Chapter 11

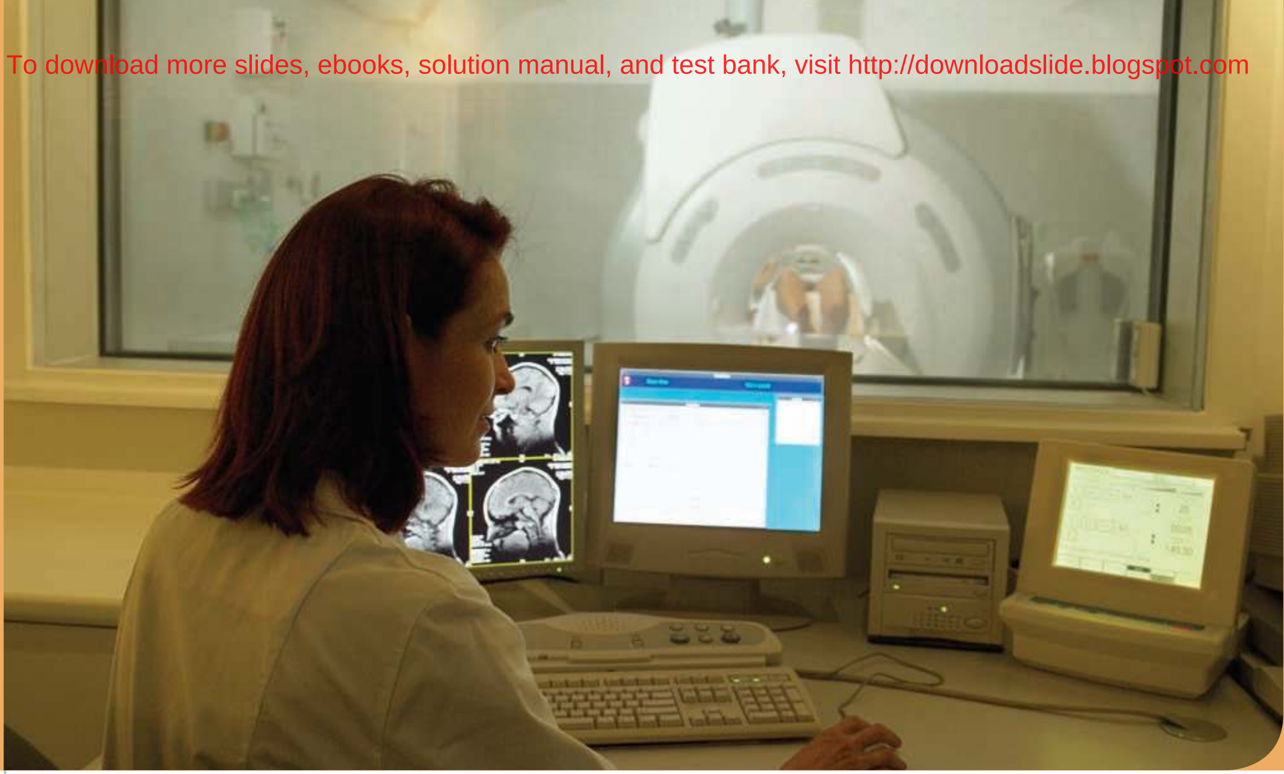
Managing Long-Lived Resources: Capital Budgeting

AS THE CHIEF ADMINISTRATOR OF St. Vincent's Hospital, Dr. Maria Rodriguez is facing increasing pressure to acquire magnetic resonance imaging (MRI) equipment. St. Vincent's patients now get the needed tests done at a nearby hospital. However, Dr. Rodriguez knows that St. Vincent's patients often must endure long waits for their appointments. She is concerned that these delays could tarnish St. Vincent's reputation and erode its customer base. Preliminary inquiries indicate that setting up an MRI facility, which has an estimated life of 10 years, will require an outlay of $1.5 million.

Before committing to such a large expenditure, Dr. Rodriguez needs to know whether St. Vincent's would recoup the $1.5 million through future benefits. She also needs to ensure that purchasing the MRI equipment is the best use of St. Vincent's limited capital.

APPLYING THE DECISION FRAMEWORK

What Is the Problem?	Dr. Rodriguez of St. Vincent's Hospital wonders whether it is worthwhile to acquire magnetic resonance imaging (MRI) equipment.
What Are the Options?	The options are to acquire MRI equipment or to continue with the current arrangement of patients getting the tests done at a nearby hospital.
What Are the Costs and Benefits?	The new MRI equipment will require a large up-front expenditure. In addition, the hospital will incur both variable and fixed operating costs. However, St. Vincent's will increase its revenue. Additional considerations include more timely diagnosis and treatment, and increased customer satisfaction, as well as the potential increase in exposure to a malpractice suit.
Make the Decision!	Using the tools for capital budgeting, we will estimate the financial impact of acquiring the MRI equipment. Based on our analysis, along with an understanding of the nonfinancial factors, we will be able to recommend a course of action for Dr. Rodriguez.



Hans Neleman/Getty Images

Dr. Rodriguez of St. Vincent's is considering whether to invest in MRI equipment.

LEARNING OBJECTIVES

After studying this chapter, you will be able to:

1. Understand the reasons for capital budgeting.
2. List the components of a project's cash flows.
3. Apply discounted cash flow techniques.
4. Compare various methods for evaluating projects.
5. Explain the role of taxes and the depreciation tax shield in project evaluation.
6. Describe issues in allocating scarce capital among projects.

In Chapters 9–10, we examined a number of long-term decisions involving the acquisition and disposal of capacity resources. In our discussions, however, we did not consider that money has a time value: a dollar today is worth more than a dollar tomorrow. We also did not consider that capacity resources are "lumpy." That is, capacity resources come in discrete sizes—we cannot buy part of a car or an MRI machine. These considerations are especially important in the acquisition of long-lived resources. In this chapter, we discuss capital budgeting, a tool that explicitly incorporates the time value of money and the lumpy nature of resources in decisions involving significant long-term investments.

We begin this chapter by examining why organizations use capital budgets to evaluate expenditures on long-lived, or capacity, resources and list the features of capital budgets. We then illustrate techniques such as net present value (NPV) and internal rate of return (IRR) analyses that firms use to evaluate projects. Next, we consider how taxes affect project value and address some qualitative issues that often do not enter into financial cost-benefit calculations. Finally, we discuss how a firm might allocate scarce capital among competing projects.

CHAPTER CONNECTIONS

Firms usually review their capital budgets at the same time they construct their operating budgets, the topic of Chapter 7. Such a linkage exists because the firm's cash budget needs to account for the outflows due to expenditures on capacity resources.

Roles of Capital Budgets

LEARNING OBJECTIVE 1

Understand the reasons for capital budgeting.

Just like St. Vincent's Hospital, organizations routinely face decisions involving significant outlays. Machines and equipment depreciate with use and need replacement. As markets grow, expenditures on new plants and machinery become necessary to exploit new opportunities. Every time Starbucks opens a new coffee shop, Chipotle opens a new restaurant, or Foley's opens a new department store, these firms incur substantial expenditures related to buying the necessary land, constructing a building or leasing store space, furnishing the store, purchasing equipment, and hiring staff. To judge whether such investments are worthwhile, we need to estimate the benefits and costs over many years. We also must decide whether a proposed investment is the best use of available funds, or whether we can put these funds to a more profitable use. **Capital budgeting** refers to the set of tools companies use to evaluate such large expenditures.

Before describing the mechanics of capital budgeting, let us first place capital budgeting in the context of earlier topics that we studied, including cost allocations and budgeting.

When firms open new stores, they evaluate cash inflows and outflows over a long time horizon. (Paul Sakuma/ ©AP/Wide World Photos)

CAPITAL BUDGETING AND COST ALLOCATIONS

In Chapters 9 and 10, we learned that cost allocations help us estimate the cost of capacity resources for long-term decisions related to people, products, customers, and resources. Despite the widespread use of allocations for decision making, they suffer from two drawbacks that are particularly important when evaluating long-lived resources. They do not account for either the time value of money or the lumpy nature of capacity resources.

The **time value of money** arises because a dollar today is worth more than a dollar tomorrow. To see why, suppose you invest a dollar today in a Certificate of Deposit (CD) that promises an annual return of 10%. When the certificate matures in a year, you will have $1.10. Thus, your dollar today is worth $1.10 a year from now. Conversely, $1.10 a year from now is only worth $1 now.

Intuitively, money is a productive asset. Its opportunity cost is the time value of money. Unlike cost allocations, capital budgeting explicitly considers this time value by **discounting** future cash inflows and outflows to their current or

present value. It allows us to express *all* future cash flows—cash flows occurring at *different* future points in time—in terms of their respective present values. This way, we can put these different cash flows on an equal footing and compare them.

It is easy to match supply and demand for some resources. We can buy raw materials and acquire electricity on an as needed basis. The amounts we purchase during a month or year closely match the amounts we need. However, it is difficult to match the supply and demand for capacity resources over a period of months or even years. The difficulty arises because many capacity resources are "**lumpy**." We cannot purchase half of a television set. St. Vincent's cannot buy three-fourths of an MRI machine. At some point, if you want to produce one more unit of a good, you need to purchase another piece of equipment and not just enough to make one more unit.

Cost allocations ignore the lumpy nature of capacity resources and estimate costs as if we can match supply and demand continuously and smoothly. However, capital budgeting techniques do not. These techniques consider the timing and magnitude of *all* of the cash inflows and outflows associated with resource acquisition, use, and disposal. Thus, particularly when evaluating large outflows, firms supplement their cost allocation estimates with capital budgeting techniques.

CAPITAL BUDGETS AND BUDGETING

Most companies prepare budgets for different time horizons—from short-term operating budgets to long-term strategic plans. Strategic plans span many years and flesh out how the firm's overall mission and core competencies will influence operations. These plans specify *how* the company intends to achieve its long-term objectives, and dictate *what* resources the firm needs to execute its plans. St. Vincent's strategic plans call for it to be the "preferred hospital in its market by providing personalized care for patients and their families." The MRI equipment would help St. Vincent's meet this goal.

Operating budgets, which we examined in Chapter 7, are short-term plans that aim for the maximum possible contribution from available capacity resources. As we know, short-term decisions treat capacity levels as fixed and capacity costs as noncontrollable. Once St. Vincent's acquires the MRI equipment, its capacity is fixed for decisions involving its utilization. The hospital will periodically review its own demand for MRI in order to decide whether to grant other hospitals access to it.

A capital budget links strategic and operating budgets. It helps determine *how much of each capacity resource an organization should acquire* and how it should invest its capital in specific assets such as plant, equipment, building, and technology. Whether to spend $1.5 million on MRI is a typical capital budgeting decision.

Like most firms, St. Vincent's performs capital budgeting in two steps. First, it identifies and evaluates individual investment proposals. Second, it prioritizes the proposals and decides which ones to execute. Just as operating budgets allocate the firm's productive capacity among products, capital budgets allocate scarce capital among available investment opportunities. Let us first consider how to evaluate an individual project.

CHAPTER CONNECTIONS

We discuss strategic planning and control in Chapter 13.

Connecting to Practice

Capital Budgeting at Stanford University Medical School

The School of Medicine (SOM) at Stanford University indicates that its "annual Capital Planning and Budgeting process occurs in four phases, progressing from more general and long-term plans to more specific annual budgets." These process phases are the University Capital Plan, SOM long-range forecast, SOM capital plan, and the SOM annual capital budget. Each of the phases lasts several months, with the phases executed sequentially, as the results of one phase provide the needed inputs into the next phase. The overall process is also iterative because the results of later evaluations cause the SOM to revisit earlier decisions.

Commentary: The SOM constructs its plans and budgets to be in tune with the university's plan. Similarly, divisions in firms such as General Motors and Johnson & Johnson construct their own plans, which are subject to corporate approval. Such layering of the capital budgeting process is common in large decentralized organizations.

Source: Medfacilities.stanford.edu/facilities/downloads/SoM_capital_plan_process.pdf (3/15/05)

Elements of Project Cash Flows

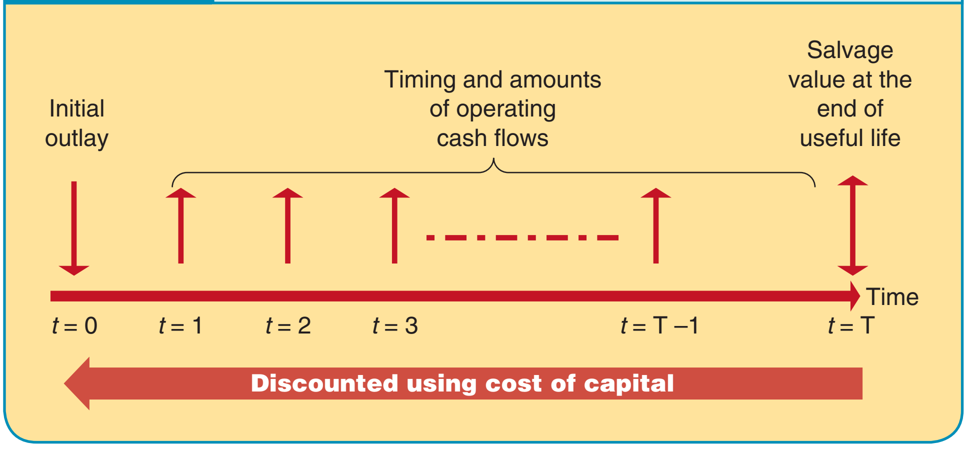
LEARNING OBJECTIVE 2

List the components of a project's cash flow.

Exhibit 11.1 highlights the four important elements of a capital-expenditure decision about a single project:

1. *Initial Outlay.* What are the costs associated with acquiring the resource and getting it ready for use?

Exhibit 11.1 *There Are Four Important Elements of a Project's Cash Flow*



2. *Estimated Life and Salvage Value.* How long do we expect to keep the resource? At the end of this period, are there any costs associated with disposing of the resource? Can we sell the resource to someone else when we are done with it?
3. *Timing and Amounts of Operating Cash Flows.* What are the expected operating expenses every year? What are the expected revenues or cost savings?
4. *Cost of Capital.* What is the opportunity cost of capital required for the proposed investment?

Let us examine each of these elements in more detail.

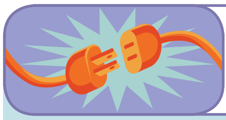
INITIAL OUTLAY

The **initial outlay** includes all costs incurred to ready the asset for its intended use. These costs include the purchase price, shipping and delivery costs, taxes, and any installation and training charges. For St. Vincent's, the initial investment of $1,500,000 includes all of these costs.

Just as we might sell our old car when buying a new car, firms often replace their old assets with new assets. The proceeds received from the sale of old assets would be deducted from the initial investment in arriving at cash outflow at time $t = 0$. In the case of St. Vincent's, this inflow is not applicable because it does not currently have its own MRI equipment.

