CHAPTER 7

Making Capital Investment Decisions

In January 2006, Sharp Corporation, the world's leading producer of flat panel LCD TVs, announced that it would spend an additional 200 billion yen ($1.75 billion) to build a new plant to produce LCD panels. This addition brought the total investment in the new plant to 350 billion yen ($3.07 billion). The extra investment increased the production capacity of the new plant from 30,000 glass substrates per month to 90,000 glass substrates per month, and the new plant would have the capacity to produce the equivalent of 22 million 32-inch TV sets by 2008. Just several days earlier, Matsushita Electric Industrial Co., the world's leading plasma TV manufacturer, announced that it would invest 180 billion yen ($1.57 billion) to build a new plant to produce plasma panels. The new plasma plant would more than double the company's production capacity to 11.1 million units per year.

This chapter follows up on our previous one by delving more deeply into capital budgeting and the evaluation of projects such as these flat panel manufacturing facilities. We identify the relevant cash flows of a project, including initial investment outlays, requirements for net working capital, and operating cash flows. Further, we look at the effects of depreciation and taxes. We also examine the impact of inflation, and show how to evaluate consistently the NPV analysis of a project.

7.1 Incremental Cash Flows

Cash Flows—Not Accounting Income

You may not have thought about it, but there is a big difference between corporate finance courses and financial accounting courses. Techniques in corporate finance generally use cash flows, whereas financial accounting generally stresses income or earnings numbers. Certainly our text follows this tradition: Our net present value techniques discount cash flows, not earnings. When considering a single project, we discount the cash flows that the firm receives from the project. When valuing the firm as a whole, we discount dividends—not earnings—because dividends are the cash flows that an investor receives.

EXAMPLE 7.1

Relevant Cash Flows The Weber-Decker Co. just paid $1 million in cash for a building as part of a new capital budgeting project. This entire $1 million is an immediate cash outflow. However, assuming straight-line depreciation over 20 years, only $50,000 (=$1 million/20) is considered an accounting expense in the current year. Current earnings are thereby reduced by only $50,000. The remaining $950,000 is expensed over the following 19 years. For capital budgeting purposes, the relevant cash outflow at date 0 is the full $1 million, not the reduction in earnings of only $50,000.

Always discount cash flows, not earnings, when performing a capital budgeting calculation. Earnings do not represent real money. You can't spend out of earnings, you can't eat out of earnings, and you can't pay dividends out of earnings. You can do these things only out of cash flow.

In addition, it is not enough to use cash flows. In calculating the NPV of a project, only cash flows that are *incremental* to the project should be used. These cash flows are the changes in the firm's cash flows that occur as a direct consequence of accepting the project. That is, we are interested in the difference between the cash flows of the firm with the project and the cash flows of the firm without the project.

The use of incremental cash flows sounds easy enough, but pitfalls abound in the real world. We describe how to avoid some of the pitfalls of determining incremental cash flows.

Sunk Costs

A **sunk cost** is a cost that has already occurred. Because sunk costs are in the past, they cannot be changed by the decision to accept or reject the project. Just as we "let bygones be bygones," we should ignore such costs. Sunk costs are not incremental cash outflows.

EXAMPLE 7.2

Sunk Costs The General Milk Company is currently evaluating the NPV of establishing a line of chocolate milk. As part of the evaluation, the company had paid a consulting firm $100,000 to perform a test marketing analysis. This expenditure was made last year. Is this cost relevant for the capital budgeting decision now confronting the management of General Milk Company?

The answer is no. The $100,000 is not recoverable, so the $100,000 expenditure is a sunk cost, or spilled milk. Of course, the decision to spend $100,000 for a marketing analysis was a capital budgeting decision itself and was perfectly relevant *before* it was sunk. Our point is that once the company incurred the expense, the cost became irrelevant for any future decision.

Opportunity Costs

Your firm may have an asset that it is considering selling, leasing, or employing elsewhere in the business. If the asset is used in a new project, potential revenues from alternative uses are lost. These lost revenues can meaningfully be viewed as costs. They are called **opportunity costs** because, by taking the project, the firm forgoes other opportunities for using the assets.

EXAMPLE 7.3

Opportunity Costs Suppose the Weinstein Trading Company has an empty warehouse in Philadelphia that can be used to store a new line of electronic pinball machines. The company hopes to sell these machines to affluent Northeastern consumers. Should the warehouse be considered a cost in the decision to sell the machines?

The answer is yes. The company could sell the warehouse if the firm decides not to market the pinball machines. Thus, the sales price of the warehouse is an opportunity cost in the pinball machine decision.

Side Effects

Another difficulty in determining incremental cash flows comes from the side effects of the proposed project on other parts of the firm. A side effect is classified as either **erosion** or **synergy**. Erosion occurs when a new product reduces the sales and, hence, the cash flows of existing products. Synergy occurs when a new project increases the cash flows of existing projects.

EXAMPLE 7.4

Synergies Suppose the Innovative Motors Corporation (IMC) is determining the NPV of a new convertible sports car. Some of the customers who would purchase the car are owners of IMC's compact sedans. Are all sales and profits from the new convertible sports car incremental?

The answer is no because some of the cash flow represents transfers from other elements of IMC's product line. This is erosion, which must be included in the NPV calculation. Without taking erosion into account, IMC might erroneously calculate the NPV of the sports car to be, say, $100 million. If half the customers are transfers from the sedan and lost sedan sales have an NPV of −$150 million, the true NPV is −$50 million (=$100 million − $150 million).

IMC is also contemplating the formation of a racing team. The team is forecast to lose money for the foreseeable future, with perhaps the best projection showing an NPV of −$35 million for the operation. However, IMC's managers are aware that the team will likely generate great publicity for all of IMC's products. A consultant estimates that the increase in cash flows elsewhere in the firm has a present value of $65 million. Assuming that the consultant's estimates of synergy are trustworthy, the net present value of the team is $30 million (=$65 million − $35 million). The managers should form the team.

Allocated Costs

Frequently a particular expenditure benefits a number of projects. Accountants allocate this cost across the different projects when determining income. However, for capital budgeting purposes, this **allocated cost** should be viewed as a cash outflow of a project only if it is an incremental cost of the project.

EXAMPLE 7.5

Allocated Costs The Voetmann Consulting Corp. devotes one wing of its suite of offices to a library requiring a cash outflow of $100,000 a year in upkeep. A proposed capital budgeting project is expected to generate revenue equal to 5 percent of the overall firm's sales. An executive at the firm, H. Sears, argues that $5,000 (=5 percent × $100,000) should be viewed as the proposed project's share of the library's costs. Is this appropriate for capital budgeting?

The answer is no. One must ask what the difference is between the cash flows of the entire firm with the project and the cash flows of the entire firm without the project. The firm will spend $100,000 on library upkeep whether or not the proposed project is accepted. Because acceptance of the proposed project does not affect this cash flow, the cash flow should be ignored when calculating the NPV of the project.

7.2 The Baldwin Company: An Example

We next consider the example of a proposed investment in machinery and related items. Our example involves the Baldwin Company and colored bowling balls.

The Baldwin Company, originally established in 1965 to make footballs, is now a leading producer of tennis balls, baseballs, footballs, and golf balls. In 1973 the company introduced "High Flite," its first line of high-performance golf balls. Baldwin management has sought opportunities in whatever businesses seem to have some potential for cash flow. Recently W. C. Meadows, vice president of the Baldwin Company, identified another segment of the sports ball market that looked promising and that he felt was not adequately served by larger manufacturers. That market was for brightly colored bowling balls, and he believed many bowlers valued appearance and style above performance. He also believed that it would be difficult for competitors to take advantage of the opportunity because of both Baldwin's cost advantages and its highly developed marketing skills.

As a result, the Baldwin Company investigated the marketing potential of brightly colored bowling balls. Baldwin sent a questionnaire to consumers in three markets: Philadelphia, Los Angeles, and New Haven. The results of the three questionnaires were much better than expected and supported the conclusion that the brightly colored bowling balls could achieve a 10 to 15 percent share of the market. Of course, some people at Baldwin complained about the cost of the test marketing, which was $250,000. (As we shall see later, this is a sunk cost and should not be included in project evaluation.)

In any case, the Baldwin Company is now considering investing in a machine to produce bowling balls. The bowling balls would be manufactured in a building owned by the firm and located near Los Angeles. This building, which is vacant, and the land can be sold for $150,000 after taxes.

Working with his staff, Meadows is preparing an analysis of the proposed new product. He summarizes his assumptions as follows: The cost of the bowling ball machine is $100,000. The machine has an estimated market value at the end of five years of $30,000. Production by year during the five-year life of the machine is expected to be as follows: 5,000 units, 8,000 units, 12,000 units, 10,000 units, and 6,000 units. The price of bowling balls in the first year will be $20. The bowling ball market is highly competitive, so Meadows believes that the price of bowling balls will increase at only 2 percent per year, as compared to the anticipated general inflation rate of 5 percent. Conversely, the plastic used to produce bowling balls is rapidly becoming more expensive. Because of this, production cash outflows are expected to grow at 10 percent per year. First-year production costs will be $10 per unit. Meadows has determined, based on Baldwin's taxable income, that the appropriate incremental corporate tax rate in the bowling ball project is 34 percent.

Net working capital is defined as the difference between current assets and current liabilities. Like any other manufacturing firm, Baldwin finds that it must maintain an investment in working capital. It will purchase raw materials before production and sale, giving rise to an investment in inventory. It will maintain cash as a buffer against unforeseen expenditures. And, its credit sales will generate accounts receivable. Management determines that an immediate (year 0) investment in the different items of working capital of $10,000 is required. Working capital is forecast to rise in the early years of the project but to fall to $0 by the project's end. In other words, the investment in working capital is to be completely recovered by the end of the project's life.

Projections based on these assumptions and Meadows's analysis appear in Tables 7.1 through 7.4. In these tables all cash flows are assumed to occur at the *end* of the year. Because of the large amount of information in these tables, it is important to see how the tables are related. Table 7.1 shows the basic data for both investment and income. Supplementary schedules on operations and depreciation, as presented in Tables 7.2 and 7.3, help explain where the numbers in Table 7.1 come from. Our goal is to obtain projections of cash flow. The data in Table 7.1 are all that are needed to calculate the relevant cash flows, as shown in Table 7.4.

An Analysis of the Project

Investments The investment outlays for the project are summarized in the top segment of Table 7.1. They consist of three parts:

1. *The bowling ball machine*: The purchase requires an immediate (year 0) cash outflow of $100,000. The firm realizes a cash inflow when the machine is sold in year 5. These cash flows are shown in line 1 of Table 7.1. As indicated in the footnote to the table, taxes are incurred when the asset is sold.

