- Calculate the net present value (NPV) of each press.
- Using NPV, evaluate the acceptability of each press.
- Rank the presses from best to worst using NPV.



- 9–10 Payback and NPV** Neil Corporation has three projects under consideration. The cash flows for each of them are shown in the following table. The firm has a 16% cost of capital.

	Project A	Project B	Project C
Initial investment ( $CF_0$ )	\$40,000	\$40,000	\$40,000
Year ( $t$ )	Cash inflows ( $CF_t$ )		
1	\$13,000	\$ 7,000	\$19,000
2	13,000	10,000	16,000
3	13,000	13,000	13,000
4	13,000	16,000	10,000
5	13,000	19,000	7,000

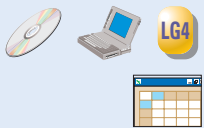
- Calculate each project's payback period. Which project is preferred according to this method?
- Calculate each project's net present value (NPV). Which project is preferred according to this method?
- Comment on your findings in parts **a** and **b**, and recommend the best project. Explain your recommendation.



- 9–11 Internal rate of return** For each of the projects shown in the following table, calculate the internal rate of return (IRR). Then indicate, for each project, the maximum cost of capital that the firm could have and still find the IRR acceptable.



	Project A	Project B	Project C	Project D
Initial investment ( $CF_0$ )	\$90,000	\$490,000	\$20,000	\$240,000
Year ( $t$ )	Cash inflows ( $CF_t$ )			
1	\$20,000	\$150,000	\$7,500	\$120,000
2	25,000	150,000	7,500	100,000
3	30,000	150,000	7,500	80,000
4	35,000	150,000	7,500	60,000
5	40,000	—	7,500	—



**9–12 IRR—Mutually exclusive projects** Bell Manufacturing is attempting to choose the better of two mutually exclusive projects for expanding the firm’s warehouse capacity. The relevant cash flows for the projects are shown in the following table. The firm’s cost of capital is 15%.

	Project X	Project Y
Initial investment ( $CF_0$ )	\$500,000	\$325,000
Year ( $t$ )	Cash inflows ( $CF_t$ )	
1	\$100,000	\$140,000
2	120,000	120,000
3	150,000	95,000
4	190,000	70,000
5	250,000	50,000

- Calculate the IRR to the nearest whole percent for each of the projects.
- Assess the acceptability of each project on the basis of the IRRs found in part a.
- Which project, on this basis, is preferred?



**9–13 IRR, investment life, and cash inflows** Oak Enterprises accepts projects earning more than the firm’s 15% cost of capital. Oak is currently considering a 10-year project that provides annual cash inflows of \$10,000 and requires an initial investment of \$61,450. (*Note:* All amounts are after taxes.)

- Determine the IRR of this project. Is it acceptable?
- Assuming that the cash inflows continue to be \$10,000 per year, how many *additional years* would the flows have to continue to make the project acceptable (that is, to make it have an IRR of 15%)?
- With the given life, initial investment, and cost of capital, what is the minimum annual cash inflow that the firm should accept?



**9–14 NPV and IRR** Benson Designs has prepared the following estimates for a long-term project it is considering. The initial investment is \$18,250, and the project is expected to yield after-tax cash inflows of \$4,000 per year for 7 years. The firm has a 10% cost of capital.

- Determine the net present value (NPV) for the project.
- Determine the internal rate of return (IRR) for the project.

- c. Would you recommend that the firm accept or reject the project? Explain your answer.



LG3

- 9–15 **NPV, with rankings** Botany Bay, Inc., a maker of casual clothing, is considering four projects. Because of past financial difficulties, the company has a high cost of capital at 15%. Which of these projects would be acceptable under those cost circumstances?

	Project A	Project B	Project C	Project D
Initial investment ( $CF_0$ )	\$50,000	\$100,000	\$80,000	\$180,000
Year ( $t$ )	Cash inflows ( $CF_t$ )			
1	\$20,000	\$35,000	\$20,000	\$100,000
2	20,000	50,000	40,000	80,000
3	20,000	50,000	60,000	60,000

- a. Calculate the NPV of each project, using a cost of capital of 15%.  
 b. Rank acceptable projects by NPV.  
 c. At what approximate cost of capital would all of the projects be acceptable?

LG2

LG3

LG4



- 9–16 **All techniques, conflicting rankings** Nicholson Roofing Materials, Inc., is considering two mutually exclusive projects, each with an initial investment of \$150,000. The company's board of directors has set a 4-year payback requirement and has set its cost of capital at 9%. The cash inflows associated with the two projects are as follows:

Year	Cash inflows ( $CF_t$ )	
	Project A	Project B
1	\$45,000	\$75,000
2	45,000	60,000
3	45,000	30,000
4	45,000	30,000
5	45,000	30,000
6	45,000	30,000

- a. Calculate the payback period for each project.  
 b. Calculate the NPV of each project at 0%.  
 c. Calculate the NPV of each project at 9%.  
 d. Derive the IRR of each project.  
 e. Rank the projects by each of the techniques used. Make and justify a recommendation.