ESTIMATED LIFE AND SALVAGE VALUE

Assets lose their productivity with use. They also become obsolete as new, more efficient technologies emerge. The MRI equipment considered by Dr. Rodriguez



Connecting to Practice

Leasing Capital Assets

IBM offers a sales-leaseback arrangement to its customers. As stated on the firm's Web site, with a sales-leaseback arrangement, "you actually sell your equipment—and transfer your title of ownership—to IBM Global Financing for the fair market value of the assets. Then you lease the equipment back at regular, low monthly payments over a flexible payment period. The cash or credit you receive can be used to acquire upgrades or new equipment, can be applied to your monthly payments, or used as you see fit. At the end of the lease term, you can choose to extend the lease, or simply transfer possession of the equipment to IBM Global Financing so you can replace it with the latest IT solutions. IBM Global Financing will even manage the disposal of your assets in accordance with EPA guidelines and U.S. federal, state, and local laws."

Commentary: The large initial outflow of capital prevents many firms from investing and upgrading capital equipment. Buying firms may also be reluctant to employ traditional methods such as a bank loan to borrow the money needed. As a liability on their balance sheet, the loan might adversely affect the firm's debt-to-equity ratio. Sellers of capital assets have devised several methods to finance the purchase, but without the implicit loan showing up in the buyer's book. IBM's offer is one such example.

represents cutting-edge technology and will last 10 years with little fear of obsolescence.

Using a reasonable and realistic estimate of life expectancy is important. Too low of an estimate understates the profitability of the investment and could result in the firm rejecting profitable opportunities. Too high of an estimate overstates the profitability of the investment and could lead to a wasteful use of scarce capital.

Firms also must consider an asset's salvage value when evaluating an investment. The **salvage value** is the residual value from disposing of the asset at the end of its useful life. While salvage value is often positive because it is a cash inflow from selling the asset, it could also be negative to mark a cash outflow. For example, to satisfy regulatory requirements, mining firms often incur significant expenses to restore the land to productive use after they stop extracting ore.

TIMING AND AMOUNTS OF OPERATING CASH FLOWS

Operating cash inflows increase directly through increased revenues. They also may increase indirectly through decreased outflows due to cost savings. When evaluating cash flows, a reduction in outflow is equivalent to an increase in inflow. Operating cash outflows typically include increases in variable costs that are proportional to the increase in revenue, increases in annual fixed costs related to hiring additional personnel, and costs associated with periodic repairs and maintenance.

Exhibit 11.2 presents the estimated cash inflows and outflows over the 10-year horizon for the MRI equipment. Dr. Rodriquez expects the following controllable cash inflows and outflows.

Exhibit 11.2 *St. Vincent's Hospital: Expected Cash Inflows and Outflows from the MRI Project*

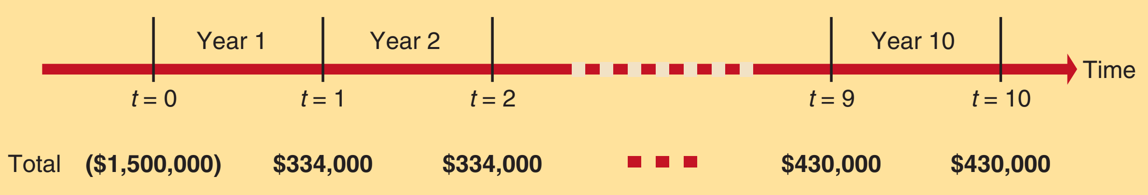
	Year 0	Cash Flow for Each of Years 1–3	Cash Flow for Each of Years 4–5	Cash Flow for Each of Years 6–10
Initial outlay	($1,500,000)			
Internal use (# of images)		2,400	2,400	2,400
Outside sales (# of images)		960	1,200	1,600
Cash inflows				
Internal use		$480,000	$480,000	$480,000
Outside sales		192,000	240,000	320,000
Total inflow		$672,000	$720,000	$800,000
Cash outflows				
Variable operating costs		(168,000)	(180,000)	(200,000)
Fixed operating costs		(150,000)	(150,000)	(150,000)
Maintenance expenses		(20,000)	(20,000)	(20,000)
Total cash outflow		(338,000)	(350,000)	(370,000)
Net cash outflows/inflows	($1,500,000)	$334,000	$370,000	$430,000

- *Cash Inflow—Internal Use:* The MRI equipment has a practical capacity of 4,000 images per year. St. Vincent's expects to receive an average of $200 per image for 2,400 images. Dr. Rodriguez expects the internal demand to remain constant, yielding annual revenue of $480,000 (2,400 images per year × $200 per image).

- *Cash Inflow— External Sales:* Dr. Rodriguez expects to earn additional revenue by renting out the MRI equipment's spare capacity of 1,600 images. St. Vincent's will directly bill the patient's insurance company for the MRI, again at an average rate of $200 per image. In years 1−3, Dr. Rodriguez expects outside sales of 960 images, for a revenue of $192,000 (960 images × $200 per image). She estimates outside use of 1,200 images per year in years 4 and 5 (revenue of $240,000 per year) and 1,600 images for each of years 6–10 (revenue of $320,000 per year).
- *Cash Outflow—Initial Investment.* To get the MRI equipment up and running requires a one-time outlay of $1,500,000.
- *Cash Outflow—Variable Operating Costs:* Variable operating costs are $50 per image. Thus, in years 1–3, annual variable costs amount to $168,000 ((2,400 + 960) images × $50 per image). By similar calculation, annual variable costs amount are $180,000 per year for years 3–5 and $200,000 per year for years 6–10.
- *Cash Outflow—Fixed Operating Costs.* Dr. Rodriguez expects to incur fixed operating costs of $150,000 per year for technician and staff salaries and use of the hospital space. She estimates maintenance expenses of $20,000 per year. Thus, the MRI machine would increase the hospitals' total fixed costs by $170,000 per year. We note that Dr. Rodriguez might rely on cost allocations, as might be obtained from an ABC system, to calculate the estimated increase in St. Vincent's fixed costs.
- *Cash Inflow/Outflow—Salvage Value.* The equipment has no salvage value at the end of 10 years. The costs of dismantling and selling the equipment will offset the expected sale price.

Exhibit 11.3 depicts these cash flows pictorially.

Exhibit 11.3 *Timing of Cash Flow*



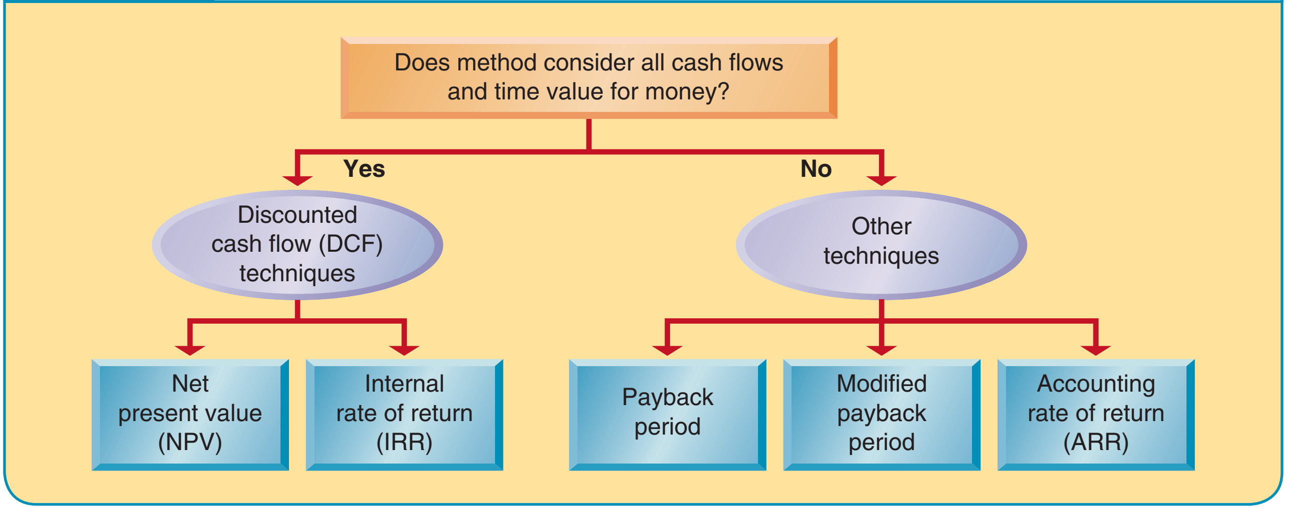
It is important to note that Exhibits 11.2 and 11.3 focus on before-tax *cash flows* and not accounting expenses. In particular, the accounting depreciation of the MRI equipment is not relevant for cash flow computations. While depreciation is an expense, it does not involve a cash outflow. We return to depreciation later in the chapter when we consider after-tax cash flows because the amount of depreciation affects taxes paid, a cash outflow.

COST OF CAPITAL

The **cost of capital** is the opportunity cost for money. We measure the cost of capital as the rate of return that providers of capital (such as shareholders, lenders, and banks) expect from their investments. We use this rate of return as the **discount rate** to calculate the *present* value of *future* cash inflows and outflows.

Estimating the cost of capital is difficult because the return expected by capital providers varies with the risks they face and other investment opportunities they have. A lender will demand a higher rate of return for a riskier project, much as a bank charges a higher interest rate for a person with poor credit. Other factors such as inflation and the state of the economy also influence the discount rate for an investment. For St. Vincent's, the treasurer informs Dr. Rodriguez that the hospital

Exhibit 11.4 *There Are Many Ways to Evaluate Project Profitability*



uses a rate of 12% to discount cash flows. That is, the hospital needs to earn at least a 12% return before it is willing to commit to an investment.

METHODS FOR EVALUATING PROJECT PROFITABILITY

As shown in Exhibit 11.4, firms use many methods to evaluate project profitability. Two of these techniques explicitly consider the time value of money and discount future cash flows. Although conceptually weaker, the other three methods continue to be popular for reasons that we discuss later in the chapter.

Discounted Cash Flow Techniques in Capital Budgeting

LEARNING OBJECTIVE 3

Apply discounted cash flow techniques.

Cash outflows and inflows associated with capital investments are spread over many years. Therefore, most firms use discounted cash flow (DCF) techniques to state future cash flows in terms of their respective present values. These techniques make all cash inflows and outflows comparable. The two main DCF techniques are net present value (NPV) and internal rate of return (IRR).

In Appendix A, we explain the mechanics of computing both the present and future values of cash flows. Before proceeding to the next section, we encourage you to complete *Check It! Exercise #1* to ensure that you are comfortable with present and future value calculations.

NET PRESENT VALUE

The **net present value (NPV)** of an investment is the total present value of *all* of its cash flows. We can compute this value by using the present value tables. Spreadsheet programs and most calculators calculate NPV by using the present value formula. *An investment is desirable if its NPV is positive.*

The initial investment amount shown in Exhibit 11.1 is already at its present value, that is, in current dollar terms. It requires no discount. However, $1 today

Check It! Exercise #1

If you are not sure how to complete this exercise, first read Appendix A. Using the tables in Appendix B, confirm your understanding of the time value of money by verifying the following amounts:

		Checked
Present value of $100 received 5 years from now, discount rate = 10%:	$62.10	_____
Future value of $100 in 3 years, discount rate = 15%:	$152.10	_____
Present value of $100 annuity in arrears for 4 years, discount rate = 8%:	$331.20	_____
Future value of $100 annuity in arrears for 6 years, discount rate = 12%:	$811.50	_____

Note: The term *in arrears* means that you will receive the cash at the end of a period.

Solution at end of chapter.

would have grown to (1 + *r*) dollars in one period, if our discount rate is *r*. Conversely, if we receive *NCF* dollars at the start of period 1, then the present value of this cash flow is $NCF_1/(1 + r)$. As you go further out in time, the **discount factor** (also known as the *present value factor*), the amount by which we need to multiply the future cash flow to obtain the present value, decreases. The present value of the cash flow in some future period *t* is $NCF_t/(1 + r)^t$; the discount factor for this cash flow is $1/(1 + r)^t$. Adding together all of the present values provides the NPV.

Exhibit 11.5 shows that NPV declines as the discount rate increases. A higher discount rate leads to a more conservative estimate of an investment's NPV. Accordingly, firms often use larger discount rates to evaluate riskier projects.

Exhibit 11.5 *Higher Discount Rates Lower the NPV of a Cash Flow*

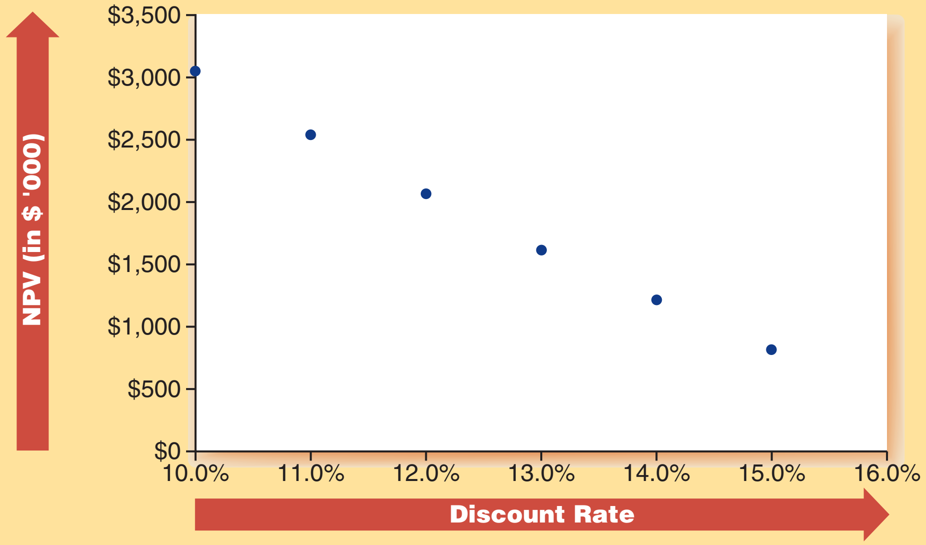


Exhibit 11.6 *St. Vincent's Hospital: Present Value of the MRI Project*

Initial Investment = $1,500,000, Life 10 years, Cost of Capital 12%

Year	Net Cash Flow	Present Value Factor	Present Value
Initial investment	($1,500,000)	1.000	($1,500,000)
Year 1	$334,000	0.893	298,262
Year 2	334,000	0.797	266,198
Year 3	334,000	0.712	237,808
Year 4	370,000	0.636	235,320
Year 5	370,000	0.567	209,790
Year 6	430,000	0.507	218,010
Year 7	430,000	0.452	194,360
Year 8	430,000	0.404	173,720
Year 9	430,000	0.361	155,230
Year 10	430,000	0.322	138,460
Net present value (NPV)			$627,158

Recall that Dr. Rodriguez uses a discount rate of 12% to evaluate St. Vincent's investment in the MRI machine. The calculations in Exhibit 11.6 discount the cash flows from Exhibit 11.2 using Table 1 in Appendix B. Our analysis shows a positive NPV, indicating that investing in the MRI equipment is profitable.