Table 7.1 **The Worksheet for Cash Flows of the Baldwin Company (in $ thousands). (All cash flows occur at the *end* of the year.)**

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Investments:						
(1) Bowling ball machine	−$100.00					$21.76*
(2) Accumulated depreciation		$ 20.00	$ 52.00	$ 71.20	$ 82.72	94.24
(3) Adjusted basis of machine after depreciation (end of year)		80.00	48.00	28.80	17.28	5.76
(4) Opportunity cost (warehouse)	−150.00					150.00
(5) Net working capital (end of year)	10.00	10.00	16.32	24.97	21.22	0
(6) Change in net working capital	−10.00		−6.32	−8.65	3.75	21.22
(7) Total cash flow of investment [(1) + (4) + (6)]	−260.00		−6.32	−8.65	3.75	192.98
Income:						
(8) Sales revenues		$100.00	$163.20	$249.72	$212.20	$129.90
(9) Operating costs		−50.00	−88.00	−145.20	−133.10	−87.84
(10) Depreciation		−20.00	−32.00	−19.20	−11.52	−11.52
(11) Income before taxes [(8) + (9) + (10)]		30.00	43.20	85.32	67.58	30.54
(12) Tax at 34 percent		−10.20	−14.69	−29.01	−22.98	−10.38
(13) Net income		19.80	28.51	56.31	44.60	20.16

*We assume that the ending market value of the capital investment at year 5 is $30 (in thousands). The taxable amount is $24.24 (=$30 − $5.76). The aftertax salvage value is $30 − [.34 × ($30 − $5.76)] = $21.76.

Table 7.2

Operating Revenues and Costs of the Baldwin Company

(1) Year	(2) Quantity Produced	(3) Price	(4) Sales Revenues	(5) Cost Per Unit	(6) Operating Costs
1	5,000	$20.00	$100,000	$10.00	$ 50,000
2	8,000	20.40	163,200	11.00	88,000
3	12,000	20.81	249,720	12.10	145,200
4	10,000	21.22	212,200	13.31	133,100
5	6,000	21.65	129,900	14.64	87,840

Prices rise at 2% a year.
Unit costs rise at 10% a year.

2. *The opportunity cost of not selling the warehouse*: If Baldwin accepts the bowling ball project, it will use a warehouse and land that could otherwise be sold. The estimated sales price of the warehouse and land is therefore included as an *opportunity cost* in year 0, as presented in line 4. Opportunity costs are treated as cash outflows for purposes of capital budgeting. However, note that if the project is accepted, management assumes that the warehouse will be sold for $150,000 (after taxes) in year 5.

   The test marketing cost of $250,000 is not included. The tests occurred in the past and should be viewed as a *sunk cost*.

Table 7.3 Depreciation (in percent) under Modified Accelerated Cost Recovery System (MACRS)

	Recovery Period Class					
Year	3 Years	5 Years	7 Years	10 Years	15 Years	20 Years
1	.333	.200	.143	.100	.050	.038
2	.444	.320	.245	.180	.095	.072
3	.148	.192	.175	.144	.086	.067
4	.074	.115	.125	.115	.077	.062
5		.115	.089	.092	.069	.057
6		.058	.089	.074	.062	.053
7			.089	.066	.059	.049
8			.045	.066	.059	.045
9				.066	.059	.045
10				.066	.059	.045
11				.033	.059	.045
12–15					.059	.045
16					.030	.045
17–20						.045
21						.022

Depreciation is expressed as a percentage of the asset's cost. These schedules are based on the IRS publication *Depreciation*. Details of depreciation are presented later in the chapter. Three-year depreciation actually carries over four years because the IRS assumes the purchase is made in midyear.

Table 7.4 Incremental Cash Flows for the Baldwin Company (in $ thousands)

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
(1) Sales revenue [line 8, Table 7.1]		$100.00	$163.20	$249.72	$212.20	$129.90
(2) Operating costs [line 9, Table 7.1]		−50.00	−88.00	−145.20	−133.10	−87.84
(3) Taxes [line 12, Table 7.1]		−10.20	−14.69	−29.01	−22.98	−10.38
(4) Cash flow from operations [(1) + (2) + (3)]		39.80	60.51	75.51	56.12	31.68
(5) Total cash flow of investment [line 7, Table 7.1]	−$260.00		−6.32	−8.65	3.75	192.98
(6) Total cash flow of project [(4) + (5)]	−260.00	39.80	54.19	66.86	59.87	224.66

NPV @		
	4%	$123.641
	10%	$51.588
	15%	$5.472
	15.67%	$0
	20%	−$31.351

3. *The investment in working capital*: Required working capital appears in line 5. Working capital rises over the early years of the project as expansion occurs. However, all working capital is assumed to be recovered at the end, a common assumption in capital budgeting. In other words, all inventory is sold by the end, the cash balance maintained as a buffer is liquidated, and all accounts receivable are collected. Increases in working capital in the early years must be funded by cash generated elsewhere in the firm. Hence, these increases are viewed as cash *outflows*. To reiterate, it is the *increase* in working capital over a year that leads to a cash outflow in that year. Even if working

capital is at a high level, there will be no cash outflow over a year if working capital stays constant over that year. Conversely, decreases in working capital in the later years are viewed as cash inflows. All of these cash flows are presented in line 6 of Table 7.1. A more complete discussion of working capital is provided later in this section.

To recap, there are three investments in this example: the bowling ball machine (line 1 in Table 7.1), the opportunity cost of the warehouse (line 4), and the changes in working capital (line 6). The total cash flow from these three investments is shown in line 7.

Income and Taxes Next the determination of income is presented in the bottom segment of Table 7.1. While we are ultimately interested in cash flow—not income—we need the income calculation to determine taxes. Lines 8 and 9 of Table 7.1 show sales revenues and operating costs, respectively. The projections in these lines are based on the sales revenues and operating costs computed in columns 4 and 6 of Table 7.2. The estimates of revenues and costs follow from assumptions made by the corporate planning staff at Baldwin. In other words, the estimates critically depend on the fact that product prices are projected to increase at 2 percent per year and costs per unit are projected to increase at 10 percent per year.

Depreciation of the \$100,000 capital investment is shown in line 10 of Table 7.1. Where do these numbers come from? Depreciation for tax purposes for U.S. companies is based on the Modified Accelerated Cost Recovery System (MACRS). Each asset is assigned a useful life under MACRS, with an accompanying depreciation schedule as shown in Table 7.3. The IRS ruled that Baldwin is to depreciate its capital investment over five years, so the second column of the table applies in this case. Because depreciation in the table is expressed as a percentage of the asset's cost, multiply the percentages in this column by \$100,000 to arrive at depreciation in dollars.

Income before taxes is calculated in line 11 of Table 7.1. Taxes are provided in line 12 of this table, and net income is calculated in line 13.

Salvage Value In calculating depreciation under current tax law, the expected economic life and future value of an asset are not issues. As a result, the book value of an asset can differ substantially from its actual market value. For example, consider the bowling machine the Baldwin Company is considering for its new project. The book value after the first year is \$100,000 less the first year's depreciation of \$20,000, or \$80,000. After six years, the book value of the machine is zero.

Suppose, at the end of the project, Baldwin sold the machine. At the end of the fifth year, the book value of the machine would be \$5,760; but based on Baldwin's experience, it would probably be worth about \$30,000. If the company actually sold it for this amount, then it would pay taxes at the ordinary income tax rate on the difference between the sale price of \$30,000 and the book value of \$5,760. With a 34 percent tax rate, the tax liability would be $.34 \times (\$30{,}000 - 5{,}760) = \$8{,}241.60$. So, the aftertax salvage value of the equipment, a cash inflow to the company, would be $\$30{,}000 - 8{,}241.60 = \$21{,}758.40$.

Taxes must be paid in this case because the difference between the market value and the book value is "excess" depreciation, and it must be "recaptured" when the asset is sold. In this case, Baldwin would have over depreciated the asset by $\$30{,}000 - 5{,}760 = \$24{,}240$. Because the depreciation was too high, the company paid too little in taxes.

Notice this is not a tax on a long-term capital gain. Further, what is and what is not a capital gain is ultimately up to taxing authorities, and the specific rules can be very complex. We will ignore capital gains taxes for the most part.

Finally, if the book value exceeds the market value, then the difference is treated as a loss for tax purposes. For example, if Baldwin sold the machine for $4,000, then the book value exceeds the market value by $1,760. In this case, a tax savings of $.34 \times \$1,760 = \$598.40$ occurs.

Cash Flow Cash flow is finally determined in Table 7.4. We begin by reproducing lines 8, 9, and 12 in Table 7.1 as lines 1, 2, and 3 in Table 7.4. Cash flow from operations, which is sales minus both operating costs and taxes, is provided in line 4 of Table 7.4. Total investment cash flow, taken from line 7 of Table 7.1, appears as line 5 of Table 7.4. Cash flow from operations plus total cash flow of the investment equals total cash flow of the project, which is displayed as line 6 of Table 7.4.

Net Present Value The NPV of the Baldwin bowling ball project can be calculated from the cash flows in line 6. As can be seen at the bottom of Table 7.4, the NPV is $51,588 if 10 percent is the appropriate discount rate and −$31,351 if 20 percent is the appropriate discount rate. If the discount rate is 15.67 percent, the project will have a zero NPV. In other words, the project's internal rate of return is 15.67 percent. If the discount rate of the Baldwin bowling ball project is above 15.67 percent, it should not be accepted because its NPV would be negative.

Which Set of Books?

It should be noted that the firm's management generally keeps two sets of books, one for the IRS (called the *tax books*) and another for its annual report (called the *stockholders' books*). The tax books follow the rules of the IRS. The stockholders' books follow the rules of the *Financial Accounting Standards Board* (FASB), the governing body in accounting. The two sets of rules differ widely in certain areas. For example, income on municipal bonds is ignored for tax purposes while being treated as income by the FASB. The differences almost always benefit the firm: The rules permit income on the stockholders' books to be higher than income on the tax books. That is, management can look profitable to the stockholders without needing to pay taxes on all of the reported profit. In fact, plenty of large companies consistently report positive earnings to the stockholders while reporting losses to the IRS.

A Note about Net Working Capital

The investment in net working capital is an important part of any capital budgeting analysis. While we explicitly considered net working capital in lines 5 and 6 of Table 7.1, students may be wondering where the numbers in these lines came from. An investment in net working capital arises whenever (1) inventory is purchased, (2) cash is kept in the project as a buffer against unexpected expenditures, and (3) credit sales are made, generating accounts receivable rather than cash. (The investment in net working capital is reduced by credit purchases, which generate accounts payable.) This investment in net working capital represents a cash outflow because cash generated elsewhere in the firm is tied up in the project.

To see how the investment in net working capital is built from its component parts, we focus on year 1. We see in Table 7.1 that Baldwin's managers predict sales in year 1 to be $100,000 and operating costs to be $50,000. If both the sales and costs were cash transactions, the firm would receive $50,000 (=$100,000 − $50,000). As stated earlier, this cash flow would occur at the *end* of year 1.

Now let's give you more information. The managers:

1. Forecast that $9,000 of the sales will be on credit, implying that cash receipts at the end of year 1 will be only $91,000 (=$100,000 − $9,000). The accounts receivable of $9,000 will be collected at the end of year 2.