LG2

LG3



- 9–17 **Payback, NPV, and IRR** Rieger International is attempting to evaluate the feasibility of investing \$95,000 in a piece of equipment that has a 5-year life. The firm has estimated the *cash inflows* associated with the proposal as shown in the following table. The firm has a 12% cost of capital.

Year ( $t$ )	Cash inflows ( $CF_t$ )
1	\$20,000
2	25,000
3	30,000
4	35,000
5	40,000

- Calculate the payback period for the proposed investment.
- Calculate the net present value (NPV) for the proposed investment.
- Calculate the internal rate of return (IRR), rounded to the nearest whole percent, for the proposed investment.
- Evaluate the acceptability of the proposed investment using NPV and IRR. What recommendation would you make relative to implementation of the project? Why?



**9–18 NPV, IRR, and NPV profiles** Thomas Company is considering two mutually exclusive projects. The firm, which has a 12% cost of capital, has estimated its cash flows as shown in the following table.

	Project A	Project B
Initial investment ( $CF_0$ )	\$130,000	\$85,000
Year ( $t$ )	Cash inflows ( $CF_t$ )	
1	\$25,000	\$40,000
2	35,000	35,000
3	45,000	30,000
4	50,000	10,000
5	55,000	5,000

- Calculate the NPV of each project, and assess its acceptability.
- Calculate the IRR for each project, and assess its acceptability.
- Draw the NPV profiles for both projects on the same set of axes.
- Evaluate and discuss the rankings of the two projects on the basis of your findings in parts a, b, and c.
- Explain your findings in part d in light of the pattern of cash inflows associated with each project.



**9–19 All techniques—Decision among mutually exclusive investments** Pound Industries is attempting to select the best of three mutually exclusive projects. The initial investment and after-tax cash inflows associated with these projects are shown in the following table.

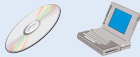
Cash flows	Project A	Project B	Project C
Initial investment ( $CF_0$ )	\$60,000	\$100,000	\$110,000
Cash inflows ( $CF_t$ ), $t = 1$ to 5	\$20,000	\$ 31,500	\$ 32,500

- Calculate the payback period for each project.

- Calculate the net present value (NPV) of each project, assuming that the firm has a cost of capital equal to 13%.
- Calculate the internal rate of return (IRR) for each project.
- Draw the net present value profiles for both projects on the same set of axes, and discuss any conflict in ranking that may exist between NPV and IRR.
- Summarize the preferences dictated by each measure, and indicate which project you would recommend. Explain why.



9–20 **All techniques with NPV profile—Mutually exclusive projects** Projects A and B, of equal risk, are alternatives for expanding the Rosa Company's capacity. The firm's cost of capital is 13%. The cash flows for each project are shown in the following table.



	Project A	Project B
Initial investment ( $CF_0$ )	\$80,000	\$50,000
Year ( $t$ )	Cash inflows ( $CF_t$ )	
1	\$15,000	\$15,000
2	20,000	15,000
3	25,000	15,000
4	30,000	15,000
5	35,000	15,000

- Calculate each project's payback period.
- Calculate the net present value (NPV) for each project.
- Calculate the internal rate of return (IRR) for each project.
- Draw the net present value profiles for both projects on the same set of axes, and discuss any conflict in ranking that may exist between NPV and IRR.
- Summarize the preferences dictated by each measure, and indicate which project you would recommend. Explain why.



9–21 **Integrative—Complete investment decision** Wells Printing is considering the purchase of a new printing press. The total installed cost of the press is \$2.2 million. This outlay would be partially offset by the sale of an existing press. The old press has zero book value, cost \$1 million 10 years ago, and can be sold currently for \$1.2 million before taxes. As a result of acquisition of the new press, sales in each of the next 5 years are expected to increase by \$1.6 million, but product costs (excluding depreciation) will represent 50% of sales. The new press will not affect the firm's net working capital requirements. The new press will be depreciated under MACRS using a 5-year recovery period (see Table 3.2 on page 100). The firm is subject to a 40% tax rate on both ordinary income and capital gains. Wells Printing's cost of capital is 11%. (*Note:* Assume that both the old and the new press will have terminal values of \$0 at the end of year 6.)



- Determine the initial investment required by the new press.
- Determine the operating cash inflows attributable to the new press. (*Note:* Be sure to consider the depreciation in year 6.)
- Determine the payback period.
- Determine the net present value (NPV) and the internal rate of return (IRR) related to the proposed new press.

- e. Make a recommendation to accept or reject the new press, and justify your answer.