Sensitivity Analysis

Like the Cost-Volume-Profit model of Chapter 5, the NPV method allows the user to perform "what if" sensitivity analysis with respect to various estimates and assumptions, and to examine alternative scenarios. For example, if Dr. Rodriguez lowers the charge from $200 to $190 per MRI, she estimates that outside sales will be 1,600 images per year for Years 1–10. (Inside sales will stay at 2,400 images.) She also expects this change to increase maintenance expenses from $20,000 per year to $25,000 per year. With these changes, does the MRI equipment still have a positive NPV?

We can answer this question by revising the cash flow estimates as seen in the top panel of Exhibit 11.7. The bottom panel of this exhibit presents the NPV calculations. *The net cash flows are the same every year.* Therefore, we treat the net cash inflow of $385,000 as an annuity in arrears (that is, received at the end of the year) and use the annuity tables (Table 3 in Appendix B) to calculate the present value.

Comparing the data in Exhibit 11.7 with that in Exhibit 11.6, we find that the change results in higher net cash inflows for the first five years. However, cash flows are lower in Years 6 through 10. Yet, the net present value with the revised MRI charge and increased maintenance expense is higher than the amount determined earlier. Why? The present value of a dollar is lower as we go farther into the future. The higher cash inflows in the earlier years of a project yield a higher present value, all else being equal. In the case of the MRI machine, charging a lower fee to outside users and increasing capacity utilization is a good idea as it increases overall profit.

In a similar vein, we could examine the sensitivity of our NPV estimate to other changes, such as a change in the discount rate, initial investment, or usage.

Exhibit 11.7 *St. Vincent's Hospital: MRI Project—Sensitivity Analysis*

	Year 0	Years 1–3	Years 4–5	Years 6–10
Initial outlay	($1,500,000)			
Internal use (# of images)		2,400	2,400	2,400
Outside sales (# of images)		1,600	1,600	1,600
Cash inflows				
Internal use		$456,000	$456,000	$456,000
Outside sales		$304,000	$304,000	$304,000
Cash outflows				
Variable operating costs		(200,000)	(200,000)	(200,000)
Fixed operating costs		(150,000)	(150,000)	(150,000)
Maintenance expenses		(25,000)	(25,000)	(25,000)
Net cash flows		$385,000	$385,000	$385,000
Present value of annuity in arrears of $425,000 million per year for 10 years @12%		$385,000 × 5.650		$2,175,250
Less: Initial investment				(1,500,000)
Net present value (NPV)				$675,250

* Notice that the PV of an annuity in arrears is the sum of the present values of the cash flows for individual years, which data we used in Exhibit 11.6. That is, 5.650 = 0.893 + 0.797 + . . . + 0.322.

Assumptions in NPV Analysis

In performing the NPV calculations illustrated above, we made some assumptions that affect our calculations.

1. The initial cash outflow takes place at the *beginning of the period*. Referring to Exhibit 11.3, time 0 designates the time of the initial investment, which is now. This assumption is the reason for not discounting the initial outlay.
2. Subsequent cash inflows and outflows occur at the *end of the relevant period*. That is, the net cash flow in year 1 occurs as a lump sum at the end of year 1, which is time t =1, or a year from time t = 0. We used this assumption to calculate the value of the annuity in Exhibit 11.7.

Check It! Exercise #2

Using Table 1 in Appendix B, verify that the NPV of the following cash flows is −$2,180 when using a discount rate of 14%. Why should you reject this project?

Item	*Amount*	*PV Factor*	*Present Value*
Initial outlay	$100,000	1.000	____________
Cash inflow in year 1	$60,000	_______	____________
Cash inflow in year 2	$50,000	_______	____________
Cash inflow in year 3	$10,000	_______	____________

Solution at end of chapter.

3. NPV calculations assume that firms reinvest future cash inflows in projects that yield a return that equals the cost of capital.

Are these assumptions reasonable? While the third assumption is acceptable, the first two assumptions may seem unrealistic. After all, firms likely receive revenue and incur costs throughout the year, not just at the beginning and end of accounting periods. Advanced accounting and finance textbooks discuss techniques that account for a continuous flow of costs and benefits during a period. Here, our purpose is to introduce you to the important concept of net present value and the need to discount future cash flows. Thus, we will continue to make these assumptions.

INTERNAL RATE OF RETURN

The **internal rate of return (IRR)** is the discount rate at which a project has zero NPV. *A project is profitable if its IRR exceeds its opportunity cost of capital*. For example, the MRI machine would be a profitable investment if its IRR exceeds 12%, the cost of capital for St. Vincent's.

Unequal Cash Flows

As is typical of most projects, St. Vincent's project has unequal cash flows over time (see Exhibit 11.2). The variance in cash flows occurs because Dr. Rodriguez projects an increasing demand for the MRI machine over time. Manually computing the IRR for a project with unequal operating cash flows spread over many years used to be difficult because the process involves a lot of trial and error. Fortunately, electronic spreadsheet programs greatly simplify this task.

Using the IRR formula in Excel, Dr. Rodriguez finds that the IRR for the MRI project is approximately 20.9%, which is considerably higher than the cost of capital of 12%. Thus, the IRR method confirms the profitability of the MRI machine.

IRR with Equal Cash Flows

The internal rate of return is easier to compute when the net cash flow is the same every year. Consider a project involving an initial investment of $50,000 and yearly net cash inflow of $15,000 for the next five years. Because the cash inflow is an annuity, we can calculate its present value using the annuity factor in Table 3. We can then calculate the annuity factor that results in a net present value of zero. In other words, we calculate

$$\$15{,}000 \times \text{Annuity Factor} = \$50{,}000, \text{ or Annuity Factor} = 3.3333$$

Referring to the present value of an annuity table (Table 3 in Appendix B), we find the row corresponding to five years and locate the column with an amount closest to this factor. For this example, the factor lies between 15 and 16%. Using Excel, we verify that the IRR = 15.24%.

Check It! Exercise #3

Using the formula for IRR in Excel, verify that the IRR of the cash flows in *Check It! Exercise #2* is 12.40%. You also can determine that the IRR is between 12 and 13% by verifying that the NPV is positive with a discount rate of 12% and negative with a discount rate of 13%. Use Table 1 in Appendix B to help with these calculations.

Solution at end of chapter.

Assumptions in IRR Analysis

Like the NPV method, the IRR method assumes that the initial cash outflow takes place at the beginning of the period, and that subsequent cash flows occur as a lump sum at the end of the respective periods. The IRR method assumes that firms reinvest future cash inflows in projects that yield a return equaling the project's IRR. That is, if the current project has an IRR of 22%, the IRR method assumes that the firm invests future cash in projects that yield an IRR of 22%.

COMPARING NPV AND IRR

Many people prefer the NPV method to the IRR method because NPV is simpler to compute and provides a unique value for each project. In contrast, it turns out that the IRR method could result in multiple values of IRR for the same projects. In such instances, qualitative judgment is needed to select the right IRR.

Another key difference between the methods is their assumption about reinvestment of subsequent cash flows. The IRR method assumes that the firm has other investment opportunities that will yield the same rate of return as the project under consideration. Particularly for projects with a high IRR, this assumption is frequently not a realistic one because *highly profitable* reinvestment opportunities may not always be available. In contrast, the NPV method assumes that a firm reinvests interim project cash flows at its cost of capital.

Finally, NPV ranks projects based on the *magnitude* of the net present value, while IRR ranks projects based on the *rate* of return. Thus, NPV tends to favor larger projects with higher absolute *profit* while IRR tends to favor smaller projects that have greater *profitability*.

Collectively, these differences between NPV and IRR often result in these techniques ranking a set of available investment proposals differently, which could be a problem when firms have limited capital available—they cannot choose *all* positive NPV projects or *all* projects whose IRR exceeds the cost of capital. In such instances, firms need to rank available projects so that they can choose the combination of projects that maximizes overall profitability. Unfortunately, the NPV and IRR techniques may not agree on what that right combination might be.

Other Evaluation Criteria for Capital Budgeting

LEARNING OBJECTIVE 4

Compare various methods for evaluating projects.

Although firms generally use NPV and IRR to evaluate investments, they also use other methods. In this section, we discuss three other methods that firms use to evaluate expenditures on long-lived resources: payback, modified payback, and accounting rate of return.

PAYBACK METHOD

Under the payback method, we compute how long it takes to recoup the initial investment using *undiscounted* cash flows. We refer to this length of time as the **payback period**. Consider a project that requires an initial investment of $60,000 and that generates a net cash inflow of $24,000 a year for the next four years. The payback period for this project is two and one-half years ($60,000/$24,000 per year = 2.50 years).

What is the payback period for St. Vincent's MRI project? Because the net cash flows differ every year, determining the payback period is more involved. In this case, Dr. Rodriguez calculates the payback period by adding the net cash flows over time. As the calculations in Exhibit 11.8 indicate, accumulated net

Exhibit 11.8 *St. Vincent's Hospital: Payback Period for the MRI Project*

Year	Net Cash Flow (Exhibit 11.2)	Cumulative Cash Inflows (Undiscounted)	
Initial investment	($1,500,000)		
Year 1	$334,000	$334,000	
Year 2	334,000	$668,000	
Year 3	334,000	$1,002,000	
Year 4	370,000	$1,372,000	
Year 5	370,000	$1,742,000	**> $1,500,000**
Year 6	430,000	$2,172,000	
Year 7	430,000	$2,602,000	
Year 8	430,000	$3,032,000	
Year 9	430,000	$3,462,000	
Year 10	430,000	$3,892,000	

Check It! Exercise #4

Suppose that a machine costs $310,000 and that annual cash inflows are $60,000 in years 1–3 and $50,000 in years 4–7. Verify that the payback period is 5.60 years.

Solution at end of chapter.

cash flows exceed the initial cash outlay of $1,500,000 somewhere between years 4 and 5. Assuming cash inflows occur uniformly throughout the year, we calculate the payback period as: 4 years + ($1,500,000 initial investment − $1,372,000 cumulative cash inflows through year 4)/$370,000 cash inflow in year 5 = 4.35 years.

The greatest advantage of the payback method is that the payback period is easy to compute and to understand. We do not need to determine the opportunity cost of capital, which can be difficult to measure. The payback method also focuses on a project's downside risk. Managers may prefer a project with a shorter payback period because it reduces the risk of losing the initial investment.

To use the payback method to accept or reject a project, a firm needs a criterion or a payback cutoff. Is a payback period of five years acceptable or is it too long? What is the minimum acceptable payback period? While prior experience with similar projects can help in this respect, it is still arbitrary.

As you know, the payback method ignores the time value of money and thus overvalues the future cash inflows it considers. Accordingly, the payback method *understates* the length of time actually required to recoup initial investment. Moreover, it ignores all cash flows that occur after the payback period, and thus favors projects that yield more cash inflows in earlier years relative to projects that take longer to bear fruit. Exhibit 11.9 provides an example in which two projects, A and B, require the same initial outlay but generate different cash flow patterns over four years of life. Project A has a shorter payback period, but Project B has a higher NPV (based on a cost of capital of 8%). Many firms use the modified payback method to address this concern.

Exhibit 11.9 *Comparison of Payback Method and NPV*

Year	Project A	Project B
Initial investment	($50,000)	($50,000)
Year 1 cash flows	30,000	10,000
Year 2 cash flows	20,000	15,000
Year 3 cash flows	10,000	20,000
Year 4 cash flows	10,000	40,000
Net present value (r = 8%)	$10,213	$17,397
Payback period	2 years	3.125 years

MODIFIED PAYBACK

The **modified payback method** computes the payback period using *discounted* cash flows, meaning that the method accounts for the time value of money. Under this method, we accumulate the present value of future cash flows over time and compare the cumulative value with the initial cash outlay. The year in which the accumulated present value of future cash flows exceeds the initial cash outflow determines the modified payback period.

As shown in Exhibit 11.10, the present value of future cash flows for the MRI project exceeds the initial outlay of $1,500,000 sometime in year 7. We calculate the payback period as 6 years + ($1,659,748 − $1,500,000)/$194,360 = 6.82 years. Under the traditional payback method, we calculated the payback period to be 4.35 years (Exhibit 11.8). Thus, the payback period increases by 2.47 years when we account for the time value of money. This disparity confirms our earlier observation that the traditional payback method understates the true length of time required to recoup the initial investment.

The modified payback method is an improvement over the simple payback method because it takes into account the time value of money. Still, it does not consider *all* future cash flows from a project as the NPV method does. In particular, it

Exhibit 11.10 *St. Vincent's Hospital: Modified Payback Method*

Initial Investment = $1,500,000, Life 10 years, Cost of Capital 12%

Year	Net Cash Flow (Exhibit 11.2)	Present Value Factor	Present Value	Cumulative Present Value
Year 1	$334,000	0.893	$298,262	$298,262
Year 2	334,000	0.797	266,198	564,460
Year 3	334,000	0.712	237,808	802,268
Year 4	370,000	0.636	235,320	1,037,588
Year 5	370,000	0.567	209,790	1,247,378
Year 6	430,000	0.507	218,010	1,465,388
Year 7	430,000	0.452	194,360	**1,659,748**
Year 8	430,000	0.404	173,720	1,833,468
Year 9	430,000	0.361	155,230	1,988,698
Year 10	430,000	0.322	138,460	2,127,158

ignores cash flows that occur after the payback period. Consequently, the payback and the modified payback methods generally are less preferable to NPV or IRR when evaluating projects, even though these methods are easier to use and understand.

ACCOUNTING RATE OF RETURN

Some firms compute an **accounting rate of return (ARR)** to evaluate long-lived resources. We compute ARR as follows:

$$\text{ARR} = \frac{\text{Average annual income from the project}}{\text{Average annual investment}}$$

We compute accounting income by subtracting annual depreciation expense from annual net cash flows. St. Vincent's plans to depreciate the MRI equipment using the straight-line method and assuming zero salvage value.

- First, we decrease the book value of the MRI equipment by the depreciation amount.
- Next, we calculate the average investment balance for each year as the average of the beginning and ending book values.
- The final step is to compute ARR as the ratio of the average income to the average investment over the life span of the investment.

As shown in Exhibit 11.11, the MRI project has an expected ARR of 31.89%.