2. Believe that they can defer payment on \$3,000 of the \$50,000 of costs, implying that cash disbursements at the end of year 1 will be only \$47,000 (=\$50,000 − \$3,000). Baldwin will pay off the \$3,000 of accounts payable at the end of year 2.
3. Decide that inventory of \$2,500 should be left on hand at the end of year 1 to avoid *stockouts* (that is, running out of inventory).
4. Decide that cash of \$1,500 should be earmarked for the project at the end of year 1 to avoid running out of cash.

Thus, net working capital at the end of year 1 is:

$$\underset{\substack{\text{Accounts}\\ \text{receivable}}}{\$9{,}000} - \underset{\substack{\text{Accounts}\\ \text{payable}}}{\$3{,}000} + \underset{\text{Inventory}}{\$2{,}500} + \underset{\text{Cash}}{\$1{,}500} = \underset{\substack{\text{Net working}\\ \text{capital}}}{\$10{,}000}$$

Because \$10,000 of cash generated elsewhere in the firm must be used to offset this requirement for net working capital, Baldwin's managers correctly view the investment in net working capital as a cash outflow of the project. As the project grows over time, needs for net working capital increase. *Changes* in net working capital from year to year represent further cash flows, as indicated by the negative numbers for the first few years on line 6 of Table 7.1. However, in the declining years of the project, net working capital is reduced—ultimately to zero. That is, accounts receivable are finally collected, the project's cash buffer is returned to the rest of the corporation, and all remaining inventory is sold off. This frees up cash in the later years, as indicated by positive numbers in years 4 and 5 on line 6.

Typically corporate worksheets (such as Table 7.1) treat net working capital as a whole. The individual components of working capital (receivables, inventory, and the like) do not generally appear in the worksheets. However, the reader should remember that the working capital numbers in the worksheets are not pulled out of thin air. Rather, they result from a meticulous forecast of the components, just as we illustrated for year 1.

A Note about Depreciation

The Baldwin case made some assumptions about depreciation. Where did these assumptions come from? Assets are currently depreciated for tax purposes according to the provisions of the 1986 Tax Reform Act. There are seven classes of depreciable property:

- The three-year class includes certain specialized short-lived property. Tractor units and racehorses over two years old are among the very few items fitting into this class.
- The five-year class includes (a) cars and trucks; (b) computers and peripheral equipment, as well as calculators, copiers, and typewriters; and (c) specific items used for research.
- The seven-year class includes office furniture, equipment, books, and single-purpose agricultural structures. It is also a catchall category because any asset not designated to be in another class is included here.
- The 10-year class includes vessels, barges, tugs, and similar equipment related to water transportation.
- The 15-year class encompasses a variety of specialized items. Included are equipment of telephone distribution plants and similar equipment used for voice and data communications, and sewage treatment plants.

- The 20-year class includes farm buildings, sewer pipe, and other very long-lived equipment.
- Real property that is depreciable is separated into two classes: residential and nonresidential. The cost of residential property is recovered over 27½ years and nonresidential property over 31½ years.

Items in the three-, five-, and seven-year classes are depreciated using the 200 percent declining-balance method, with a switch to straight-line depreciation at a point specified in the Tax Reform Act. Items in the 15- and 20-year classes are depreciated using the 150 percent declining-balance method, with a switch to straight-line depreciation at a specified point. All real estate is depreciated on a straight-line basis.

All calculations of depreciation include a half-year convention, which treats all property as if it were placed in service at midyear. To be consistent, the IRS allows half a year of depreciation for the year in which property is disposed of or retired. The effect of this is to spread the deductions for property over one year more than the name of its class—for example, six tax years for five-year property.

Interest Expense

It may have bothered you that interest expense was ignored in the Baldwin example. After all, many projects are at least partially financed with debt, particularly a bowling ball machine that is likely to increase the debt capacity of the firm. As it turns out, our approach of assuming no debt financing is rather standard in the real world. Firms typically calculate a project's cash flows under the assumption that the project is financed only with equity. Any adjustments for debt financing are reflected in the discount rate, not the cash flows. The treatment of debt in capital budgeting will be covered in depth later in the text. Suffice it to say at this time that the full ramifications of debt financing are well beyond our current discussion.

7.3 Inflation and Capital Budgeting

Inflation is an important fact of economic life, and it must be considered in capital budgeting. We begin our examination of inflation by considering the relationship between interest rates and inflation.

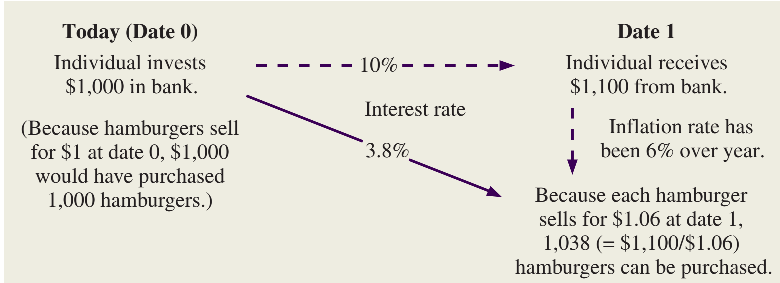
Interest Rates and Inflation

Suppose a bank offers a one-year interest rate of 10 percent. This means that an individual who deposits \$1,000 will receive \$1,100 (=\$1,000 × 1.10) in one year. Although 10 percent may seem like a handsome return, one can put it in perspective only after examining the rate of inflation.

Imagine that the rate of inflation is 6 percent over the year and it affects all goods equally. For example, a restaurant that charges \$1.00 for a hamburger today will charge \$1.06 for the same hamburger at the end of the year. You can use your \$1,000 to buy 1,000 hamburgers today (date 0). Alternatively, if you put your money in the bank, you can buy 1,038 (=\$1,100/\$1.06) hamburgers at date 1. Thus, lending increases your hamburger consumption by only 3.8 percent.

Because the prices of all goods rise at this 6 percent rate, lending lets you increase your consumption of any single good or any combination of goods by only 3.8 percent. Thus, 3.8 percent is what you are *really* earning through your savings account, after adjusting for

Figure 7.1
Calculation of Real Rate of Interest



Hamburger is used as an illustrative good. 1,038 hamburgers can be purchased on date 1 instead of 1,000 hamburgers at date 0. Real interest rate = 1,038/1,000 — 1 = 3.8%.

inflation. Economists refer to the 3.8 percent number as the *real interest rate*. Economists refer to the 10 percent rate as the *nominal interest rate* or simply the *interest rate*. This discussion is illustrated in Figure 7.1.

We have used an example with a specific nominal interest rate and a specific inflation rate. In general, the formula between real and nominal interest rates can be written as follows:

$$1 + \text{Nominal interest rate} = (1 + \text{Real interest rate}) \times (1 + \text{Inflation rate})$$

Rearranging terms, we have:

$$\text{Real interest rate} = \frac{1 + \text{Nominal interest rate}}{1 + \text{Inflation rate}} - 1 \qquad \textbf{(7.1)}$$

The formula indicates that the real interest rate in our example is 3.8 percent ($=1.10/1.06 - 1$).

Equation 7.1 determines the real interest rate precisely. The following formula is an approximation:

$$\text{Real interest rate} \cong \text{Nominal interest rate} - \text{Inflation rate} \qquad \textbf{(7.2)}$$

The symbol $\cong$ indicates that the equation is approximately true. This latter formula calculates the real rate in our example like this:

$$4\% = 10\% - 6\%$$

The student should be aware that, although Equation 7.2 may seem more intuitive than Equation 7.1, 7.2 is only an approximation. This approximation is reasonably accurate for low rates of interest and inflation. In our example the difference between the approximate calculation and the exact one is only 0.2 percent ($=4$ percent $-$ 3.8 percent). Unfortunately, the approximation becomes poor when rates are higher.

EXAMPLE 7.6

Real and Nominal Rates The little-known monarchy of Gerberovia recently had a nominal interest rate of 300 percent and an inflation rate of 280 percent. According to Equation 7.2, the real interest rate is:

$$300\% - 280\% = 20\% \text{ (Approximate formula)}$$

However, according to Equation 7.1 this rate is:

$$\frac{1 + 300\%}{1 + 280\%} - 1 = 5.26\% \quad \text{(Exact formula)}$$

(continued)

How do we know that the second formula is indeed the exact one? Let's think in terms of hamburgers again. Had you deposited $1,000 in a Gerberovian bank a year ago, the account would be worth $4,000 [=$1,000 × (1 + 300%)] today. However, while a hamburger cost $1 a year ago, it costs $3.80 (=1 + 280%) today. Therefore, you would now be able to buy 1,052.6 (=$4,000/3.80) hamburgers, implying a real interest rate of 5.26 percent.

Cash Flow and Inflation

The previous analysis defines two types of interest rates, nominal rates and real rates, and relates them through Equation 7.1. Capital budgeting requires data on cash flows as well as on interest rates. Like interest rates, cash flows can be expressed in either nominal or real terms.

A **nominal cash flow** refers to the actual dollars to be received (or paid out). A **real cash flow** refers to the cash flow's purchasing power. These definitions are best explained by examples.

EXAMPLE 7.7

Nominal versus Real Cash Flow Burrows Publishing has just purchased the rights to the next book of famed romantic novelist Barbara Musk. Still unwritten, the book should be available to the public in four years. Currently, romantic novels sell for $10.00 in softcover. The publishers believe that inflation will be 6 percent a year over the next four years. Because romantic novels are so popular, the publishers anticipate that their prices will rise about 2 percent per year more than the inflation rate over the next four years. Burrows Publishing plans to sell the novel at $13.60 [$=(1.08)^4 \times$ $10.00] four years from now, anticipating sales of 100,000 copies.

The expected cash flow in the fourth year of $1.36 million (=$13.60 × 100,000) is a *nominal cash flow*. That is, the firm expects to receive $1.36 million at that time. In other words, a nominal cash flow refers to the actual dollars to be received in the future.

The purchasing power of $1.36 million in four years is:

$$\$1.08 \text{ million} = \frac{\$1.36 \text{ million}}{(1.06)^4}$$

The figure of $1.08 million is a *real cash flow* because it is expressed in terms of purchasing power. Extending our hamburger example, the $1.36 million to be received in four years will only buy 1.08 million hamburgers because the price of a hamburger will rise from $1 to $1.26 [$=\$1 \times (1.06)^4$] over the period.

EXAMPLE 7.8

Depreciation EOBII Publishers, a competitor of Burrows, recently bought a printing press for $2,000,000 to be depreciated by the straight-line method over five years. This implies yearly depreciation of $400,000 (=$2,000,000/5). Is this $400,000 figure a real or a nominal quantity?

Depreciation is a *nominal* quantity because $400,000 is the actual tax deduction over each of the next four years. Depreciation becomes a real quantity if it is adjusted for purchasing power. Hence, $316,837 [$=\$400{,}000/(1.06)^4$] is depreciation in the fourth year, expressed as a real quantity.