- 9–22 **Integrative—Investment decision** Holliday Manufacturing is considering the replacement of an existing machine. The new machine costs \$1.2 million and requires installation costs of \$150,000. The existing machine can be sold currently for \$185,000 before taxes. It is 2 years old, cost \$800,000 new, and has a \$384,000 book value and a remaining useful life of 5 years. It was being depreciated under MACRS using a 5-year recovery period (see Table 3.2 on page 100) and therefore has the final 4 years of depreciation remaining. If it is held until the end of 5 years, the machine's market value will be \$0. Over its 5-year life, the new machine should reduce operating costs by \$350,000 per year. The new machine will be depreciated under MACRS using a 5-year recovery period (see Table 3.2 on page 100). The new machine can be sold for \$200,000 net of removal and clean up costs at the end of 5 years. An increased investment in net working capital of \$25,000 will be needed to support operations if the new machine is acquired. Assume that the firm has adequate operating income against which to deduct any loss experienced on the sale of the existing machine. The firm has a 9% cost of capital and is subject to a 40% tax rate on both ordinary income and capital gains.
- Develop the relevant cash flows needed to analyze the proposed replacement.
  - Determine the net present value (NPV) of the proposal.
  - Determine the internal rate of return (IRR) of the proposal.
  - Make a recommendation to accept or reject the replacement proposal, and justify your answer.
  - What is the highest cost of capital that the firm could have and still accept the proposal? Explain.

## CHAPTER 9 CASE

### Making Norwich Tool's Lathe Investment Decision

Norwich Tool, a large machine shop, is considering replacing one of its lathes with either of two new lathes—lathe A or lathe B. Lathe A is a highly automated, computer-controlled lathe; lathe B is a less expensive lathe that uses standard technology. To analyze these alternatives, Mario Jackson, a financial analyst, prepared estimates of the initial investment and incremental (relevant) cash inflows associated with each lathe. These are shown in the following table.

	Lathe A	Lathe B
Initial investment ( $CF_0$ )	\$660,000	\$360,000
Year ( $t$ )	Cash inflows ( $CF_t$ )	
1	\$128,000	\$ 88,000
2	182,000	120,000
3	166,000	96,000
4	168,000	86,000
5	450,000	207,000

Note that Mario plans to analyze both lathes over a 5-year period. At the end of that time, the lathes would be sold, thus accounting for the large fifth-year cash inflows.

Mario believes that the two lathes are equally risky and that the acceptance of either of them will not change the firm's overall risk. He therefore decides to apply the firm's 13% cost of capital when analyzing the lathes. Norwich Tool requires all projects to have a maximum payback period of 4.0 years.

### Required



- Use the payback period to assess the acceptability and relative ranking of each lathe.
- Assuming equal risk, use the following sophisticated capital budgeting techniques to assess the acceptability and relative ranking of each lathe:
  - Net present value (NPV).
  - Internal rate of return (IRR).
- Summarize the preferences indicated by the techniques used in parts a and b. Do the projects have conflicting rankings?
- Draw the net present value profiles for both projects on the same set of axes, and discuss any conflict in rankings that may exist between NPV and IRR. Explain any observed conflict in terms of the relative differences in the magnitude and timing of each project's cash flows.
- Use your findings in parts a through d to indicate, on both (1) a theoretical and (2) a practical basis, which lathe would be preferred. Explain any difference in recommendations.

### WEB EXERCISE



Go to the Web site [www.arachnoid.com/lutus/p/finance\\_old.html](http://www.arachnoid.com/lutus/p/finance_old.html). Page down to the portion of this screen that contains the financial calculator.

- To determine the internal rate of return (IRR) of a project whose initial investment was \$5,000 and whose cash inflows are \$1,000 per year for the next 10 years, perform the steps outlined below. By entering various interest rates, you will eventually get a present value of \$5,000. When this happens you have determined the IRR of the project.  
To get started, into **PV**, enter 0; into **FV**, enter 0; into **np**, enter 1000; into **pmt**, enter 10; and then into **ir**, enter 8. Click on **Calculate PV**. This gives you a number much greater than \$5,000. Now change **ir** to 20 and then click on **Calculate PV**. Keeping changing the **ir** until  $PV = \$5,000$ , the same as the initial investment.
- Try another project. The initial investment is \$10,000. The cash inflows are \$2,500 per year for the next 6 years. What is its IRR?
- To calculate the IRR of an investment of \$3,000 with a single cash inflow of \$4,800 to be received exactly 3 years after the investment, do the following: Into **FV**, enter 4800; into **np**, enter 3; into **pmt**, enter 0; and then into **ir**, enter 8. Then click on **Calculate PV**. As before, keep changing **ir** until the **PV** is equal to the initial investment of \$3,000. What is this investment's IRR?

**Remember to check the book's Web site at**

[www.aw.com/gitman](http://www.aw.com/gitman)

**for additional resources, including additional Web exercises.**