Exhibit 11.11 *St. Vincent's Hospital: Accounting Rate of Return*

Initial Investment = $1,500,000, Life 10 years, Cost of Capital 12%

Year	Opening Book Value	Net Cash Flow (Exhibit 11.2)	Depreciation	Accounting Income	Ending Book Value	Average Book Value
Year 1	$1,500,000	$334,000	$150,000	$184,000	$1,350,000	$1,425,000
Year 2	1,350,000	334,000	150,000	184,000	1,200,000	1,275,000
Year 3	1,200,000	334,000	150,000	184,000	1,050,000	1,125,000
Year 4	1,050,000	370,000	150,000	220,000	900,000	975,000
Year 5	900,000	370,000	150,000	220,000	750,000	825,000
Year 6	750,000	430,000	150,000	280,000	600,000	675,000
Year 7	600,000	430,000	150,000	280,000	450,000	525,000
Year 8	450,000	430,000	150,000	280,000	300,000	375,000
Year 9	300,000	430,000	150,000	280,000	150,000	225,000
Year 10	150,000	430,000	150,000	280,000	0	75,000
		Average		239,200		$750,000

Accounting Rate of Return (ARR) = $239,200/$750,000 = 31.9%

Like the payback methods, ARR is relatively straightforward to compute. However, like the traditional payback method, it ignores the time value of money. Thus, we caution against the exclusive use of these methods for project acceptance decisions.

POPULARITY OF DISCOUNTED CASH FLOW TECHNIQUES

Exhibit 11.12 provides a comparison of the various methods for evaluating projects. As you can tell, the discounted cash flow (DCF) techniques are the conceptually

Exhibit 11.12 *Comparison of Methods for Evaluating Project Proposals*

Feature of Method	Net Present Value	Internal Rate of Return	Payback	Modified Payback	Accounting Rate of Return
Considers time value of money	Yes	Yes	No	Yes	No
Considers all cash flows	Yes	Yes	No	No	Yes
Return earned on invested cash inflows	Cost of capital	IRR	Not applicable	Not applicable	Not applicable
Ease of computations	Moderate	Moderate to difficult	Easy	Easy to moderate	Easy to moderate
Greater focus on avoiding losses than on making profit	No	No	Yes	Yes	No
Integrates well with accounting performance measures	No	No	No	No	Yes

Exhibit 11.13 *Capital Budgeting Techniques—Usage Patterns*

	Often or Always	Sometimes	Rarely or Never
NPV	85.1%	10.9%	4.0%
IRR	76.7	15.4	7.9
Payback	52.6	21.9	25.5
Modified payback	37.6	19.1	43.3
ARR	14.7	18.6	66.7

Source: P. A. Ryan and G. P. Ryan, "Capital Budgeting Practices of the Fortune 1000: How Have Things Changed?" *Journal of Business and Management* 8 (4), 2002.

correct way to evaluate projects, although they are computationally intensive. Perhaps because of growing comfort with spreadsheet programs, over the years, the popularity of DCF techniques has grown. Most major corporations use these techniques, particularly for large outlays. Nevertheless, as the survey data in Exhibit 11.13 indicate, even some Fortune 1000 firms still use the payback method to complement NPV and other DCF techniques, perhaps because of their simplicity.

Taxes and Capital Budgeting

LEARNING OBJECTIVE 5

Explain the role of taxes and the depreciation tax shield on capital budgets.

Regardless of the method they use to evaluate projects, firms need to consider one very important factor: taxes. Taxes affect both the amount and timing of cash flows. A firm pays taxes on accounting income, not on cash flows. Therefore, it needs to compute accounting income to determine taxes.

Operating cash inflows and outflows influence accounting income significantly. However, net cash flows do not typically equal accounting income. A major reason is depreciation, which is an accounting expense but does not involve any cash outflow.

Tax laws allow corporations to deduct depreciation when calculating taxable income. Thus, depreciation offers a *tax shield* that reduces the cash outflow associated with tax payments. Let us explore this idea further.

DEPRECIATION TAX SHIELD

We compute the depreciation tax shield as

Depreciation tax shield in a year = Tax rate × Depreciation deduction in that year

Consider the cash flow data presented in Exhibit 11.2 for the MRI project. Assume that St. Vincent's follows a straight-line depreciation method for tax purposes. Also, assume that the applicable tax rate is 30% and that St. Vincent's is a for-profit hospital. Given an initial investment of $1,500,000 and a useful life of 10 years, the annual depreciation is $150,000.

Exhibit 11.14 presents cash flow calculations for the first year of the MRI project with and without the depreciation tax effect. In the first column, the cash inflow for year 1 is $334,000. This amount triggers a 30% tax payment of $100,200, which reduces the after-tax cash flow to $233,800.

The second column shows the effect of depreciation. Subtracting the allowable depreciation deduction reduces taxable income from $334,000 to $184,000. Taxes paid also decrease, from $100,200 to $55,200. The net after-tax cash flow is then $278,800. We add back depreciation to after-tax income when we calculate this after-tax cash flow. We do this because depreciation is a noncash expense, but we deducted it earlier to compute taxable income. Notice too that the depreciation tax shield of $45,000 equals the tax rate of 30% times the depreciation amount of $150,000.

After revising the cash flows to reflect taxes and the depreciation shield, we can then apply the NPV or IRR techniques to evaluate the project. For example, incorporating taxes and depreciation into St. Vincent's MRI decision, we find that the NPV = $243,306 and the IRR = 15.6%. Thus, the MRI project is still profitable even after considering tax effects and using the two most popular DCF techniques.

Exhibit 11.14 *St. Vincent's Hospital: Illustration of Depreciation Tax Shield*

Initial Investment = $1,500,000, Life 10 years, Cost of Capital 12%

	Without Depreciation	**With Depreciation**
Year 1 cash flows of the MRI project (Exhibit 11.2)		
Cash inflows		
Internal use	$480,000	$480,000
Outside sales	192,000	192,000
Cash outflows		
Variable operating costs	(168,000)	(168,000)
Fixed operating costs	(150,000)	(150,000)
Maintenance expenses	(20,000)	(20,000)
Depreciation deduction	0	(150,000)
Taxable income	$334,000	$184,000
Tax payments (30%)	(100,200)	(55,200)
Add back depreciation	0	150,000
Net cash flows	$233,800	$278,800
Difference (Depreciation tax shield = $150,000 × 0.30)		$45,000

Check It! Exercise #5

Refer back to Exhibit 11.2. Verify that when considering taxes and depreciation, the net cash flows from the MRI equipment are $304,000 in year 5 and $346,000 in year 10.

Solution at end of chapter.

Connecting to Practice

Modified Accelerated Cost Recovery System (MACRS)

In addition to the straight-line depreciation method, U.S. tax laws also allow depreciation deductions as stipulated by the Modified Accelerated Cost Recovery System (MACRS). The total undiscounted amount of depreciation is the same under both methods. However, MACRS allows firms to take higher depreciation charges earlier in the asset's life. In turn, because a dollar saved in tax payments today is worth more than a dollar saved tomorrow, firms generally prefer MACRS.

Commentary: Tax policies can spur investment by allowing firms to realize tax benefits earlier in an asset's useful life. Such benefits often include an investment tax credit that allows the organization to write off some portion (usually 10%) of the initial outlay in the first year and accelerated depreciation schedules such as MACRS.

SALVAGE VALUE AND TAXES

Recall that salvage value is the value of an asset at the end of its useful life. Even though an asset may have lost its productive use, a company may be able to sell some parts of the asset in the replacement market. This sale price constitutes a cash inflow at the end of the asset's useful life. If a company can estimate the salvage value of an asset when acquiring it, it should include it in present value calculations. Ignoring the salvage value will *understate* the net present value of the asset.

How do taxes affect salvage value? Accounting depreciation usually does not equal the economic decline in value. Therefore, the value of an asset in the firm's books frequently differs from its economic or market value. When a firm disposes of an asset, it might realize a gain or loss due to the sale, a taxable amount. The tax code provides alternate rates for different kinds of income (e.g., earned income, dividend income, income from capital gains). For simplicity, we assume that the same tax rate applies for all kinds of income.

At the end of 10 years, St. Vincent's will have recognized 10 years of depreciation expense at $150,000 a year, or $1,500,000 in total. As net book value is the purchase cost less accumulated depreciation, the machine will have zero book value. Assume that Dr. Rodriguez believes St. Vincent's can sell the MRI equipment for $100,000 at the end of 10 years. While St. Vincent's will receive the $100,000 in cash, the entire amount is taxable. After subtracting $30,000 in taxes, St. Vincent's after-tax cash flow from disposition will be $70,000. In turn, that $70,000 has a present value of $22,540.

Similarly, a loss reduces the amount of taxes paid. For example, suppose that the hospital sells the MRI machine at the end of 9 years, foregoing the revenues and costs for year 10. At this time, the MRI equipment will have a book value of $150,000. If St. Vincent's then sells the machine for $130,000, the hospital's after-tax cash flow will be $130,000 plus the tax savings of $6,000 (= $20,000 loss × 0.30 tax rate) on the loss from sale. That is, the loss of $20,000 *reduces* the taxes owed on *other* income.

Allocating Capital Among Projects

LEARNING OBJECTIVE 6

Describe issues in allocating scarce capital among projects.

Thus far, we have examined how to evaluate any given project, discussing how firms project future cash flows, and how to use discounted cash flow techniques to gauge the project's worth. Ideally, firms should fund any investment whose NPV is positive or whose IRR exceeds the cost of capital. However, firms have limited access to the capital, managerial talent, and other organizational resources needed to undertake new projects. They cannot undertake all positive NPV projects. Many companies use a subjectively determined internal hurdle rate instead of the cost of capital as the benchmark for project acceptance decisions. The **hurdle rate** is the minimum expected rate of return of the management from any project. Thus, any project that has an IRR greater than the hurdle rate (which means that the project will have a positive NPV when discounted at the hurdle rate) would be acceptable.

We also find that firms may not always allocate capital to their highest-ranking projects. They may make such a seemingly bad decision to take advantage of synergies *across* projects. That is, the value of a portfolio of projects may exceed the sum of the NPVs of the individual projects in the portfolio. Moreover, some projects may align better with the firm's overall strategy than other projects. While some firms use sophisticated techniques to quantify these synergies and strategic fits, others qualitatively consider these factors in choosing which projects to fund.

Connecting to Practice

EQUIPMENT REPLACEMENT AT U.S. NAVY

In its proposal to replace three old cranes with a 151-ton dock crane, the Portsmouth Naval Ship Yard stresses the safety aspects, reduced environmental impact, and consistency with the Navy's overall strategic plans. The proposal also highlights the cost savings accruing from installing the new crane.

COMMENTARY: Capital expenditures commit organizational resources for many years. It is therefore vital that such expenditures reinforce the organization's overall missions and goals. As a result, strategic and qualitative considerations play a key role in equipment replacement decisions. Many organizations require that proposals for capital expenditures have a direct tie-in or justification based on the organization's strategic plans.

Source: U.S. Department of Navy, Justification Management System, 164.224.25.30 /fy04.nsf/($reload)/ 85256CAE007091FC8 5256BC80046665C/$FILE/Shipyards_Fund9b_FY0405PB.pdf on March 11, 2005

NONFINANCIAL COSTS AND BENEFITS

Estimating future cash inflows and outflows, and identifying the appropriate discount rate for present value calculations is not enough. Companies also need to determine the future nonfinancial costs and benefits from a capital expenditure. This is not an easy task. In the case of St. Vincent's MRI project, how would it quantify the benefits from more timely diagnoses and better patient service?

Ignoring future benefits because they are hard to quantify can lead to lost opportunities. Using judgment to arrive at reasonable estimates, and performing sensitivity analyses to determine how changes in these estimates would impact investment decisions, could go a long way in helping managers make the right decisions.

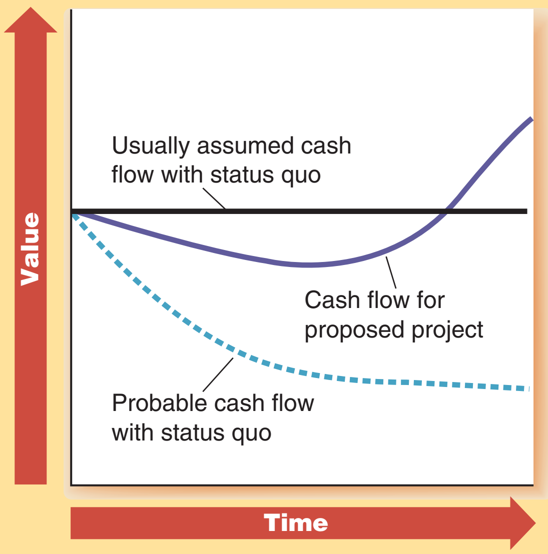
Fit with Overall Strategy

Firms must consider how proposed projects affect the firm's ability to compete in the evolving marketplace. By virtue of their longevity, capital investments entail substantial risk, as it is hard to predict many years into the future. Some firms demand high rates of return to compensate for the risk from taking on such projects. Thus, they may use a high hurdle rate to discount future cash flows. Such practices lead to conservative investments. Such conservatism may come with a high price tag, as it erodes the firm's ability to compete.

Indeed, many experts cite unduly high discount rates as a primary reason why U.S. companies lost their technological advantage to Japanese firms in the 1970s, especially in the implementation of Just-in-Time and flexible manufacturing systems. Because they considered such investments risky, U.S. manufacturers such as Ford and Chrysler invested less than their Japanese counterparts did. However, these investments gave a significant competitive advantage to Japanese firms such as Toyota and Honda, allowing them to make substantial inroads into and become the dominant vendors in the U.S. automobile market.

Considering strategic impact is particularly important. The status quo may not be a viable option. As Exhibit 11.15 illustrates, an investment may be unattractive

Exhibit 11.15 *It is Important to Pick the Right Benchmark for Evaluating Strategic Investments*



REJECT With usually assumed cash flow pattern for status quo

ACCEPT With probable cash flow pattern for status quo relative to the status quo, which implicitly asserts that the existing state of affairs will continue. However, this may not be a realistic assumption. Market forces may dictate that the status quo itself is not viable. Therefore, no action would significantly erode expected cash flows. The new investment may well be justified when compared to a revised benchmark that considers market forces on competitive position and expected cash flows.