Discounting: Nominal or Real?

Our previous discussion showed that interest rates can be expressed in either nominal or real terms. Similarly, cash flows can be expressed in either nominal or real terms. Given these choices, how should one express interest rates and cash flows when performing capital budgeting?

Financial practitioners correctly stress the need to maintain *consistency* between cash flows and discount rates. That is:

Nominal cash flows must be discounted at the *nominal* rate.

Real cash flows must be discounted at the *real* rate.

As long as one is consistent, either approach is correct. To minimize computational error, it is generally advisable in practice to choose the approach that is easiest. This idea is illustrated in the following two examples.

EXAMPLE 7.9

Real and Nominal Discounting Shields Electric forecasts the following nominal cash flows on a particular project:

	0	1	2
Cash flow	−$1,000	$600	$650

The nominal discount rate is 14 percent, and the inflation rate is forecast to be 5 percent. What is the value of the project?

Using Nominal Quantities The NPV can be calculated as:

$$\$26.47 = -\$1{,}000 + \frac{\$600}{1.14} + \frac{\$650}{(1.14)^2}$$

The project should be accepted.

Using Real Quantities The real cash flows are these:

	0	1	2
Cash flow	−$1,000	$571.43	$589.57
		$\left(\frac{\$600}{1.05}\right)$	$\left(\frac{\$650}{(1.05)^2}\right)$

As we have discussed, the real discount rate is 8.57143 percent (=1.14/1.05 − 1).

The NPV can be calculated as:

$$\$26.47 = -\$1{,}000 + \frac{\$571.43}{1.0857143} + \frac{\$589.57}{(1.0857143)^2}$$

The NPV is the same whether cash flows are expressed in nominal or in real quantities. It must always be the case that the NPV is the same under the two different approaches.

Because both approaches always yield the same result, which one should be used? Use the approach that is simpler because the simpler approach generally leads to fewer computational errors. The Shields Electric example begins with nominal cash flows, so nominal quantities produce a simpler calculation here.

EXAMPLE 7.10

Real and Nominal NPV Altshuler, Inc., generated the following forecast for a capital budgeting project:

	Year		
	0	1	2
Capital expenditure	$1,210		
Revenues (in real terms)		$1,900	$2,000
Cash expenses (in real terms)		950	1,000
Depreciation (straight-line)		605	605

The president, David Altshuler, estimates inflation to be 10 percent per year over the next two years. In addition, he believes that the cash flows of the project should be discounted at the nominal rate of 15.5 percent. His firm's tax rate is 40 percent.

Mr. Altshuler forecasts all cash flows in *nominal* terms, leading to the following spreadsheet:

	Year		
	0	1	2
Capital expenditure	−$1,210		
Revenues		$2,090 (= 1,900 × 1.10)	$2,420 [= 2,000 × $(1.10)^2$]
−Expenses		−1,045 (= 950 × 1.10)	−1,210 [= 1,000 × $(1.10)^2$]
−Depreciation		−605 (= 1,210/2)	−605
Taxable income		$ 440	$ 605
−Taxes (40%)		−176	−242
Income after taxes		$ 264	$ 363
+Depreciation		+605	+605
Cash flow		$ 869	$ 968

$$\text{NPV} = -\$1{,}210 + \frac{\$869}{1.155} + \frac{\$968}{(1.155)^2} = \$268$$

Mr. Altshuler's sidekick, Stuart Weiss, prefers working in real terms. He first calculates the real rate to be 5 percent (= 1.155/1.10 − 1). Next, he generates the following spreadsheet in *real* quantities:

	Year		
	0	1	2
Capital expenditure	−$1,210		
Revenues		$1,900	$ 2,000
−Expenses		−950	−1,000
−Depreciation		−550 (= 605/1.1)	−500 [= 605/$(1.1)^2$]
Taxable income		$ 400	$ 500
−Taxes (40%)		−160	−200
Income after taxes		$ 240	$ 300
+Depreciation		+550	+500
Cash flow		$ 790	$ 800

(*continued*)

$$\text{NPV} = -\$1{,}210 + \frac{\$790}{1.05} + \frac{\$800}{(1.05)^2} = \$268$$

In explaining his calculations to Mr. Altshuler, Mr. Weiss points out these facts:

1. The capital expenditure occurs at date 0 (today), so its nominal value and its real value are equal.
2. Because yearly depreciation of $605 is a nominal quantity, one converts it to a real quantity by discounting at the inflation rate of 10 percent.

It is no coincidence that both Mr. Altshuler and Mr. Weiss arrive at the same NPV number. Both methods must always generate the same NPV.

7.4 Alternative Definitions of Operating Cash Flow

The analysis we went through in the previous section is quite general and can be adapted to just about any capital investment problem. In the next section, we illustrate a particularly useful variation. Before we do so, we need to discuss the fact that different definitions of project operating cash flow are commonly used, both in practice and in finance texts.

As we will see, the different approaches to operating cash flow all measure the same thing. If they are used correctly, they all produce the same answer, and one is not necessarily any better or more useful than another. Unfortunately, the fact that alternative definitions are used sometimes leads to confusion. For this reason, we examine several of these variations next to see how they are related.

In the discussion that follows, keep in mind that when we speak of cash flow, we literally mean dollars in less dollars out. This is all we are concerned with. Different definitions of operating cash flow simply amount to different ways of manipulating basic information about sales, costs, depreciation, and taxes to get at cash flow.

For a particular project and year under consideration, suppose we have the following estimates:

$$\begin{aligned} \text{Sales} &= \$1{,}500 \\ \text{Costs} &= \$700 \\ \text{Depreciation} &= \$600 \end{aligned}$$

With these estimates, notice that EBIT is:

$$\begin{aligned} \text{EBIT} &= \text{Sales} - \text{Costs} - \text{Depreciation} \\ &= \$1{,}500 - 700 - 600 \\ &= \$200 \end{aligned}$$

Once again, we assume that no interest is paid, so the tax bill is:

$$\begin{aligned} \text{Taxes} &= \text{EBIT} \times t_c \\ &= \$200 \times .34 = \$68 \end{aligned}$$

where t_c, the corporate tax rate, is 34 percent.

When we put all of this together, we see that project operating cash flow, OCF, is:

$$\begin{aligned} \text{OCF} &= \text{EBIT} + \text{Depreciation} - \text{Taxes} \\ &= \$200 + 600 - 68 = \$732 \end{aligned}$$

It turns out there are some other ways to determine OCF that could be (and are) used. We consider these next.

The Bottom-Up Approach

Because we are ignoring any financing expenses, such as interest, in our calculations of project OCF, we can write project net income as:

$$\begin{aligned}\text{Project net income} &= \text{EBIT} - \text{Taxes} \\ &= \$200 - 68 \\ &= \$132\end{aligned}$$

If we simply add the depreciation to both sides, we arrive at a slightly different and very common expression for OCF:

$$\begin{aligned}\text{OCF} &= \text{Net income} + \text{Depreciation} \\ &= \$132 + 600 \\ &= \$732\end{aligned} \tag{7.3}$$

This is the *bottom-up* approach. Here, we start with the accountant's bottom line (net income) and add back any noncash deductions such as depreciation. It is crucial to remember that this definition of operating cash flow as net income plus depreciation is correct only if there is no interest expense subtracted in the calculation of net income.

The Top-Down Approach

Perhaps the most obvious way to calculate OCF is this:

$$\begin{aligned}\text{OCF} &= \text{Sales} - \text{Costs} - \text{Taxes} \\ &= \$1{,}500 - 700 - 68 = \$732\end{aligned} \tag{7.4}$$

This is the *top-down* approach, the second variation on the basic OCF definition. Here we start at the top of the income statement with sales and work our way down to net cash flow by subtracting costs, taxes, and other expenses. Along the way, we simply leave out any strictly noncash items such as depreciation.

The Tax Shield Approach

The third variation on our basic definition of OCF is the *tax shield* approach. This approach will be very useful for some problems we consider in the next chapter. The tax shield definition of OCF is:

$$\text{OCF} = (\text{Sales} - \text{Costs}) \times (1 - t_c) + \text{Depreciation} \times t_c \tag{7.5}$$

where t_c is again the corporate tax rate. Assuming that $t_c = 34$ percent, the OCF works out to be:

$$\begin{aligned}\text{OCF} &= (\$1{,}500 - 700) \times .66 + 600 \times .34 \\ &= \$528 + 204 \\ &= \$732\end{aligned}$$

This is just as we had before.

This approach views OCF as having two components. The first part is what the project's cash flow would be if there were no depreciation expense. In this case, this would-have-been cash flow is $528.

The second part of OCF in this approach is the depreciation deduction multiplied by the tax rate. This is called the **depreciation tax shield**. We know that depreciation is a noncash expense. The only cash flow effect of deducting depreciation is to reduce our taxes, a benefit to us. At the current 34 percent corporate tax rate, every dollar in depreciation expense saves us 34 cents in taxes. So, in our example, the $600 depreciation deduction saves us $600 × .34 = $204 in taxes.

Conclusion

Now that we've seen that all of these approaches are the same, you're probably wondering why everybody doesn't just agree on one of them. One reason is that different approaches are useful in different circumstances. The best one to use is whichever happens to be the most convenient for the problem at hand.

7.5 Investments of Unequal Lives: The Equivalent Annual Cost Method

Suppose a firm must choose between two machines of unequal lives. Both machines can do the same job, but they have different operating costs and will last for different time periods. A simple application of the NPV rule suggests taking the machine whose costs have the lower present value. This choice might be a mistake, however, because the lower-cost machine may need to be replaced before the other one.

Let's consider an example. The Downtown Athletic Club must choose between two mechanical tennis ball throwers. Machine *A* costs less than machine *B* but will not last as long. The cash *outflows* from the two machines are shown here:

	Date				
Machine	**0**	**1**	**2**	**3**	**4**
A	$500	$120	$120	$120	
B	$600	$100	$100	$100	$100

Machine *A* costs $500 and lasts three years. There will be maintenance expenses of $120 to be paid at the end of each of the three years. Machine *B* costs $600 and lasts four years. There will be maintenance expenses of $100 to be paid at the end of each of the four years. We place all costs in real terms, an assumption greatly simplifying the analysis. Revenues per year are assumed to be the same, regardless of machine, so they are ignored in the analysis. Note that all numbers in the previous chart are *outflows*.

To get a handle on the decision, let's take the present value of the costs of each of the two machines. Assuming a discount rate of 10 percent, we have:

$$\text{Machine } A\text{: } \$798.42 = \$500 + \frac{\$120}{1.1} + \frac{\$120}{(1.1)^2} + \frac{\$120}{(1.1)^3}$$

$$\text{Machine } B\text{: } \$916.99 = \$600 + \frac{\$100}{1.1} + \frac{\$100}{(1.1)^2} + \frac{\$100}{(1.1)^3} + \frac{\$100}{(1.1)^4}$$

Machine *B* has a higher present value of outflows. A naive approach would be to select machine *A* because of its lower present value. However, machine *B* has a longer life, so perhaps its cost per year is actually lower.