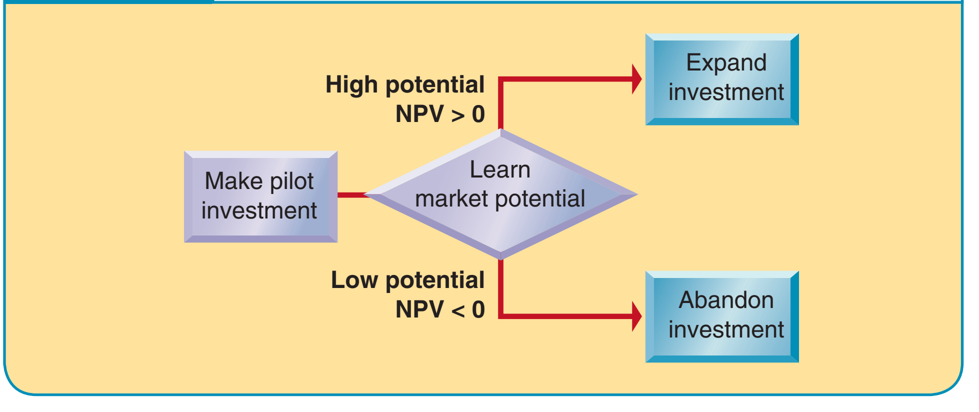
FLEXIBILITY AND REAL OPTIONS

Flexibility is the ability to defer, abandon, expand, or contract an investment. Investments differ greatly in the flexibility they afford. Nike gains considerable manufacturing flexibility because it outsources all production. If the firm owned a plant to make its sneakers, it would not be as nimble in responding to market changes. Likewise, many firms begin projects on a small scale or on a pilot basis to gather information. Favorable outcomes lead to expansion, while failures are abandoned. Consumer firms such as Procter and Gamble and Lever Brothers routinely test new products in select markets before committing to a national launch. Amazon's substantial investment to develop its customer base, brand name, and information infrastructure for its core book business added substantial value by giving the firm the ability to extend its operations into a variety of new businesses. As seen in these examples and in Exhibit 11.16, increasing a firm's future flexibility is a key element of value, particularly for projects with considerable uncertainty in their estimated cash flows.

Many firms subjectively incorporate flexibility into project evaluation and capital allocation decisions. In recent years, both academics and practitioners have developed sophisticated mathematical models to place a quantitative value on flexibility. This branch of study, known as **real options analysis**, complements standard techniques such as NPV and IRR. It allows companies to blend strategic intuition with analytic rigor.

As a member of the hospital's executive board, Dr. Rodriguez is acutely aware that the hospital faces many demands for its limited capital. The surgeons have petitioned to upgrade the operating room, the hospital's roof is overdue for repairs, and there is a strong effort to expand the hospital's prize-winning geriatric ward. After considering these competing investments, Dr. Rodriguez still ranks the MRI project as her first choice. She believes that the new machine will substantively decrease patient turnaround time for procedures that require an MRI. The board also believes that the machine will add to the hospital's excellence in geriatric care because many diagnoses for age-related illness make use of the MRI machine. Finally, Dr. Rodriguez thinks that the downside risk is small. She is confident that she can sell the excess capacity in MRI machines to other hospitals and clinics if, contrary to current expectations, demand from St. Vincent's own patients drops.

Exhibit 11.16 *Real Option Analysis Helps Firms Value the Flexibility of a Project*



Connecting to Practice

OPTIONS AND PHARMACEUTICAL RESEARCH

Joint ventures and shared research arrangements are common in the high-risk biotechnology and drug development industry. For example, several years ago Merck paid Biogen $15 million up front, plus up to $130 million in milestone payments, to help it develop and bring an asthma drug to market. During the development process, Biogen faced expanded tests, a changing asthma drug market, and the risk of abandonment for safety reasons. Meanwhile, Merck could have abandoned the contract at any time without cause.

COMMENTARY: We can view this transaction as Merck purchasing a stream of options, including the option to market the drug or to abandon the product. A CSFB study, using real options analysis, revealed that the deal was worth more than the $145 million of up-front and milestone payments, making it a profitable venture for Merck. From Biogen's perspective, the venture gave it a ready stream of cash at a time of need and allowed it to partner with a pharmaceutical giant.

Source: Adopted from *Get Real: Using Real Options in Security Analysis*, Research Report by CSFB, June 1999, Merck press release, Biogen press release.

Drug development often contains exit and escalation clauses to react to future contingencies. (Emile Wamsteker/Bloomberg News/Landov LLC)

APPLYING THE DECISION FRAMEWORK

What Is the Problem? Dr. Rodriguez of St. Vincent's Hospital wonders whether it is worthwhile to acquire magnetic resonance imaging (MRI) equipment.

What Are the Options? The options are to buy the MRI equipment or to continue with the current arrangement of patients getting the tests done at a nearby hospital.

What Are the Costs and the Benefits? The MRI equipment has a substantially positive NPV, and the IRR exceeds the hospital's cost of capital. Considerable nonfinancial benefits also appear to exist. However, the investment will tie up capital for many years and reduce the hospital's flexibility in terms of future investments.

Make the Decision! Dr. Rodriguez confidently recommends that St. Vincent's proceed with its plans to acquire the MRI machine.

SUMMARY

In this chapter, we studied how firms evaluate expenditures on long-lived resources using the tools of capital budgeting. We discussed many capital budgeting techniques that firms use in decision making, including net present value, internal rate of return, payback period, and accounting rate of return analyses. Finally, we discussed the role of taxes in capital budgeting and the need to consider qualitative considerations, such as the strategic fit of a project and the flexibility afforded in project execution.

In the next chapter, we consider how firms track the results associated with expenditures on long-lived resources. Just as variance analysis helps firms evaluate the outcome of short-term plans and budgets, measures such as the return on investment (ROI) and residual income (RI) help firms evaluate the outcomes of their capital budgeting decisions.

RAPID REVIEW

LEARNING OBJECTIVE 1

Understand the reasons for capital budgeting.

- Capital budgeting is the collective term for the mechanisms and tools used to evaluate expenditures on long-lived resources.
- Capital budgeting complements the use of cost allocations for decision making by considering the time value of money and the "lumpy" nature of capacity resources.
- Capital budgets provide the link between strategic and operating budgets by determining how much capacity to acquire.

LEARNING OBJECTIVE 2

List the components of a project's cash flow.

- A project's cash flow has four elements: (1) the initial outlay; (2) the useful life and salvage value; (3) the timing and amounts of operating cash flows; and (4) the cost of capital.
- The initial outlay includes all costs incurred to ready the asset for its intended use. Using a reasonable and realistic estimate of life expectancy is important as the estimate significantly influences the profitability of the investment. The salvage value is the residual value from selling the asset at the end of its useful life. Operating cash inflows come in the form of revenue increases or cost reductions. Operating cash outflows typically include increases in variable costs and increases in controllable fixed costs. The cost of capital is the opportunity cost of foregone monetary returns. The cost of capital is higher for riskier projects and can be difficult to estimate.

LEARNING OBJECTIVE 3

Apply discounted cash flow techniques.

- The time value of money (a dollar today is worth more than a dollar tomorrow) is an important consideration when evaluating capital expenditures. By discounting future cash flows, we place all cash inflows and outflows on an equal footing.
- The net present value (NPV) of a project is the sum of all discounted future cash flows less the initial outlay. A profitable project has a positive NPV, and an unprofitable project has a negative NPV. NPV analysis also allows users to perform "what if" analysis with respect to assumptions regarding the timing and magnitude of cash flows and the cost of capital.
- The internal rate of return (IRR) is the discount rate at which a project has zero NPV. A profitable project has an IRR that exceeds the firm's cost of capital.
- NPV computations assume that firms reinvest all cash inflows at the cost of capital used in the discounting process. IRR computations assume that firms reinvest all cash inflows at the IRR. Because of their differing assumptions about reinvestment, NPV and IRR could rank projects differently.

LEARNING OBJECTIVE 4

Compare various methods for evaluating projects.

- The payback period is the number of periods required to recoup the initial outlay in undiscounted dollars. The modified payback adjusts for the time value for money. The accounting rate of return computes profit over average book value to determine project profitability.
- Though widely used, the payback method suffers from several disadvantages, including ignoring cash flows after the payback period and ignoring the time value of money. However, it does play a role in measuring downside risk. Surveys show that DCF techniques are the dominant method for evaluating capital investments.

LEARNING OBJECTIVE 5

Explain the role of taxes and the depreciation tax shield in project evaluation.

- Though not a cash flow, depreciation expense is tax deductible. The reduction in taxes payable due to depreciation is the depreciation tax shield.
- Salvage value is the proceeds received from disposing of the asset. The gain or loss due to the sale, which is the salvage value less the book value, is taxable and therefore affects cash flows.

LEARNING OBJECTIVE 6

Describe issues in allocating scarce capital among projects.

- Most organizations have capital constraints that limit the number of projects they can execute. Organizations therefore look at portfolios of projects, as well as nonfinancial considerations when choosing among projects.
- It is difficult to estimate cash flows due to intangible benefits such as reputation. However, ignoring these nonfinancial costs and benefits, such as the fit with overall strategy, can distort a project's value.
- Much like a financial option, the real option stemming from the flexibility in expanding, contracting, modifying, or abandoning a project has value. Firms use sophisticated mathematical models to estimate the value of these real options, which can be substantial in many instances.

Appendix A
PRESENT AND FUTURE VALUE CALCULATIONS

We illustrate present and future value computations using a series of four examples. These computations require the use of the present and future value tables in Appendix B.

Example 1: Future Value of an Investment

Sam Williams recently inherited \$20,000 from a distant aunt. He invests the money in a stock fund that promises an expected annual return of 8% for a period of 10 years. Sam reinvests any interim proceeds in the same fund.

How will Sam's money grow in the fund? How much will Sam expect to get back at the end of 10 years? In other words, what is the future value of \$20,000 at the end of 10 years if the annual rate of return is 8%?

Suppose Sam invests \$20,000 at the beginning of year 1. At the end of year 1, Sam expects to have \$20,000 plus the annual return of \$1,600 (\$20,000 × 0.08). That is, Sam expects to have \$21,600.

$$\text{Future value at the end of year 1} = 20{,}000 \times (1 + 0.08) = \$21{,}600$$

How much will Sam have at the end of year 2? Sam will have invested \$21,600 at the end of year 1. This amount will grow by 8% during year 2. Thus, he will have \$23,328 at the end of year 2. We could also compute the future value at the end of year 2 as

$$\begin{aligned}\text{Future value at the end of year 2} &= 21{,}600 \times (1 + 0.08)\\ &= [20{,}000 \times (1 + 0.08)] \times (1 + 0.08)\\ &= 20{,}000 \times (1 + 0.08)^2 = \$23{,}328\end{aligned}$$

Proceeding along these lines, the future value at the end of 10 years is

$$\text{Future value at the end of year 10} = 20{,}000 \times (1 + 0.08)^{10} = \$43{,}178.50$$

In general, the future value of a principal amount P at the end of n periods given a rate of return of r% per period is

$$FV(P, r, n) = P \times (1 + r)^n$$

where $(1 + r)^n$ is the future value factor.

We can compute future values by using the built-in formula in spreadsheet programs. Alternatively, we could look up the future value factor for \$1 from a table (such as Table 2 in Appendix B). The rows of this table correspond to the rate of return per period (e.g., quarter, year), and columns correspond to the number of periods. Using the table, a rate of return of 8% and a horizon of 10 years corresponds to a factor of 2.159. Thus, we compute the future value at \$43,180 = \$20,000 × 2.159 (the \$1.50 difference in answers is due to rounding).

Example 2: Present Value of a Future Financial Need

Suppose Sam wishes to add some of his own money to the $20,000 he inherited, so that when he retires 16 years from now, he will have access to a sum of $100,000. As before, he expects to earn 8% from his investments. How much should Sam add to the inheritance?

In this case, because we know what the future value should be at the end of 16 years, we need to calculate its present value. That is, we wish to calculate the principal amount P in the formula for future value:

$$FV(P, r, n) = P \times (1 + r)^n \Leftrightarrow P = FV(P, r, n)\left(\frac{1}{(1 + r)^n}\right)$$

The factor $1/(1 + r)^n$ is the present value factor. Applying the formula, we have

$$\$100{,}000 = P \times (1.08)^{16} \text{ or } P = \$29{,}189.04$$

$$\text{OR,} \qquad P = \$100{,}000 \times 1/(1.08)^{16} = \$100{,}000 \times 0.2918904 = \$29{,}189.04$$

Because he already has $20,000 from the inheritance, Sam needs to invest $9,189.04 ($29,189.04 − $20,000) more to reach his target.

We can compute the required factor by either using the formula above or by referring to the discount factor from Table 1 in Appendix B. Using the table, a rate of return of 8% and a horizon of 16 years corresponds to a factor of 0.292. Thus, we compute the present value as $100,000 × 0.292 = $29,200 (the difference in answers is due to rounding). In either case, we compute the present value by discounting the future value at 8%, hence the term *discount rate* for the 8% rate of return expected from the investment.

Example 3: Present Value of an Annuity in Arrears

Sam is planning for the college education expenses of his daughter, Samantha, who will finish high school in a year's time. Sam estimates that college tuition is $10,000 per year. This amount is due at the start of each year for the next four years. Sam would like to set aside enough money now to cover these expenses. He decides to invest sufficient money in a low-risk mutual fund, which yields a return of 6%.

How much should Sam invest now? Notice that Sam needs the first installment one year from now, the second two years from now, the third three years from now, and the final one four years from now. One way to compute the answer is therefore to compute the present value of $10,000 a year from now, two years from now and so on, and add the present values. This approach, however, can get tedious if we consider cash flows that span more than a few years.

Another approach takes advantage of the fact that the cash flow is the same amount for each year. Such a cash flow is termed an **annuity**. We modify the present value formula slightly to compute the present value of an annuity in arrears (i.e., payment at the end of a period).

$$\text{Present Value of an Annuity Factor} = \frac{1 - (1 + r)^{-n}}{r}$$

Using the formula, we get the annuity factor for four years (n) and 6% (r) as 3.465, which means that Sam needs to invest $10,000 × 3.465 = $34,650 to satisfy his anticipated cash needs. Alternatively, we can use Table 3 in Appendix B, the present value of an annuity table, to get the annuity factor of 3.465 corresponding to four years and 6% discount rate. With this factor, we calculate the required present value as $10,000 × 3.465 = $34,650. Sam needs to invest $34,650 now to achieve his goal of having $10,000 available at the start of each year for the next four years.

Example 4: Future Value of an Annuity in Arrears

Sam believes that he can save $7,500 at the end of each year. How much money will Sam have in 10 years if he invests his savings in a fund that returns 10% per year?

For each year's contribution, we calculate its future value for the remaining years in the 10-year horizon. Thus, for the first contribution, we calculate the future value at the end of the remaining 9 years [*FV*(0.10,9,0,7500) = $17,684.61]. The amount grows for 9 years only as Sam invests the first installment at the end of year 1. For the second year, we calculate the future value at the end of the remaining 8 years [*FV*(0.10,8,0,7500) = $16,076.92], and so on. Notice that the last installment will have an FV factor of 1. We can then sum the future values to determine that Sam will have $119,542.50.

Alternatively, we can use Table 4 in Appendix B to find the Future Value of an Annuity in Arrears Factor. Using this table, a rate of return of 10% and a horizon of 10 years corresponds to a factor of 15.937. Therefore, the future value of annuity of $7,500 over 10 years at a rate of return of 10% is ($7,500 × 15.937) = $119,527.50 (the difference is due to rounding).

Appendix B
PRESENT AND FUTURE VALUE TABLES

Table 1: Present Value of \$1; $\frac{1}{(1+r)^n}$

Rate of return	Number of Periods 1	2	3	4	5	6	7	8	9	10	12	14	16	20	25
6%	0.943	0.890	0.840	0.792	0.747	0.705	0.665	0.627	0.592	0.558	0.497	0.442	0.394	0.312	0.233
7%	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508	0.444	0.388	0.339	0.258	0.184
8%	0.926	0.857	0.794	0.735	0.681	0.630	0.583	0.540	0.500	0.463	0.397	0.340	0.292	0.215	0.146
9%	0.917	0.842	0.772	0.708	0.650	0.596	0.547	0.502	0.460	0.422	0.356	0.299	0.252	0.178	0.116
10%	0.909	0.826	0.751	0.683	0.621	0.564	0.513	0.467	0.424	0.386	0.319	0.263	0.218	0.149	0.092
11%	0.901	0.812	0.731	0.659	0.593	0.535	0.482	0.434	0.391	0.352	0.286	0.232	0.188	0.124	0.074
12%	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404	0.361	0.322	0.257	0.205	0.163	0.104	0.059
13%	0.885	0.783	0.693	0.613	0.543	0.480	0.425	0.376	0.333	0.295	0.231	0.181	0.141	0.087	0.047
14%	0.877	0.769	0.675	0.592	0.519	0.456	0.400	0.351	0.308	0.270	0.208	0.160	0.123	0.073	0.038
15%	0.870	0.756	0.658	0.572	0.497	0.432	0.376	0.327	0.284	0.247	0.187	0.141	0.107	0.061	0.030
16%	0.862	0.743	0.641	0.552	0.476	0.410	0.354	0.305	0.263	0.227	0.168	0.125	0.093	0.051	0.024
18%	0.847	0.718	0.609	0.516	0.437	0.370	0.314	0.266	0.225	0.191	0.137	0.099	0.071	0.037	0.016
20%	0.833	0.694	0.579	0.482	0.402	0.335	0.279	0.233	0.194	0.162	0.112	0.078	0.054	0.026	0.010
22%	0.820	0.672	0.551	0.451	0.370	0.303	0.249	0.204	0.167	0.137	0.092	0.062	0.042	0.019	0.007
24%	0.806	0.650	0.524	0.423	0.341	0.275	0.222	0.179	0.144	0.116	0.076	0.049	0.032	0.014	0.005

Table 2: Future Value of \$1; $(1+r)^n$

Rate of return	Number of Periods 1	2	3	4	5	6	7	8	9	10	12	14	16	20	25
6%	1.060	1.124	1.191	1.262	1.338	1.419	1.504	1.594	1.689	1.791	2.012	2.261	2.540	3.207	4.292
7%	1.070	1.145	1.225	1.311	1.403	1.501	1.606	1.718	1.838	1.967	2.252	2.579	2.952	3.870	5.427
8%	1.080	1.166	1.260	1.360	1.469	1.587	1.714	1.851	1.999	2.159	2.518	2.937	3.426	4.661	6.848
9%	1.090	1.188	1.295	1.412	1.539	1.677	1.828	1.993	2.172	2.367	2.813	3.342	3.970	5.604	8.623
10%	1.100	1.210	1.331	1.464	1.611	1.772	1.949	2.144	2.358	2.594	3.138	3.797	4.595	6.727	10.835
11%	1.110	1.232	1.368	1.518	1.685	1.870	2.076	2.305	2.558	2.839	3.498	4.310	5.311	8.062	13.585
12%	1.120	1.254	1.405	1.574	1.762	1.974	2.211	2.476	2.773	3.106	3.896	4.887	6.130	9.646	17.000
13%	1.130	1.277	1.443	1.630	1.842	2.082	2.353	2.658	3.004	3.395	4.335	5.535	7.067	11.523	21.231
14%	1.140	1.300	1.482	1.689	1.925	2.195	2.502	2.853	3.252	3.707	4.818	6.261	8.137	13.743	26.462
15%	1.150	1.323	1.521	1.749	2.011	2.313	2.660	3.059	3.518	4.046	5.350	7.076	9.358	16.367	32.919
16%	1.160	1.346	1.561	1.811	2.100	2.436	2.826	3.278	3.803	4.411	5.936	7.988	10.748	19.461	40.874
18%	1.180	1.392	1.643	1.939	2.288	2.700	3.185	3.759	4.435	5.234	7.288	10.147	14.129	27.393	62.669
20%	1.200	1.440	1.728	2.074	2.488	2.986	3.583	4.300	5.160	6.192	8.916	12.839	18.488	38.338	95.396
22%	1.220	1.488	1.816	2.215	2.703	3.297	4.023	4.908	5.987	7.305	10.872	16.182	24.086	53.358	144.210
24%	1.240	1.538	1.907	2.364	2.932	3.635	4.508	5.590	6.931	8.594	13.215	20.319	31.243	73.864	216.542

Table 3: Present Value of an Annuity of $1 in Arrears; $\frac{1-(1+r)^{-n}}{r}$

Rate of return	Number of Periods 1	2	3	4	5	6	7	8	9	10	12	14	16	20	25
6%	0.943	1.833	2.673	3.465	4.212	4.917	5.582	6.210	6.802	7.360	8.384	9.295	10.106	11.470	12.783
7%	0.935	1.808	2.624	3.387	4.100	4.767	5.389	5.971	6.515	7.024	7.943	8.745	9.447	10.594	11.654
8%	0.926	1.783	2.577	3.312	3.993	4.623	5.206	5.747	6.247	6.710	7.536	8.244	8.851	9.818	10.675
9%	0.917	1.759	2.531	3.240	3.890	4.486	5.033	5.535	5.995	6.418	7.161	7.786	8.313	9.129	9.823
10%	0.909	1.736	2.487	3.170	3.791	4.355	4.868	5.335	5.759	6.145	6.814	7.367	7.824	8.514	9.077
11%	0.901	1.713	2.444	3.102	3.696	4.231	4.712	5.146	5.537	5.889	6.492	6.982	7.379	7.963	8.422
12%	0.893	1.690	2.402	3.037	3.605	4.111	4.564	4.968	5.328	5.650	6.194	6.628	6.974	7.469	7.843
13%	0.885	1.668	2.361	2.974	3.517	3.998	4.423	4.799	5.132	5.426	5.918	6.302	6.604	7.025	7.330
14%	0.877	1.647	2.322	2.914	3.433	3.889	4.288	4.639	4.946	5.216	5.660	6.002	6.265	6.623	6.873
15%	0.870	1.626	2.283	2.855	3.352	3.784	4.160	4.487	4.772	5.019	5.421	5.724	5.954	6.259	6.464
16%	0.862	1.605	2.246	2.798	3.274	3.685	4.039	4.344	4.607	4.833	5.197	5.468	5.668	5.929	6.097
18%	0.847	1.566	2.174	2.690	3.127	3.498	3.812	4.078	4.303	4.494	4.793	5.008	5.162	5.353	5.467
20%	0.833	1.528	2.106	2.589	2.991	3.326	3.605	3.837	4.031	4.192	4.439	4.611	4.730	4.870	4.948
22%	0.820	1.492	2.042	2.494	2.864	3.167	3.416	3.619	3.786	3.923	4.127	4.265	4.357	4.460	4.514
24%	0.806	1.457	1.981	2.404	2.745	3.020	3.242	3.421	3.566	3.682	3.851	3.962	4.033	4.110	4.147

Table 4: Future Value of an Annuity of $1 in Arrears; $\frac{(1+r)^{n}-1}{r}$

Rate of return	Number of Periods 2	3	4	5	6	7	8	9	10	12	14	16	20	25
6%	2.060	3.184	4.375	5.637	6.975	8.394	9.897	11.491	13.181	16.870	21.015	25.673	36.786	54.865
7%	2.070	3.215	4.440	5.751	7.153	8.654	10.260	11.978	13.816	17.888	22.550	27.888	40.995	63.249
8%	2.080	3.246	4.506	5.867	7.336	8.923	10.637	12.488	14.487	18.977	24.215	30.324	45.762	73.106
9%	2.090	3.278	4.573	5.985	7.523	9.200	11.028	13.021	15.193	20.141	26.019	33.003	51.160	84.701
10%	2.100	3.310	4.641	6.105	7.716	9.487	11.436	13.579	15.937	21.384	27.975	35.950	57.275	98.347
11%	2.110	3.342	4.710	6.228	7.913	9.783	11.859	14.164	16.722	22.713	30.095	39.190	64.203	114.413
12%	2.120	3.374	4.779	6.353	8.115	10.089	12.300	14.776	17.549	24.133	32.393	42.753	72.052	133.334
13%	2.130	3.407	4.850	6.480	8.323	10.405	12.757	15.416	18.420	25.650	34.883	46.672	80.947	155.620
14%	2.140	3.440	4.921	6.610	8.536	10.730	13.233	16.085	19.337	27.271	37.581	50.980	91.025	181.871
15%	2.150	3.473	4.993	6.742	8.754	11.067	13.727	16.786	20.304	29.002	40.505	55.717	102.444	212.793
16%	2.160	3.506	5.066	6.877	8.977	11.414	14.240	17.519	21.321	30.850	43.672	60.925	115.380	249.214
18%	2.180	3.572	5.215	7.154	9.442	12.142	15.327	19.086	23.521	34.931	50.818	72.939	146.628	342.603
20%	2.200	3.640	5.368	7.442	9.930	12.916	16.499	20.799	25.959	39.581	59.196	87.442	186.688	471.981
22%	2.220	3.708	5.524	7.740	10.442	13.740	17.762	22.670	28.657	44.874	69.010	104.935	237.989	650.955
24%	2.240	3.778	5.684	8.048	10.980	14.615	19.123	24.712	31.643	50.895	80.496	126.011	303.601	898.092

Answers to Check It! Exercises

Exercise #1: \$62.10 = \$100 × 0.621; \$152.10 = \$100 × 1.521; \$331.20 = \$100 × 3.312; \$811.52 = \$100 × 8.115.

Exercise #2: The PV factors are 1.000, 0.877, 0.769, and 0.675, yielding present values of −\$100,000, \$52,620, \$38,450, and \$6,750 for years 0–3. Thus, the NPV = \$6,750 + \$38,450 + \$52,620 – \$100,000 = −\$2,180. We reject the project because it has a negative NPV.

Exercise #3: In Excel, enter cash flows in cells A1 to A4 (starting with the –\$100,000 for the initial outlay in A1). In cell A5, type "=IRR(A1:A4)" and Excel will reveal that the IRR = 12.40%. Using the same approach as in *Check it! Exercise #2,* we can calculate NPV(12%) = \$550; NPV(13%) = −\$820, and confirm the validity of our estimate. Finally, we reject the project because its IRR is lower than the cost of capital (14%).

Exercise #4: Cumulative cash inflows through year 5 = \$60,000 year 1 + \$60,000 year 2 + \$60,000 year 3 + \$50,000 year 4 + \$50,000 year 5 = \$280,000. Payback period of 5.6 = 5 years + (\$310,000 initial investment – \$280,000 cumulative cash inflows through year 5)/\$50,000 cash flow in year 6.

Exercise #5: \$304,000 in year 5 = \$370,000 net cash inflow from Exhibit 11.2 – [(\$370,000 – \$150,000 depreciation expense) × 0.30 in taxes due]. *Alternatively,* \$370,000 – \$150,000 = \$220,000 in taxable income; \$220,000 × 0.30 = \$66,000 in taxes. Thus, \$304,000 = \$220,000 in income – \$66,000 in taxes + \$150,000 in depreciation in expense. \$346,000 in year 10 = \$430,000 net cash inflow from Exhibit 11.2 – [(\$430,000 – \$150,000 depreciation expense) × 0.30 in taxes due].

Self-Study Problem

The Clinging Vine Café is considering the purchase of a new dishwashing machine. This machine will cost \$60,000 now. When sold as scrap at the end of three years, it will fetch \$3,000. Alternatively, the café can continue hiring college students on a part-time basis to wash dishes, at an annual payroll cost of \$22,000. While the dishwasher will increase outflows for power and water, manual washing leads to greater breakage. Considering all of these costs, the dishwasher would save \$2,000 annually in operating costs. If the Café purchases the new dishwashing machine, it will depreciate the washer over three years using straight-line depreciation.

In each of the following three cases, use the net present value method to determine whether The Clinging Vine Café should purchase the dishwashing machine. Treat each case independently.

a. *Ivy, the owner of the Clinging Vine Café, claims that she puts all of her money in her mattress and never goes near banks. This would mean that to Ivy, the opportunity cost of capital is just a less lumpy mattress. Ignore taxes for now.*

From the perspective of buying the dishwasher, we have:

Initial outlay	(\$60,000)
Salvage value	\$3,000
Savings—student wages for three years (\$22,000 × 3)	\$66,000
Savings—Broken dishes for three years (\$2,000 × 3)	\$6,000
NPV (with 0% as cost of capital)	\$15,000

Thus, The Clinging Vine saves \$15,000 by purchasing the new dishwashing machine.

b. *Ivy meets an investment banker and expands her horizons. She now estimates that her cost of capital is 10%. Again, ignore taxes.*

First, let's draw a time line from the perspective of buying the dishwasher.

	Year 0	*Year 1*	*Year 2*	*Year 3*
Sell machine				$3,000
Student wages		$22,000	$22,000	$22,000
Broken dishes		$2,000	$2,000	$2,000
Buy machine	($60,000)			
Total flow	($60,000)	$24,000	$24,000	$27,000

Next, we obtain the discount factors from Table 1 in Appendix B. We calculate the NPV by applying these factors to the raw cash flows each year.

Year	*Cash Flow*	*PV Factor (10%)*	*NPV*
0	($60,000)	1	($60,000)
1	$24,000	.909	$21,816
2	$24,000	.826	$19,824
3	$27,000	.751	$20,277
		NPV	$1,917

Thus, we still find that the café should purchase the dishwashing machine.

c. *Redo the analysis for part(b) assuming a tax rate of 40%.*

In addition to discounting, we also have to consider tax effects. Let's again create a time line from the perspective of buying the dishwasher; for illustration purposes we consider *all individual* cash flows. We place cash inflows above the line and cash outflows below the line.