How might one properly adjust for the difference in useful life when comparing the two machines? Perhaps the easiest approach involves calculating something called the *equivalent annual cost* of each machine. This approach puts costs on a per-year basis.

The previous equation showed that payments of ($500, $120, $120, $120) are equivalent to a single payment of $798.42 at date 0. We now wish to equate the single payment of $798.42 at date 0 with a three-year annuity. Using techniques of previous chapters, we have:

$$\$798.42 = C \times A^3_{.10}$$

$A^3_{.10}$ is an annuity of $1 a year for three years, discounted at 10 percent. C is the unknown—the annuity payment per year such that the present value of all payments equals $798.42. Because $A^3_{.10}$ equals 2.4869, C equals $321.05 (=$798.42/2.4869). Thus, a payment stream of ($500, $120, $120, $120) is equivalent to annuity payments of $321.05 made at the *end* of each year for three years. We refer to $321.05 as the *equivalent annual cost* of machine A.

This idea is summarized in the following chart:

	Date			
	0	1	2	3
Cash outflows of machine *A*	$500	$120	$120	$120
Equivalent annual cost of machine *A*		$321.05	$321.05	$321.05

The Downtown Athletic Club should be indifferent between cash outflows of ($500, $120, $120, $120) and cash outflows of ($0, $321.05, $321.05, $321.05). Alternatively, one can say that the purchase of the machine is financially equivalent to a rental agreement calling for annual lease payments of $321.05.

Now let's turn to machine B. We calculate its equivalent annual cost from:

$$\$916.99 = C \times A^4_{.10}$$

Because $A^4_{.10}$ equals 3.1699, C equals $916.99/3.1699, or $289.28.

As we did for machine A, we can create the following chart for machine B:

	Date				
	0	1	2	3	4
Cash outflows of machine *B*	$600	$100	$100	$100	$100
Equivalent annual cost of machine *B*		$289.28	$289.28	$289.28	$289.28

The decision is easy once the charts of the two machines are compared. Would you rather make annual lease payments of $321.05 or $289.28? Put this way, the problem becomes a no-brainer: A rational person would rather pay the lower amount. Thus, machine B is the preferred choice.

Two final remarks are in order. First, it is no accident that we specified the costs of the tennis ball machines in real terms. Although B would still have been the preferred machine had the costs been stated in nominal terms, the actual solution would have been much more difficult. As a general rule, always convert cash flows to real terms when working through problems of this type.

Second, such analysis applies only if one anticipates that both machines can be replaced. The analysis would differ if no replacement were possible. For example, imagine that the only company that manufactured tennis ball throwers just went out of business and no new producers are expected to enter the field. In this case, machine *B* would generate revenues in the fourth year whereas machine *A* would not. Here, simple net present value analysis for mutually exclusive projects including both revenues and costs would be appropriate.

The General Decision to Replace

The previous analysis concerned the choice between machine *A* and machine *B*, both of which were new acquisitions. More typically firms must decide when to replace an existing machine with a new one. This decision is actually quite straightforward. One should replace if the annual cost of the new machine is less than the annual cost of the old machine. As with much else in finance, an example clarifies this approach better than further explanation.

EXAMPLE 7.11

Replacement Decisions Consider the situation of BIKE, which must decide whether to replace an existing machine. BIKE currently pays no taxes. The replacement machine costs $9,000 now and requires maintenance of $1,000 at the end of every year for eight years. At the end of eight years, the machine would be sold for $2,000 after taxes.

The existing machine requires increasing amounts of maintenance each year, and its salvage value falls each year, as shown:

Year	Maintenance	Aftertax Salvage
Present	$ 0	$4,000
1	1,000	2,500
2	2,000	1,500
3	3,000	1,000
4	4,000	0

This chart tells us that the existing machine can be sold for $4,000 now after taxes. If it is sold one year from now, the resale price will be $2,500 after taxes, and $1,000 must be spent on maintenance during the year to keep it running. For ease of calculation, we assume that this maintenance fee is paid at the end of the year. The machine will last for four more years before it falls apart. In other words, salvage value will be zero at the end of year 4. If BIKE faces an opportunity cost of capital of 15 percent, when should it replace the machine?

Our approach is to compare the annual cost of the replacement machine with the annual cost of the old machine. The annual cost of the replacement machine is simply its *equivalent annual cost* (EAC). Let's calculate that first.

Equivalent Annual Cost of New Machine The present value of the cost of the new replacement machine is as follows:

$$\begin{aligned} PV_{costs} &= \$9{,}000 + \$1{,}000 \times A^{8}_{.15} - \frac{\$2{,}000}{(1.15)^8} \\ &= \$9{,}000 + \$1{,}000 \times (4.4873) - \$2{,}000 \times (.3269) \\ &= \$12{,}833 \end{aligned}$$

(*continued*)

Notice that the $2,000 salvage value is an inflow. It is treated as a *negative* number in this equation because it *offsets* the cost of the machine.

The EAC of a new replacement machine equals:

$$\text{PV/8-year annuity factor at 15\%} = \frac{\text{PV}}{A^{8}_{.15}} = \frac{\$12{,}833}{4.4873} = \$2{,}860$$

This calculation implies that buying a replacement machine is financially equivalent to renting this machine for $2,860 per year.

Cost of Old Machine This calculation is a little trickier. If BIKE keeps the old machine for one year, the firm must pay maintenance costs of $1,000 a year from now. But this is not BIKE's only cost from keeping the machine for one year. BIKE will receive $2,500 at date 1 if the old machine is kept for one year but would receive $4,000 today if the old machine were sold immediately. This reduction in sales proceeds is clearly a cost as well.

Thus the PV of the costs of keeping the machine one more year before selling it equals:

$$\$4{,}000 + \frac{\$1{,}000}{1.15} - \frac{\$2{,}500}{1.15} = \$2{,}696$$

That is, if BIKE holds the old machine for one year, BIKE does *not* receive the $4,000 today. This $4,000 can be thought of as an opportunity cost. In addition, the firm must pay $1,000 a year from now. Finally, BIKE does receive $2,500 a year from now. This last item is treated as a negative number because it offsets the other two costs.

Although we normally express cash flows in terms of present value, the analysis to come is easier if we express the cash flow in terms of its future value one year from now. This future value is:

$$\$2{,}696 \times 1.15 = \$3{,}100$$

In other words, the cost of keeping the machine for one year is equivalent to paying $3,100 at the end of the year.

Making the Comparison Now let's review the cash flows. If we replace the machine immediately, we can view our annual expense as $2,860, beginning at the end of the year. This annual expense occurs forever if we replace the new machine every eight years. This cash flow stream can be written as follows:

	Year 1	Year 2	Year 3	Year 4	. . .
Expenses from replacing machine immediately	$2,860	$2,860	$2,860	$2,860	. . .

If we replace the old machine in one year, our expense from using the old machine for that final year can be viewed as $3,100, payable at the end of the year. After replacement, our annual expense is $2,860, beginning at the end of two years. This annual expense occurs forever if we replace the new machine every eight years. This cash flow stream can be written like this:

	Year 1	Year 2	Year 3	Year 4	. . .
Expenses from using old machine for one year and then replacing it	$3,100	$2,860	$2,860	$2,860	. . .

(continued)

Put this way, the choice is a no-brainer. Anyone would rather pay $2,860 at the end of the year than $3,100 at the end of the year. Thus, BIKE should replace the old machine immediately to minimize the expense at year 1.[1]

Two final points should be made about the decision to replace. First, we have examined a situation where both the old machine and the replacement machine generate the same revenues. Because revenues are unaffected by the choice of machine, revenues do not enter our analysis. This situation is common in business. For example, the decision to replace either the heating system or the air conditioning system in one's home office will likely not affect firm revenues. However, sometimes revenues will be greater with a new machine. The approach here can easily be amended to handle differential revenues.

Second, we want to stress the importance of the current approach. Applications of this approach are pervasive in business because *every* machine must be replaced at some point.

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[1] One caveat is in order. Perhaps the old machine's maintenance is high in the first year but drops after that. A decision to replace immediately might be premature in that case. Therefore, we need to check the cost of the old machine in future years.

The cost of keeping the existing machine a second year is:

$$\text{PV of costs at time 1} = \$2{,}500 + \frac{\$2{,}000}{1.15} - \frac{\$1{,}500}{1.15} = \$2{,}935$$

which has a future value of $3,375 (=$2,935 × 1.15).

The costs of keeping the existing machine for years 3 and 4 are also greater than the EAC of buying a new machine. Thus, BIKE's decision to replace the old machine immediately is still valid.

Summary and Conclusions

This chapter discussed a number of practical applications of capital budgeting.

1. Capital budgeting must be placed on an incremental basis. This means that sunk costs must be ignored, whereas both opportunity costs and side effects must be considered.
2. In the Baldwin case we computed NPV using the following two steps:
   - **a.** Calculate the net cash flow from all sources for each period.
   - **b.** Calculate the NPV using these cash flows.
3. Inflation must be handled consistently. One approach is to express both cash flows and the discount rate in nominal terms. The other approach is to express both cash flows and the discount rate in real terms. Because either approach yields the same NPV calculation, the simpler method should be used. The simpler method will generally depend on the type of capital budgeting problem.
4. A firm should use the equivalent annual cost approach when choosing between two machines of unequal lives.

Concept Questions

1. **Opportunity Cost** In the context of capital budgeting, what is an opportunity cost?
2. **Incremental Cash Flows** Which of the following should be treated as an incremental cash flow when computing the NPV of an investment?
   - **a.** A reduction in the sales of a company's other products caused by the investment.
   - **b.** An expenditure on plant and equipment that has not yet been made and will be made only if the project is accepted.
   - **c.** Costs of research and development undertaken in connection with the product during the past three years.
   - **d.** Annual depreciation expense from the investment.

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   e. Dividend payments by the firm.
   f. The resale value of plant and equipment at the end of the project's life.
   g. Salary and medical costs for production personnel who will be employed only if the project is accepted.