	Year 0	*Year 1*	*Year 2*	*Year 3*
Sell machine				$3,000
Depreciation tax shield = $20,000 depreciation expense × 0.40 tax rate		$8,000	$8,000	$8,000
Student wages		$22,000	$22,000	$22,000
Broken dishes		$2,000	$2,000	$2,000
Buy machine	($60,000)			
Tax savings lost − student wages		($8,800)	($8,800)	($8,800)
Tax savings lost − broken dishes		(800)	(800)	(800)
Tax on gain from sale = ($3,000 in proceeds − $0 salvage value) × 0.40 tax rate				(1,200)
Total cash flow	−$60,000	$22,400	$22,400	$24,200

Tax savings lost − student wages = (student wages × tax rate)
Tax savings lost − broken dishes = (cost broken dishes × tax rate)

Our next step is to discount the cash flows:

Year	*Cash Flow*	*PV Factor (10%)*	*NPV*
0	($60,000)	1	($60,000.00)
1	$22,400	.909	$20,361.60
2	$22,400	.826	$18,502.40
3	$24,200	.751	$18,174.20
		NPV	($2,961.80)

We find that the NPV is negative; thus, the café should keep the students! This problem illustrates the importance of considering both the time value of money and tax effects when making decisions regarding long-lived resources. Moreover, our answers differ in both direction and magnitude depending on whether we incorporate the opportunity cost of capital and taxes.

Alternate Approach

We underscore the link between capital budgeting and decision making by evaluating the two options separately. If Ivy keeps the students, she would spend $24,000 (= $22,000 + $2,000) annually. Because this expenditure is deductible when computing taxable income, the expense reduces taxes paid by 40% × \$24,000 = \$9,600, leading to a net cash outflow of \$14,400 per year. Using the annuity factor for three years (Table 3 in the Appendix), Ivy computes a discounted cash flow of (\$14,400 × 2.487) = \$35,812.50, where \$14,400 = \$24,000 − \$9,600.

If Ivy buys the dishwasher, she incurs an immediate cash flow of \$60,000. She get a depreciation tax shield of \$8,000 (= 40% × \$60,000/3) for each of three years. Finally, she gets sale proceeds of \$3,000 but pays taxes of \$1,200 (= 40% × \$3,000) on the gain from the sale. The discounted value of these flows is \$38,760.20 (use the PV factors from Table 1 in Appendix B). Keeping the students has a lower cost and saves her \$2,947.70 per year. (The difference of \$14.40 is due to rounding in the PV factor calculations.)

Glossary

Accounting rate of return (ARR) The average annual income from a project divided by the average annual investment in the project.

Annuity A stream of cash flow with the property that the cash flows per period.

Capital budgeting The collective term for the mechanisms and tools used to evaluate expenditures on long-lived resources.

Cost of capital The opportunity cost of money in the form of returns from alternate investments.

Discounting The practice of expressing a future cash flow in terms of its present value.

Discount factor The amount by which a future cash flow is multiplied to obtain its present value.

Discount rate The rate of return employed to compute the present value of future cash flows.

Hurdle rate Minimum required rate of return chosen by management. Often exceeds the cost of capital.

Initial outlay All costs connected with purchasing an asset and getting it ready for its intended use.

Internal rate of return (IRR) The discount rate at which a project's net present value is zero.

Lumpy resource Resources for which it is difficult to match the demand for capacity with the supply.

Modified payback method/period The length of time it takes to recoup the initial investment using discounted cash flows.

Net present value (NPV) The present value of all of the cash flows associated with a resource.

Payback method/period The length of time it takes to recoup the initial investment using undiscounted cash flows.

Present value The value today of a future cash flow.

Real option analysis A collection of mathematical techniques for valuing the flexibility associated with a project.

Salvage value The final one-time costs or benefits associated with disposing of a resource.

Time value of money Phrase used to denote that a dollar today is worth more than a dollar tomorrow.

Review Questions

11.1 LO1. What is capital budgeting?

11.2 LO1. What does the notion "time value of money" mean? Why is it important for project evaluation?

11.3 LO1. "Capacity resources are lumpy in nature." What does the term *lumpy* mean in this statement? Why is it relevant in the context of capital budgeting?

11.4 LO1. What is the difference between a capital budget and an operating budget?

11.5 LO2. What are the four important elements of a capital expenditure decision?

11.6 LO3. Define the term *net present value*. Describe how you would calculate the NPV for a project proposal.

11.7 LO3. Define the term *internal rate of return* or IRR. Describe how you would calculate the IRR for a project proposal.

11.8 LO3. List three assumptions underlying the NPV method.

11.9 LO4. List two key advantages of the payback method.

11.10 LO4. What is the difference between the payback and modified payback methods?

11.11 LO4. Define the accounting rate of return.

11.12 LO5. Why are taxes important in capital budgeting?

11.13 LO5. What is a depreciation tax shield? Is this tax shield a cash inflow or a cash outflow?

11.14 LO6. What is a hurdle rate?

11.15 LO6. Why do many firms begin projects on a small scale before making considerable investments?

Discussion Questions

11.16 LO1, LO2. In Chapters 9 and 10, we used cost allocations to estimate the cost of capacity resources, and to measure the long-term profitability of investing in resources and products. In what ways does this approach differ from capital budgeting principles discussed in this chapter?

11.17 LO1, LO2. "I don't do any capital budgeting for buying my machines. They typically last for more than 10 years. If I have to do capital budgeting, I need to estimate my future cash inflows and outflows for the next 10 years, which is very difficult to do. I don't have time for all that. I know that my company is making money now, and if I need to buy a new machine and replace an existing machine, I just do it." How would you respond to this argument?

11.18 LO2, LO5. What are the tax implications of selling an asset when it still has some economic value? Consider, in particular, the issue when we use an accelerated depreciation schedule for calculating taxable income.

11.19 LO3. List and discuss two advantages of the net present value method relative to the internal rate of return method.

11.20 LO3. The net present value method assumes that future cash inflows are reinvested at the cost of capital. The internal rate of return method assumes that the reinvestment takes place at the internal rate of return. Which is a better assumption and why?

11.21 LO3. What are some of the considerations that go into the choice of discount rate under the net present value method?

11.22 LO2, LO3, LO4. "I don't see any reason to do this net present value stuff. The payback method works well for me. It tells me how many years it takes to recoup the initial money I put in. As long as my payback period is as good as anybody else's in the industry, I am okay." How would you respond to this argument?

11.23 LO3. Discounted cash flow techniques allow us to evaluate a long-term investment by taking future financial benefits into account. However, there could be many nonfinancial costs and benefits as well. Many experts are of the view that when it comes to these non-financial aspects, "it is better to be approximately right than precisely wrong." Do you agree? Explain.

11.24 LO4. Even though the payback method ignores time value of money, many firms continue to use it when evaluating projects. Why might this practice be in the *manager's* best interest?

11.25 LO4. List and discuss two advantages and two disadvantages of the accounting rate of return method.

11.26 LO3. Under the internal rate of return method, how would you decide which projects to accept and which projects to reject? Explain.

11.27 LO3, LO6. Is it always advisable to accept projects with the highest (positive) NPVs? IRRs? Why or why not?

11.28 LO5 (Advanced). Research the term *Modified Accelerated Cost Recovery System* (MACRS) and explain its relevance to project evaluation.

11.29 L05. Often, firms will employ different schedules for computing the depreciation expense for computing accounting and taxable income. Which schedule is relevant from a project evaluation perspective?

11.30 LO6. In the context of investing in advanced manufacturing technologies, why is the current state of affairs an inappropriate baseline for evaluating project benefits?

Exercises

11.31 Present value calculations (LO3). Refer to the data in the following table:

Setting	*Initial Outlay*	*Life (years)*	*Discount Rate (compounded annually)*	*Future Value (at the end of life)*
1	$225,000	5	10%	?
2	?	10	12%	$400,000
3	$157,950	8	?	$450,000
4	$150,000	?	12%	$371,400

Required:

Treating each row of the table independently, compute the missing information. Use the present value/future value tables at the end of the book.

11.32 Annuity calculation (LO3). Kim Barth decides to start a small restaurant near a busy shopping mall. She applies for a loan of $150,000, to be repaid in five annual installments, with each installment due at the end of each of the next five years. The bank charges an interest rate of 10%, compounded annually.

Required:

Compute the annual installment amount. Use the annuity tables at the end of the book.

11.33 Mortgage loan (LO3). Diana and Jason just bought a house for $484,000, inclusive of title insurance and closing costs. They plan to make a down payment of $84,000. They were able to secure a 30-year fixed mortgage loan at an annual percentage rate of 6%, compounded *monthly* from a mortgage lending company.

Required:

a. Using Excel, calculate the monthly payment that Diana and Jason have to make to the mortgage lending company. Because interest is compounded monthly, remember to convert the annual rate into a monthly rate, and convert the number of periods in the mortgage loan from years to months.

b. What would be the outstanding loan balance at the end of five years (*Hint*: Use the annuity as calculated in part (a) above, and consider only the remaining monthly installment payments)?

11.34 Future value calculation (LO3). Haidan and Ying Li just had a baby girl, Julie. They want to make sure that they will have enough money to send Julie to college. They estimate that, 18 years from now, college will cost $35,000 per year for four years. Assume that these cash flows occur at the start of years 18–21. Further, Haidan and Ying believe that they could earn 8% a year on their investments.

Required:

a. How much money should they invest right now (as a lump sum) to have the required amount on hand at the start of year 18? That is, what is the present value of the future payments?

b. Haidan and Ying do not have the necessary cash to make a lump-sum investment today for Julie's college costs. Rather, they plan to save systematically for the next 18 years. How much should they save each year to cover the expected cost? Notice that there will be 18 investments, starting now at the start of year 1 and ending at the start of year 18.

11.35 Depreciation tax shield (LO2, LO5). Quality Metal Works, Inc., is considering a proposal to buy a new furnace for $2,500,000 (all costs included). The furnace will have a useful life of 10 years, with no expected salvage value at the end of its life. The firm requires a rate of return of 8% on all its investments. For convenience, assume that cash flows occur at the end of each year. Assume straight-line depreciation for tax purposes. The applicable tax rate is 30%.

Required:

a. Ignore the depreciation tax shield. What are the minimum annual cash inflows that this furnace must generate for the company to justify the investment?

b. How much is the annual depreciation tax shield? What is the present value of the depreciation tax shield?

c. If you take into account the depreciation tax shield, will the minimum annual cash inflows from operations (pretax) needed to justify this investment increase or decrease? By how much?

11.36 Gain/loss on asset sale, taxes (LO5): Pringle Plastics recently sold a forklift for $12,500. The firm, which pays taxes on income at the rate of 45%, had purchased the forklift for $50,000. The firm's books show accumulated depreciation of $38,700.

Required:

What is the after-tax cash flow due to the sale of the forklift?

11.37 Net present value, depreciation tax shield (LO2, LO3, LO5). The owner of Polyplast, Inc., Joshua Ronen, is trying to decide what to do with a capital of $500,000 at his disposal. Ronen is considering two options: invest the money in shares of another company or expand the capacity of his plastics plant by buying a new injection molding machine. With the first option, he expects to earn a return of 12% over the next 10 years. With the second option, he expects to make annual net cash inflow of $108,000. The tax rate is 30%, and the machine will not have any salvage value at the end of its useful life of 10 years.

Required:

What should Ronen do? (Assume straight-line depreciation for tax purposes.)

11.38 Internal rate of return (LO2, LO3, LO5). Refer to the data in Exercise 11.37. The company has been using the internal rate of return approach to evaluate its long-term investments in the past, and its policy has been to invest in only those projects with internal rates return in excess of 14%.

Required:

a. What is the internal rate of return from investing in the injection molding machine? As per company policy, will it accept or reject this option?

b. Assume that the only other option is the one described in Exercise 11.37—invest the money in the shares of another company. Will Ronen's company be making the right choice if it adheres to its policy of requiring an internal rate of return in excess of 14%? What is the right "hurdle" rate to use for this decision?

11.39 Payback, ARR (LO1, LO2, LO4). Refer to the data in Exercise 11.37.

Required:

a. What is the payback period corresponding to investing in the injection molding machine?

b. What is the modified payback period corresponding to investing in the injection molding machine?

c. What is the accounting rate of return corresponding to investing in the injection molding machine?

11.40 Payback and ARR (LO4). Rego and Associates plans to invest $1,200,000 in modernizing their call centers. They expect productivity to increase and generate 8,000 more billable hours annually. The current bill rate is $50 per hour. The effect of the investment on productivity will last for over five years, although the effects become harder to predict for beyond five years. The company uses a discount factor of 10% on its capital projects.

Required:

a. What is the payback period on this project?

b. What is the modified payback period on this project?

c. What is the project's accounting rate of return? Ignore taxes.

11.41 Payback and ARR (LO4). Gleason and Company is planning to invest $5 million in a new, stand-alone project. Before depreciation, it expects this project to yield a positive cash flow of $1.4 million each year for five years. The firm expects to depreciate the investment on a straight-line basis over five years and with zero salvage value. The applicable discount rate is 12% and the tax rate is 30%.

Required:

a. What is the payback period on this project?

b. What is the modified payback period on this project?

c. What is the project's accounting rate of return?

11.42 Net present value and IRR, equal cash flows (LO3, LO4, LO5). To stave off a sudden increase in competition in the cookware industry, Rahul Sheth of Delight Cookware, Inc., is considering several cost-saving proposals to remain profitable. One such proposal promises an expected cost saving of $275,000 annually over the next five years. The required rate of return on the investment is 8%. Ignore tax effects.

Required:

a. What is the maximum amount that Rahul will be willing to invest in the project?

b. Assuming that Rahul invests the amount you calculate in a. above, what is the payback period on the project?

c. What is the project's internal rate of return?

11.43 Net present value and IRR, equal cash flows (LO3, LO4, LO5). Acme Industries is considering several ideas for expanding its scope of operations. It is planning to open an office in California to tap the Western market. Such an office would require an initial investment of $3.4 million and annual cash operating expenses of $750,000. The office, however, would generate a contribution of $1.6 million per year before considering operating expenses. Acme expects to depreciate (using a straight-line basis) the assets over an eight-year period. At the end of eight years, Acme expects to sell the California office for $400,000. Acme pays taxes at the rate of 30% of income and uses a discount rate of 10% on its capital projects.

Required:

a. Calculate the net present value (NPV) and the internal rate of return (IRR) for the California office. Based on these criteria, should Acme open the office in California?

b. What would be the payback period for this project?

11.44 NPV, IRR, Unequal cash flows (LO3). The following table presents the initial cash outlay and cash flow projections for a new line of digital cameras that DigiCam, Inc., is evaluating.

Initial cash outlay	$2,350,000
Net pretax cash inflows—year 1	$1,000,000
Net pretax cash inflows—year 2	$1,200,000
Net pretax cash inflows—year 3	$1,300,000
Salvage value (at the end of year 3)	$250,000

The company uses a discount rate of 10% for evaluating such projects. The corporate tax rate is 30%. Assume straight-line depreciation for tax.

Required:

a. What is the net present value of the project?

b. Using Excel, calculate the internal rate of return (IRR) for this project.

11.45 NPV, IRR, alternate methods, unequal cash flows (LO3, LO4, LO5). The following table presents the initial cash outlay and cash flow projections for a new store that TopSports, Inc., is planning to open in Boston, Massachusetts

Initial cash outlay	$6,750,000
Net cash inflows—year 1	$2,250,000
Net cash inflows—year 2	$2,250,000
Net cash inflows—year 3	$1,000,000
Net cash inflows—year 4	$700,000
Net cash inflows—year 5	$250,000
Salvage value (at the end of year 5)	$750,000

The company uses a discount rate of 8% for such project evaluations. The corporate tax rate is 30%. Assume straight-line depreciation for tax purposes.

Required:

a. What is the net present value of the project?

b. What is the payback period for the project?

c. What is the modified payback period for the project?

PROBLEMS

11.46 Equipment replacement, totals approach (LO2, LO3, LO5). Copy Center, Inc., offers a variety of document and computer services to the business community in midtown Cleveland. It is considering replacing one of its copiers. The old copier has a book value of $5,000 but can be sold for $12,000. The new copier being considered will cost $90,000 and offers a number of attractive features. The expected life is three years with no expected salvage value at the end of its life. The company expects that the new copier will generate $40,000, $35,000, and $25,000 in after-tax cash flows, respectively, in the first, second, and the third year of operations. The firm's manager, however, tells you that this estimate does not include the depreciation tax shield.

On the other hand, the old copier is in a relatively good condition and can last three more years with careful maintenance. Demand, though, is expected to be lower because the old copier lacks the features of the new copier. Taking these factors into account, the company projects that the old copier will generate $10,000, $8,000, and $5,000 in after tax cash flows over the next three years. Again, this estimate excludes any tax shield arising from depreciating the copier. At the end of three years, this old copier will have no salvage value.

Copy Center uses a cost of capital of 12% for discounting purposes. Copy Center depreciates its copiers on a straight-line basis over a period of three years. The corporate tax rate is 25%, and *all* taxes are paid at the end of each year. If Copy Center decided to retain the old copier, it will depreciate the remaining $5,000 book value over the next three years.

Required:

a. Compute the net present value of the new copier, assuming that the company goes ahead with the replacement decision.

b. Compute the internal rate of return from investment in the new copier (round off to the nearest percentage), assuming that the company goes ahead with the replacement decision.

c. What is the net present value from keeping the old copier?

d. Under the net present value method, which is the better option? What assumption does this method make with respect to the money that is freed up if the company were to retain the old copier? Does this assumption seem reasonable?

e. Discuss some of the qualitative/nonfinancial factors that may be relevant to this decision.

11.47 Net present value (LO3, LO5). The owner of WS Industries, Jayant Krishnan, is considering the purchase of an advanced milling machine. This machine costs $2,500,000 to purchase. Installing the machine, calibrating it and training operators will cost another $500,000. Jayant expects the machine to reduce materials costs by 20% and labor time by 40%. He expects the machine to have a useful life of five years, with zero salvage value.

Currently, Jayant makes 200,000 units of the product annually. For each unit, he incurs $8 in materials cost and $12 in labor costs. WS Industries' cost of capital is 14% and it pays income taxes at the rate of 35%. Assume straight-line depreciation for tax purposes.

Required:

What is the NPV for the project?

11.48 Net present value and IRR, growing cash flows (LO2, LO3, LO5). Thompson and Company plans to invest $8 million in a new product line. It expects the product to sell for $20 per unit. Variable costs are $8 per unit, and annual fixed operating costs (excluding depreciation) are $750,000. The firm expects sales to begin at 200,000 units and grow by 10% a year for four years, leveling off thereafter. Sales will decrease by 25% a year starting in year 8. Thompson expects to close the plant and discontinue the product line at the end of year 10, realizing zero salvage value. The required rate of return on the investment is 12%, and the company uses straight-line depreciation for tax purposes. The corporate tax rate is 30%.

Required:

a. Calculate the annual net after-tax cash flows for each of the 10 years of the proposed product line.

b. What is the net present value of the project?

c. What is the IRR for this project? (Use Excel to calculate the IRR.)

11.49 Ranking projects (NPV vs. IRR) (LO1, LO2, LO3, LO5). Consider the two alternate investment proposals presented in the following table:

	Proposal 1	Proposal 2
Initial outlay	$1,500,000	$1,000,000
Useful life	10 years	10 years
Salvage value at the end of useful life	0	0
Annual revenues	800,000	800,000
Total variable costs	350,000	475,000
Annual fixed costs (excluding depreciation)	100,000	100,000
Required rate of return	12%	12%
Corporate tax rate	30%	30%

Proposal 1 requires higher up-front investment than Proposal 2 but helps in keeping the annual variable costs at a lower level than Proposal 2. If Proposal 2 is chosen, assume that the capital of $500,000 (i.e., the difference between the initial outlays of the two proposals) can be invested elsewhere at the cost of capital.

Required:

a. Rank the alternatives using the NPV method.

b. Rank the alternatives using the IRR method.

c. Some argue that the NPV does not control for project size. In other words, larger projects tend to have higher NPV, everything else remaining the same. Is this argument applicable in this problem? Explain.

d. What is the annual operating leverage under each proposal? (Refer to Chapter 5 for a definition and description of operating leverage.) Discuss the relative operating leverages of the two proposals in light of their rankings using the NPV and IRR methods in (a) and (b) above.

11.50 Ranking projects (Payback and adjusted payback) (LO1, LO2, LO3, LO5, Advanced). Refer to the data regarding two alternate investment proposals in the previous problem.

Required:

a. Rank the alternatives using the payback period method.

b. Rank the alternatives using the modified payback period method.

The modified payback period method identifies when the present value future cash flows covers initial investment.

c. Rank the alternatives using the accounting rate of return method.

d. Compare and contrast the rankings using payback period, adjusted payback period, accounting rate of return, NPP, and IRR methods.

11.51 Equipment Replacement (LO3, LO4, LO6). Tom and Lynda are contemplating the purchase of some cardio machines (e.g., treadmills, elliptical trainers, and stair master). They project that the purchase of gym quality machines would cost $25,000. Operating expenses such as power and maintenance would be $1,200 per year. Tom and Lynda project that the machines would last three years. While current clients would appreciate access to newer equipment, no new members would be added if Tom and Lynda replaced the machine. Each member generates $65 in contribution per month.

Required:

a. Calculate the net present value (NPV) of the purchase at 15%. Assume that the cash outflow takes place now, that all cash inflows take place at the end of the year, and that the machines have zero salvage value at the end of three years. Ignore taxes in your analysis.

b. Suppose Tom and Lynda tell you that not replacing the machines would lead to the loss of 15 members this year, 20 more the next, and 25 the year following. Redo the analysis in part (a).

c. What inference do you draw about the role of the status quo option in NPV analysis?

11.52 Make vs. buy (LO1, LO2, LO3, LO5, Advanced). Simco Blenders makes different kinds of electrical blenders, mixers, and grinders for various kitchen needs. These products are powered by small electric motors. Presently, Simco buys these motors from an outside vendor. However, Simco is considering setting up a facility to make these motors in house. The following table presents financial information for both of these options.

Option 1: Making motors in house	
Initial outlay	$1,500,000
Useful life	10 years
Salvage value at the end of useful life	0
Unit variable cost	$16
Annual fixed costs (excluding depreciation)	$200,000
Required rate of return	12%
Corporate tax rate	30%
Annual demand for motors	250,000
After-sales customer support cost (per unit)	$1
Option 2: Buying motors from vendor	
Unit price	$18
After-sales customer support cost (per unit)	$2

Required:

What should Simco Blenders do?

11.53 Long-term pricing and capital budgeting (LO1, LO2, LO3, LO5, Advanced). Precision Medicals makes medical instruments. It wishes to introduce a new line of electronic blood pressure gauges for use in hospitals and homes. The company will set up a new division solely for this purpose, and the division manager will be fully responsible for all aspects of the business. After much research, the chief financial officer of the company put together the following table to evaluate this proposal.

Initial outlay	$22,250,000
Maximum production capacity	100,000 units
Useful life	15 years
Salvage value at the end of useful life	zero
Unit variable cost	$85
Annual fixed costs (excluding depreciation)	$400,000
Required rate of return	12%
Corporate tax rate	25%
Expected annual sales	80,000 units

Required:

Assume that the company wishes to maintain a stable pricing policy over the entire 15-year horizon. What is the minimum price per unit that the company needs to sell this product in order for this investment to be justifiable in the long run?

11.54 NPV versus payback (LO3, LO4). The following table presents financial information regarding two alternative proposals.

	Proposal 1	Proposal 2
Initial cash outlay	$8,750,000	$8,750,000
Net cash inflows—year 1	$3,750,000	750,000
Net cash inflows—year 2	$4,250,000	1,000,000
Net cash inflows—year 3	$2,000,000	3,250,000
Net cash inflows—year 4	$700,000	3,875,000
Net cash inflows—year 5	$250,000	4,250,000

The salvage value is expected to be zero for both proposals at the end of five years. The company uses a discount rate of 10% for such project evaluations. Ignore income taxes.

Required:

a. Rank the two projects using the net present value method. Which project is preferable?

b. Rank the two projects using payback periods. Which project is preferable?

c. What conclusions can you draw about using the payback period method for project selection?

11.55 NPV versus Payback (LO1, LO2, LO3, LO4, LO6). The following table presents financial information regarding two alternative projects.

	Project 1	Project 2
Initial cash outlay	$6,750,000	$6,750,000
Net cash inflows—year 1	2,000,000	2,500,000
Net cash inflows—year 2	2,000,000	2,500,000
Net cash inflows—year 3	2,000,000	2,500,000
Net cash inflows—year 4	1,400,000	800,000
Net cash inflows—year 5	1,400,000	800,000

The salvage value is expected to be zero for both projects at the end of five years. The company uses a discount rate of 10% for such project evaluations. Ignore income taxes.

Required:

a. Rank the two projects using the net present value method. Which project is preferable?

b. Rank the two projects using payback periods. Which project is preferable?

c. Rank the two projects using *modified* payback periods. Which project is preferable?

MINI-CASES

11.56 Asset replacement, an incremental approach (LO1, LO2, LO3, LO4). STC & Tweety, LLP, own and operate a canary breeding farm. For the most recent year, STC & Tweety generated revenues of $250,000, incurred cash operating costs of $120,000, and had an after-tax net income of $77,000.

STC & Tweety are considering replacing their canary breeding barn. The current ("old") breeding barn has a book value of $60,000 and could be sold today for $45,000. Alternatively, the current barn could be used for the next three years, after which if could be sold for $3,000.

If STC & Tweety decide to keep using the old barn then they anticipate spending $10,000 to fix (repair) the barn at the end of the first year. These costs are considered a routine maintenance expense and will not increase the barn's book value.

A new canary barn would cost $180,000, but it would save STC & Tweety $70,000 in before-tax operating costs for each of the next three years. In addition, after the third year STC & Tweety could sell the new barn to a local farmer for $5,000.

STC & Tweety depreciate all of their assets using straight-line depreciation and zero assumed salvage value. Their required rate of return (cost of capital) is 10%, and their tax rate is 30%.

Assume all operating cash flows occur at year end.

Required:

a. Define the status quo.

b. Define the alternative.

c. What is the incremental *initial* after-tax cash outflow associated with the alternative you have defined? Be sure to include all relevant cash flows.

d. What is the alternative's incremental after-tax cash inflow for the end of year 2?

e. Draw a time line that shows all of the incremental cash flows associated with the alternative you have defined.

f. Should STC & Tweety, LLP invest in the new barn?

11.57 New product introduction (LO3, LO4, LO5). ComCo makes wireless routers and other network communication products. Since its inception in the early 1990s, ComCo has successfully implemented a strategy of investing heavily in product development and introducing a new model with more enhanced features every three to four years. Every time a new model of a product is introduced, the old model is slowly phased out by first cutting prices on the old model to push as much of the inventory out as possible, and then abandoning the model.

In January, 2008 ComCo introduced the next generation of wireless broadband routers, C200H, and quickly abandoned the previous model. The following table presents the initial outlays and cash flow estimates for the next four years for C200H, based on which the CEO of ComSys, Martha Kline, gave a green light to introducing the product.

Initial cash outlay	$9,000,000
Net cash inflows—year 1	$5,000,000
Net cash inflows—year 2	$6,500,000
Net cash inflows—year 3	$4,000,000
Net cash inflows—year 4	$1,000,000
Salvage value (at the end of year 5)	0

The company expects 14% rate of return on all its projects. The corporate tax rate is 30%. In August, 2008, Lara Garcia, one of the product development engineers, burst into Martha's office all excited. Her product development team had just successfully tested a new and much improved router. This was truly an innovative product. It did not take long for Martha to realize that she had a jewel in her hand. Her senior associates agreed. The new product, C300G, had the potential of propelling the company leaps and bounds ahead of the competition.

Soon, however, an unsettling calm set in as the management team tried to get a handle on the decision they were facing. They came up with a list of issues to take into account and address:

- The new router, C300G, could be introduced as early as January 2009. However, it would require a separate production facility from the existing facility used for making C200H.
- Introduction of C300G in January 2009 would mean that the existing router, which was beginning to do well in the market, would lose some of its market because most customers would prefer C300G over C200H.
- It was only a matter of time before other competitors came up with a technology comparable to C300G. The team estimated that they had about a year's head start on this new technology. So, while delaying the introduction of C300G to the following year could help sell the existing product (C200H) and recoup some of the investment in that product, it could cost the company some market share in C300G (the company would lose the timing advantage).

Members of the management team were split in their opinions on what was the right course of action, and decided to prepare a report providing a financial comparison of two options:

1. Introduce C300G on January 1, 2009, and phase out C200H over the next three years.
2. Introduce C300G on January 1, 2010, and phase out C200H over the next two years.

Under both options, the company will continue to produce as much of C200H as it can sell over the remaining years. The management team performed a careful analysis and presented a report to Martha with their recommendations. The following two tables present the financial estimates corresponding to the two options:

Option 1 (introduce C300G in Jan 2009)	C300G	C200H
Cash outlay to introduce C300G	$15,000,000	
Net cash inflows—2009	$10,000,000	$2,200,000
Net cash inflows—2010	$6,000,000	$850,000
Net cash inflows—2011	$4,000,000	$250,000
Net cash inflows—2012	$2,000,000	—
Salvage value (at the end of 2012)	0	

Option 2 (introduce C300G in 1/2010)	C300G	C200H
Net cash inflows—2009	—	$6,500,000
Cash outlay to introduce C300G at the end of 2009	$15,000,000	—
Net cash inflows—2010	$6,000,000	$500,000
Net cash inflows—2011	$4,500,000	$150,000
Net cash inflows—2012	$2,000,000	—
Net cash inflows—2013	$1,000,000	
Salvage value (at the end of 2013)	0	

Required:

a. What should Martha do? Assume that all equipment is depreciated over four years, using the straight-line method.

b. What are some of the qualitative considerations that Martha and her management team should take into account?