3. **Incremental Cash Flows** Your company currently produces and sells steel shaft golf clubs. The board of directors wants you to consider the introduction of a new line of titanium bubble woods with graphite shafts. Which of the following costs are *not* relevant?
   a. Land you already own that will be used for the project, but otherwise will be sold for $700,000, its market value.
   b. A $300,000 drop in your sales of steel shaft clubs if the titanium woods with graphite shafts are introduced.
   c. $200,000 spent on research and development last year on graphite shafts.
4. **Depreciation** Given the choice, would a firm prefer to use MACRS depreciation or straight-line depreciation? Why?
5. **Net Working Capital** In our capital budgeting examples, we assumed that a firm would recover all of the working capital it invested in a project. Is this a reasonable assumption? When might it not be valid?
6. **Stand-Alone Principle** Suppose a financial manager is quoted as saying, "Our firm uses the stand-alone principle. Because we treat projects like minifirms in our evaluation process, we include financing costs because they are relevant at the firm level." Critically evaluate this statement.
7. **Equivalent Annual Cost** When is EAC analysis appropriate for comparing two or more projects? Why is this method used? Are there any implicit assumptions required by this method that you find troubling? Explain.
8. **Cash Flow and Depreciation** "When evaluating projects, we're only concerned with the relevant incremental aftertax cash flows. Therefore, because depreciation is a noncash expense, we should ignore its effects when evaluating projects." Critically evaluate this statement.
9. **Capital Budgeting Considerations** A major college textbook publisher has an existing finance textbook. The publisher is debating whether to produce an "essentialized" version, meaning a shorter (and lower-priced) book. What are some of the considerations that should come into play?

To answer the next three questions, refer to the following example. In 2003, Porsche unveiled its new sports utility vehicle (SUV), the Cayenne. With a price tag of over $40,000, the Cayenne goes from zero to 62 mph in 8.5 seconds. Porsche's decision to enter the SUV market was in response to the runaway success of other high-priced SUVs such as the Mercedes-Benz M class. Vehicles in this class had generated years of very high profits. The Cayenne certainly spiced up the market, and, in 2006, Porsche introduced the Cayenne Turbo S, which goes from zero to 60 mph in 4.8 seconds and has a top speed of 168 mph. The base price for the Cayenne Turbo S? Almost $112,000!

Some analysts questioned Porsche's entry into the luxury SUV market. The analysts were concerned because not only was Porsche a late entry into the market, but also the introduction of the Cayenne might damage Porsche's reputation as a maker of high-performance automobiles.

10. **Erosion** In evaluating the Cayenne, would you consider the possible damage to Porsche's reputation as erosion?
11. **Capital Budgeting** Porsche was one of the last manufacturers to enter the sports utility vehicle market. Why would one company decide to proceed with a product when other companies, at least initially, decide not to enter the market?
12. **Capital Budgeting** In evaluating the Cayenne, what do you think Porsche needs to assume regarding the substantial profit margins that exist in this market? Is it likely that they will be maintained as the market becomes more competitive, or will Porsche be able to maintain the profit margin because of its image and the performance of the Cayenne?

Questions and Problems

BASIC
(Questions 1–10)

1. **Calculating Project NPV** Raphael Restaurant is considering the purchase of a $10,000 souffle maker. The souffle maker has an economic life of five years and will be fully depreciated by the straight-line method. The machine will produce 2,000 souffles per year, with each costing $2 to make and priced at $5. Assume that the discount rate is 17 percent and the tax rate is 34 percent. Should Raphael make the purchase?

2. **Calculating Project NPV** The Best Manufacturing Company is considering a new investment. Financial projections for the investment are tabulated here. The corporate tax rate is 34 percent. Assume all sales revenue is received in cash, all operating costs and income taxes are paid in cash, and all cash flows occur at the end of the year. All net working capital is recovered at the end of the project.

	Year 0	Year 1	Year 2	Year 3	Year 4
Investment	$10,000	–	–	–	–
Sales revenue	–	$7,000	$7,000	$7,000	$7,000
Operating costs	–	2,000	2,000	2,000	2,000
Depreciation	–	2,500	2,500	2,500	2,500
Net working capital spending	200	250	300	200	?

   a. Compute the incremental net income of the investment for each year.
   b. Compute the incremental cash flows of the investment for each year.
   c. Suppose the appropriate discount rate is 12 percent. What is the NPV of the project?

3. **Calculating Project NPV** Down Under Boomerang, Inc., is considering a new three-year expansion project that requires an initial fixed asset investment of $2.7 million. The fixed asset will be depreciated straight-line to zero over its three-year tax life, after which it will be worthless. The project is estimated to generate $2,400,000 in annual sales, with costs of $960,000. The tax rate is 35 percent and the required return is 15 percent. What is the project's NPV?

4. **Calculating Project Cash Flow from Assets** In the previous problem, suppose the project requires an initial investment in net working capital of $300,000 and the fixed asset will have a market value of $210,000 at the end of the project. What is the project's year 0 net cash flow? Year 1? Year 2? Year 3? What is the new NPV?

5. **NPV and Modified ACRS** In the previous problem, suppose the fixed asset actually falls into the three-year MACRS class. All the other facts are the same. What is the project's year 1 net cash flow now? Year 2? Year 3? What is the new NPV?

6. **Project Evaluation** Your firm is contemplating the purchase of a new $925,000 computer-based order entry system. The system will be depreciated straight-line to zero over its five-year life. It will be worth $90,000 at the end of that time. You will save $360,000 before taxes per year in order processing costs, and you will be able to reduce working capital by $125,000 (this is a one-time reduction). If the tax rate is 35 percent, what is the IRR for this project?

7. **Project Evaluation** Dog Up! Franks is looking at a new sausage system with an installed cost of $390,000. This cost will be depreciated straight-line to zero over the project's five-year life, at the end of which the sausage system can be scrapped for $60,000. The sausage system will save the firm $120,000 per year in pretax operating costs, and the system requires an initial investment in net working capital of $28,000. If the tax rate is 34 percent and the discount rate is 10 percent, what is the NPV of this project?

8. **Calculating Salvage Value** An asset used in a four-year project falls in the five-year MACRS class for tax purposes. The asset has an acquisition cost of $9,300,000 and will be sold for

$2,100,000 at the end of the project. If the tax rate is 35 percent, what is the aftertax salvage value of the asset?

9. **Calculating NPV** Howell Petroleum is considering a new project that complements its existing business. The machine required for the project costs $2 million. The marketing department predicts that sales related to the project will be $1.2 million per year for the next four years, after which the market will cease to exist. The machine will be depreciated down to zero over its four-year economic life using the straight-line method. Cost of goods sold and operating expenses related to the project are predicted to be 25 percent of sales. Howell also needs to add net working capital of $100,000 immediately. The additional net working capital will be recovered in full at the end of the project's life. The corporate tax rate is 35 percent. The required rate of return for Howell is 14 percent. Should Howell proceed with the project?

10. **Calculating EAC** You are evaluating two different silicon wafer milling machines. The Techron I costs $210,000, has a three-year life, and has pretax operating costs of $34,000 per year. The Techron II costs $320,000, has a five-year life, and has pretax operating costs of $23,000 per year. For both milling machines, use straight-line depreciation to zero over the project's life and assume a salvage value of $20,000. If your tax rate is 35 percent and your discount rate is 14 percent, compute the EAC for both machines. Which do you prefer? Why?

INTERMEDIATE (Questions 11–29)

11. **Cost-Cutting Proposals** Massey Machine Shop is considering a four-year project to improve its production efficiency. Buying a new machine press for $480,000 is estimated to result in $160,000 in annual pretax cost savings. The press falls in the MACRS five-year class, and it will have a salvage value at the end of the project of $70,000. The press also requires an initial investment in spare parts inventory of $20,000, along with an additional $3,000 in inventory for each succeeding year of the project. If the shop's tax rate is 35 percent and its discount rate is 14 percent, should Massey buy and install the machine press?

12. **Comparing Mutually Exclusive Projects** Hagar Industrial Systems Company (HISC) is trying to decide between two different conveyor belt systems. System A costs $430,000, has a four-year life, and requires $120,000 in pretax annual operating costs. System B costs $540,000, has a six-year life, and requires $80,000 in pretax annual operating costs. Both systems are to be depreciated straight-line to zero over their lives and will have zero salvage value. Whichever system is chosen, it will *not* be replaced when it wears out. If the tax rate is 34 percent and the discount rate is 20 percent, which system should the firm choose?

13. **Comparing Mutually Exclusive Projects** Suppose in the previous problem that HISC always needs a conveyor belt system; when one wears out, it must be replaced. Which system should the firm choose now?

14. **Comparing Mutually Exclusive Projects** Vandalay Industries is considering the purchase of a new machine for the production of latex. Machine A costs $2,100,000 and will last for six years. Variable costs are 35 percent of sales, and fixed costs are $150,000 per year. Machine B costs $4,500,000 and will last for nine years. Variable costs for this machine are 30 percent and fixed costs are $100,000 per year. The sales for each machine will be $9 million per year. The required return is 10 percent and the tax rate is 35 percent. Both machines will be depreciated on a straight-line basis. If the company plans to replace the machine when it wears out on a perpetual basis, which machine should you choose?

15. **Capital Budgeting with Inflation** Consider the following cash flows on two mutually exclusive projects:

Year	Project *A*	Project *B*
0	−$40,000	−$50,000
1	20,000	10,000
2	15,000	20,000
3	15,000	40,000

The cash flows of project *A* are expressed in real terms, whereas those of project *B* are expressed in nominal terms. The appropriate nominal discount rate is 15 percent and the inflation rate is 4 percent. Which project should you choose?

16. **Inflation and Company Value** Sparkling Water, Inc., expects to sell 2 million bottles of drinking water each year in perpetuity. This year each bottle will sell for $1.25 in real terms and will cost $0.70 in real terms. Sales income and costs occur at year-end. Revenues will rise at a real rate of 6 percent annually, while real costs will rise at a real rate of 5 percent annually. The real discount rate is 10 percent. The corporate tax rate is 34 percent. What is Sparkling worth today?

17. **Calculating Nominal Cash Flow** Etonic Inc. is considering an investment of $250,000 in an asset with an economic life of five years. The firm estimates that the nominal annual cash revenues and expenses at the end of the first year will be $200,000 and $50,000, respectively. Both revenues and expenses will grow thereafter at the annual inflation rate of 3 percent. Etonic will use the straight-line method to depreciate its asset to zero over five years. The salvage value of the asset is estimated to be $30,000 in nominal terms at that time. The one-time net working capital investment of $10,000 is required immediately and will be recovered at the end of the project. All corporate cash flows are subject to a 34 percent tax rate. What is the project's total nominal cash flow from assets for each year?

18. **Cash Flow Valuation** Phillips Industries runs a small manufacturing operation. For this fiscal year, it expects real net cash flows of $120,000. Phillips is an ongoing operation, but it expects competitive pressures to erode its real net cash flows at 6 percent per year in perpetuity. The appropriate real discount rate for Phillips is 11 percent. All net cash flows are received at year-end. What is the present value of the net cash flows from Phillips's operations?

19. **Equivalent Annual Cost** Bridgton Golf Academy is evaluating different golf practice equipment. The "Dimple-Max" equipment costs $45,000, has a three-year life, and costs $5,000 per year to operate. The relevant discount rate is 12 percent. Assume that the straight-line depreciation method is used and that the equipment is fully depreciated to zero. Furthermore, assume the equipment has a salvage value of $10,000 at the end of the project's life. The relevant tax rate is 34 percent. All cash flows occur at the end of the year. What is the equivalent annual cost (EAC) of this equipment?

20. **Equivalent Annual Cost** Harwell University must purchase word processors for its typing lab. The university can buy 10 EVF word processors that cost $8,000 each and have annual, year-end maintenance costs of $2,000 per machine. The EVF word processors will be replaced at the end of year 4 and have no value at that time. Alternatively, Harwell can buy 11 AEH word processors to accomplish the same work. The AEH word processors will be replaced after three years. They each cost $5,000 and have annual, year-end maintenance costs of $2,500 per machine. Each AEH word processor will have a resale value of $500 at the end of three years. The university's opportunity cost of funds for this type of investment is 14 percent. Because the university is a nonprofit institution, it does not pay taxes. It is anticipated that whichever manufacturer is chosen now will be the supplier of future machines. Would you recommend purchasing 10 EVF word processors or 11 AEH machines?

21. **Calculating Project NPV** Scott Investors, Inc., is considering the purchase of a $500,000 computer with an economic life of five years. The computer will be fully depreciated over five years using the straight-line method. The market value of the computer will be $100,000 in five years. The computer will replace five office employees whose combined annual salaries are $120,000. The machine will also immediately lower the firm's required net working capital by $100,000. This amount of net working capital will need to be replaced once the machine is sold. The corporate tax rate is 34 percent. Is it worthwhile to buy the computer if the appropriate discount rate is 12 percent?

22. **Calculating NPV and IRR for a Replacement** A firm is considering an investment in a new machine with a price of $32 million to replace its existing machine. The current machine has a book value of $1 million and a market value of $9 million. The new machine is expected

to have a four-year life, and the old machine has four years left in which it can be used. If the firm replaces the old machine with the new machine, it expects to save $8 million in operating costs each year over the next four years. Both machines will have no salvage value in four years. If the firm purchases the new machine, it will also need an investment of $500,000 in net working capital. The required return on the investment is 18 percent, and the tax rate is 39 percent.

a. What are the NPV and IRR of the decision to replace the old machine?

b. The new machine saves $32 million over the next four years and has a cost of $32 million. When you consider the time value of money, how is it possible that the NPV of the decision to replace the old machine has a positive NPV?

23. **Project Analysis and Inflation** Sanders Enterprises, Inc., has been considering the purchase of a new manufacturing facility for $120,000. The facility is to be fully depreciated on a straight-line basis over seven years. It is expected to have no resale value after the seven years. Operating revenues from the facility are expected to be $50,000, in nominal terms, at the end of the first year. The revenues are expected to increase at the inflation rate of 5 percent. Production costs at the end of the first year will be $20,000, in nominal terms, and they are expected to increase at 7 percent per year. The real discount rate is 14 percent. The corporate tax rate is 34 percent. Sanders has other ongoing profitable operations. Should the company accept the project?

24. **Calculating Project NPV** With the growing popularity of casual surf print clothing, two recent MBA graduates decided to broaden this casual surf concept to encompass a "surf lifestyle for the home." With limited capital, they decided to focus on surf print table and floor lamps to accent people's homes. They projected unit sales of these lamps to be 5,000 in the first year, with growth of 15 percent each year for the next five years. Production of these lamps will require $28,000 in net working capital to start. Total fixed costs are $75,000 per year, variable production costs are $20 per unit, and the units are priced at $45 each. The equipment needed to begin production will cost $60,000. The equipment will be depreciated using the straight-line method over a five-year life and is not expected to have a salvage value. The effective tax rate is 34 percent, and the required rate of return is 25 percent. What is the NPV of this project?

25. **Calculating Project NPV** You have been hired as a consultant for Pristine Urban-Tech Zither, Inc. (PUTZ), manufacturers of fine zithers. The market for zithers is growing quickly. The company bought some land three years ago for $1 million in anticipation of using it as a toxic waste dump site but has recently hired another company to handle all toxic materials. Based on a recent appraisal, the company believes it could sell the land for $800,000 on an aftertax basis. The company also hired a marketing firm to analyze the zither market, at a cost of $125,000. An excerpt of the marketing report is as follows:

> The zither industry will have a rapid expansion in the next four years. With the brand name recognition that PUTZ brings to bear, we feel that the company will be able to sell 2,900, 3,800, 2,700, and 1,900 units each year for the next four years, respectively. Again, capitalizing on the name recognition of PUTZ, we feel that a premium price of $700 can be charged for each zither. Because zithers appear to be a fad, we feel at the end of the four-year period, sales should be discontinued.

PUTZ feels that fixed costs for the project will be $350,000 per year, and variable costs are 15 percent of sales. The equipment necessary for production will cost $3.8 million and will be depreciated according to a three-year MACRS schedule. At the end of the project, the equipment can be scrapped for $400,000. Net working capital of $120,000 will be required by the end of the first year. PUTZ has a 38 percent tax rate, and the required return on the project is 13 percent. What is the NPV of the project? Assume the company has other profitable projects.

26. **Calculating Project NPV** Pilot Plus Pens is deciding when to replace its old machine. The machine's current salvage value is $2 million. Its current book value is $1 million. If not sold, the old machine will require maintenance costs of $400,000 at the end of the year for the next five years. Depreciation on the old machine is $200,000 per year. At the end of five years, it will have a salvage value of $200,000 and a book value of $0. A replacement machine costs $3 million now and requires maintenance costs of $500,000 at the end of each year during its economic life of five years. At the end of the five years, the new machine will have a salvage value of $500,000. It will be fully depreciated by the straight-line method. In five years a replacement machine will cost $3,500,000. Pilot will need to purchase this machine regardless of what choice it makes today. The corporate tax rate is 34 percent and the appropriate discount rate is 12 percent. The company is assumed to earn sufficient revenues to generate tax shields from depreciation. Should Pilot Plus Pens replace the old machine now or at the end of five years?

27. Calculating EAC Gold Star Industries is contemplating a purchase of computers. The firm has narrowed its choices to the SAL 5000 and the DET 1000. Gold Star would need 10 SALs, and each SAL costs $3,750 and requires $500 of maintenance each year. At the end of the computer's eight-year life, Gold Star expects to sell each one for $500. Alternatively, Gold Star could buy seven DETs. Each DET costs $5,250 and requires $700 of maintenance every year. Each DET lasts for six years and has a resale value of $600 at the end of its economic life. Gold Star will continue to purchase the model that it chooses today into perpetuity. Gold Star has a 34 percent tax rate. Assume that the maintenance costs occur at year-end. Depreciation is straight-line to zero. Which model should Gold Star buy if the appropriate discount rate is 11 percent?

28. EAC and Inflation Office Automation, Inc., must choose between two copiers, the XX40 or the RH45. The XX40 costs $700 and will last for three years. The copier will require an aftertax cost of $100 per year after all relevant expenses. The RH45 costs $900 and will last five years. The real aftertax cost for the RH45 will be $110 per year. All cash flows occur at the end of the year. The inflation rate is expected to be 5 percent per year, and the nominal discount rate is 14 percent. Which copier should the company choose?

29. Project Analysis and Inflation Dickinson Brothers, Inc., is considering investing in a machine to produce computer keyboards. The price of the machine will be $400,000, and its economic life is five years. The machine will be fully depreciated by the straight-line method. The machine will produce 10,000 keyboards each year. The price of each keyboard will be $40 in the first year and will increase by 5 percent per year. The production cost per keyboard will be $20 in the first year and will increase by 10 percent per year. The project will have an annual fixed cost of $50,000 and require an immediate investment of $25,000 in net working capital. The corporate tax rate for the company is 34 percent. If the appropriate discount rate is 15 percent, what is the NPV of the investment?

CHALLENGE (Questions 30–40)

30. Project Evaluation Aguilera Acoustics (AAI), Inc., projects unit sales for a new seven-octave voice emulation implant as follows:

Year	Unit Sales
1	85,000
2	98,000
3	106,000
4	114,000
5	93,000

Production of the implants will require $1,500,000 in net working capital to start and additional net working capital investments each year equal to 15 percent of the projected sales increase for the following year. Total fixed costs are $900,000 per year, variable production costs are $240 per unit, and the units are priced at $325 each. The equipment needed to begin production has an installed cost of $21,000,000. Because the implants are intended for professional singers, this equipment is considered industrial machinery and thus qualifies as seven-year MACRS property. In five years, this equipment can be sold for about 20 percent of its acquisition cost. AAI is in the 35 percent marginal tax bracket and has a required return on all its projects of 18 percent. Based on these preliminary project estimates, what is the NPV of the project? What is the IRR?

31. Calculating Required Savings A proposed cost-saving device has an installed cost of $480,000. The device will be used in a five-year project but is classified as three-year MACRS property for tax purposes. The required initial net working capital investment is $40,000, the marginal tax rate is 35 percent, and the project discount rate is 12 percent. The device has an estimated year 5 salvage value of $45,000. What level of pretax cost savings do we require for this project to be profitable?

32. **Calculating a Bid Price** Another utilization of cash flow analysis is setting the bid price on a project. To calculate the bid price, we set the project NPV equal to zero and find the required price. Thus the bid price represents a financial break-even level for the project. Guthrie Enterprises needs someone to supply it with 150,000 cartons of machine screws per year to support its manufacturing needs over the next five years, and you've decided to bid on the contract. It will cost you $780,000 to install the equipment necessary to start production; you'll depreciate this cost straight-line to zero over the project's life. You estimate that in five years this equipment can be salvaged for $50,000. Your fixed production costs will be $240,000 per year, and your variable production costs should be $8.50 per carton. You also need an initial investment in net working capital of $75,000. If your tax rate is 35 percent and you require a 16 percent return on your investment, what bid price should you submit?

33. **Financial Break-Even Analysis** The technique for calculating a bid price can be extended to many other types of problems. Answer the following questions using the same technique as setting a bid price; that is, set the project NPV to zero and solve for the variable in question.

a. In the previous problem, assume that the price per carton is $13 and find the project NPV. What does your answer tell you about your bid price? What do you know about the number of cartons you can sell and still break even? How about your level of costs?

b. Solve the previous problem again with the price still at $13—but find the quantity of cartons per year that you can supply and still break even. (*Hint*: It's less than 150,000.)

c. Repeat (b) with a price of $13 and a quantity of 150,000 cartons per year, and find the highest level of fixed costs you could afford and still break even. (*Hint*: It's more than $240,000.)

34. **Calculating a Bid Price** Your company has been approached to bid on a contract to sell 10,000 voice recognition (VR) computer keyboards a year for four years. Due to technological improvements, beyond that time they will be outdated and no sales will be possible. The equipment necessary for the production will cost $2.4 million and will be depreciated on a straight-line basis to a zero salvage value. Production will require an investment in net working capital of $75,000 to be returned at the end of the project, and the equipment can be sold for $200,000 at the end of production. Fixed costs are $500,000 per year, and variable costs are $165 per unit. In addition to the contract, you feel your company can sell 3,000, 6,000, 8,000, and 5,000 additional units to companies in other countries over the next four years, respectively, at a price of $275. This price is fixed. The tax rate is 40 percent, and the required return is 13 percent. Additionally, the president of the company will undertake the project only if it has an NPV of $100,000. What bid price should you set for the contract?

35. **Replacement Decisions** Suppose we are thinking about replacing an old computer with a new one. The old one cost us $650,000; the new one will cost $780,000. The new machine will be depreciated straight-line to zero over its five-year life. It will probably be worth about $140,000 after five years.

The old computer is being depreciated at a rate of $130,000 per year. It will be completely written off in three years. If we don't replace it now, we will have to replace it in two years. We can sell it now for $230,000; in two years it will probably be worth $90,000. The new machine will save us $125,000 per year in operating costs. The tax rate is 38 percent, and the discount rate is 14 percent.

a. Suppose we recognize that if we don't replace the computer now, we will be replacing it in two years. Should we replace now or should we wait? (*Hint*: What we effectively have here is a decision either to "invest" in the old computer—by not selling it—or to invest in the new one. Notice that the two investments have unequal lives.)

b. Suppose we consider only whether we should replace the old computer now without worrying about what's going to happen in two years. What are the relevant cash flows? Should we replace it or not? (*Hint*: Consider the net change in the firm's aftertax cash flows if we do the replacement.)

36. **Project Analysis** Benson Enterprises is evaluating alternative uses for a three-story manufacturing and warehousing building that it has purchased for $225,000. The company can continue to rent the building to the present occupants for $12,000 per year. The present occupants have indicated an interest in staying in the building for at least another 15 years. Alternatively, the company could modify the existing structure to use for its own manufacturing and warehousing needs. Benson's production engineer feels the building could be adapted to handle one of two new product lines. The cost and revenue data for the two product alternatives are as follows:

	Product *A*	Product *B*
Initial cash outlay for building modifications	$ 36,000	$ 54,000
Initial cash outlay for equipment	144,000	162,000
Annual pretax cash revenues (generated for 15 years)	105,000	127,500
Annual pretax expenditures (generated for 15 years)	60,000	75,000

The building will be used for only 15 years for either product *A* or product *B*. After 15 years the building will be too small for efficient production of either product line. At that time, Benson plans to rent the building to firms similar to the current occupants. To rent the building again, Benson will need to restore the building to its present layout. The estimated cash cost of restoring the building if product *A* has been undertaken is $3,750. If product *B* has been manufactured, the cash cost will be $28,125. These cash costs can be deducted for tax purposes in the year the expenditures occur.

Benson will depreciate the original building shell (purchased for $225,000) over a 30-year life to zero, regardless of which alternative it chooses. The building modifications and equipment purchases for either product are estimated to have a 15-year life. They will be depreciated by the straight-line method. The firm's tax rate is 34 percent, and its required rate of return on such investments is 12 percent.

For simplicity, assume all cash flows occur at the end of the year. The initial outlays for modifications and equipment will occur today (year 0), and the restoration outlays will occur at the end of year 15. Benson has other profitable ongoing operations that are sufficient to cover any losses. Which use of the building would you recommend to management?

37. **Project Analysis and Inflation** The Biological Insect Control Corporation (BICC) has hired you as a consultant to evaluate the NPV of its proposed toad ranch. BICC plans to breed toads and sell them as ecologically desirable insect control mechanisms. They anticipate that the business will continue into perpetuity. Following the negligible start-up costs, BICC expects the following nominal cash flows at the end of the year:

Revenues	$150,000
Labor costs	80,000
Other costs	40,000

The company will lease machinery for $20,000 per year. The lease payments start at the end of year 1 and are expressed in nominal terms. Revenues will increase by 5 percent per year in real terms. Labor costs will increase by 3 percent per year in real terms. Other costs will decrease by 1 percent per year in real terms. The rate of inflation is expected to be 6 percent per year. BICC's required rate of return is 10 percent in real terms. The company has a 34 percent tax rate. All cash flows occur at year-end. What is the NPV of BICC's proposed toad ranch today?

38. **Project Analysis and Inflation** Sony International has an investment opportunity to produce a new stereo color TV. The required investment on January 1 of this year is $32 million. The firm will depreciate the investment to zero using the straight-line method over four years. The investment has no resale value after completion of the project. The firm is in the 34 percent tax

bracket. The price of the product will be $400 per unit, in real terms, and will not change over the life of the project. Labor costs for year 1 will be $15.30 per hour, in real terms, and will increase at 2 percent per year in real terms. Energy costs for year 1 will be $5.15 per physical unit, in real terms, and will increase at 3 percent per year in real terms. The inflation rate is 5 percent per year. Revenues are received and costs are paid at year-end. Refer to the following table for the production schedule:

	Year 1	Year 2	Year 3	Year 4
Physical production, in units	100,000	200,000	200,000	150,000
Labor input, in hours	2,000,000	2,000,000	2,000,000	2,000,000
Energy input, physical units	200,000	200,000	200,000	200,000

The real discount rate for Sony is 8 percent. Calculate the NPV of this project.

39. **Project Analysis and Inflation** After extensive medical and marketing research, Pill, Inc., believes it can penetrate the pain reliever market. It is considering two alternative products. The first is a medication for headache pain. The second is a pill for headache and arthritis pain. Both products would be introduced at a price of $4 per package in real terms. The headache-only medication is projected to sell 5 million packages a year, whereas the headache and arthritis remedy would sell 10 million packages a year. Cash costs of production in the first year are expected to be $1.50 per package in real terms for the headache-only brand. Production costs are expected to be $1.70 in real terms for the headache and arthritis pill. All prices and costs are expected to rise at the general inflation rate of 5 percent.

Either product requires further investment. The headache-only pill could be produced using equipment costing $10.2 million. That equipment would last three years and have no resale value. The machinery required to produce the broader remedy would cost $12 million and last three years. The firm expects that equipment to have a $1 million resale value (in real terms) at the end of year 3.

Pill, Inc., uses straight-line depreciation. The firm faces a corporate tax rate of 34 percent and believes that the appropriate real discount rate is 13 percent. Which pain reliever should the firm produce?

40. **Calculating Project NPV** J. Smythe, Inc., manufactures fine furniture. The company is deciding whether to introduce a new mahogany dining room table set. The set will sell for $5,600, including a set of eight chairs. The company feels that sales will be 1,300; 1,325; 1,375; 1,450; and 1,320 sets per year for the next five years, respectively. Variable costs will amount to 45 percent of sales, and fixed costs are $1.7 million per year. The new tables will require inventory amounting to 10 percent of sales, produced and stockpiled in the year prior to sales. It is believed that the addition of the new table will cause a loss of 200 tables per year of the oak tables the company produces. These tables sell for $4,500 and have variable costs of 40 percent of sales. The inventory for this oak table is also 10 percent. J. Smythe currently has excess production capacity. If the company buys the necessary equipment today, it will cost $10.5 million. However, the excess production capacity means the company can produce the new table without buying the new equipment. The company controller has said that the current excess capacity will end in two years with current production. This means that if the company uses the current excess capacity for the new table, it will be forced to spend the $10.5 million in two years to accommodate the increased sales of its current products. In five years, the new equipment will have a market value of $2.8 million if purchased today, and $6.1 million if purchased in two years. The equipment is depreciated on a seven-year MACRS schedule. The company has a tax rate of 38 percent, and the required return for the project is 14 percent.

a. Should J. Smythe undertake the new project?

b. Can you perform an IRR analysis on this project? How many IRRs would you expect to find?

c. How would you interpret the profitability index?

Bethesda Mining Company

Bethesda Mining is a midsized coal mining company with 20 mines located in Ohio, Pennsylvania, West Virginia, and Kentucky. The company operates deep mines as well as strip mines. Most of the coal mined is sold under contract, with excess production sold on the spot market.

The coal mining industry, especially high-sulfur coal operations such as Bethesda, has been hard-hit by environmental regulations. Recently, however, a combination of increased demand for coal and new pollution reduction technologies has led to an improved market demand for high-sulfur coal. Bethesda has just been approached by Mid-Ohio Electric Company with a request to supply coal for its electric generators for the next four years. Bethesda Mining does not have enough excess capacity at its existing mines to guarantee the contract. The company is considering opening a strip mine in Ohio on 5,000 acres of land purchased 10 years ago for $6 million. Based on a recent appraisal, the company feels it could receive $5 million on an aftertax basis if it sold the land today.

Strip mining is a process where the layers of topsoil above a coal vein are removed and the exposed coal is removed. Some time ago, the company would simply remove the coal and leave the land in an unusable condition. Changes in mining regulations now force a company to reclaim the land; that is, when the mining is completed, the land must be restored to near its original condition. The land can then be used for other purposes. Because it is currently operating at full capacity, Bethesda will need to purchase additional necessary equipment, which will cost $30 million. The equipment will be depreciated on a seven-year MACRS schedule. The contract runs for only four years. At that time the coal from the site will be entirely mined. The company feels that the equipment can be sold for 60 percent of its initial purchase price. However, Bethesda plans to open another strip mine at that time and will use the equipment at the new mine.

The contract calls for the delivery of 600,000 tons of coal per year at a price of $34 per ton. Bethesda Mining feels that coal production will be 650,000 tons, 725,000 tons, 810,000 tons, and 740,000 tons, respectively, over the next four years. The excess production will be sold in the spot market at an average of $40 per ton. Variable costs amount to $13 per ton, and fixed costs are $2,500,000 per year. The mine will require a net working capital investment of 5 percent of sales. The NWC will be built up in the year prior to the sales.

Bethesda will be responsible for reclaiming the land at termination of the mining. This will occur in year 5. The company uses an outside company for reclamation of all the company's strip mines. It is estimated the cost of reclamation will be $4 million. After the land is reclaimed, the company plans to donate the land to the state for use as a public park and recreation area. This will occur in year 6 and result in a charitable expense deduction of $6 million. Bethesda faces a 38 percent tax rate and has a 12 percent required return on new strip mine projects. Assume that a loss in any year will result in a tax credit.

You have been approached by the president of the company with a request to analyze the project. Calculate the payback period, profitability index, average accounting return, net present value, internal rate of return, and modified internal rate of return for the new strip mine. Should Bethesda Mining take the contract and open the mine?

Goodweek Tires, Inc.

After extensive research and development, Goodweek Tires, Inc., has recently developed a new tire, the SuperTread, and must decide whether to make the investment necessary to produce and market it. The tire would be ideal for drivers doing a large amount of wet weather and off-road driving in addition to normal freeway usage. The research and development costs so far have totaled about $10 million. The SuperTread would be put on the market beginning this year, and Goodweek expects it to stay on the market for a total of four years. Test marketing costing $5 million has shown that there is a significant market for a SuperTread-type tire.

As a financial analyst at Goodweek Tires, you have been asked by your CFO, Adam Smith, to evaluate the SuperTread project and provide a recommendation on whether to go ahead with the investment. Except for the initial investment that will occur immediately, assume all cash flows will occur at year-end.

Goodweek must initially invest $120 million in production equipment to make the SuperTread. This equipment can be sold for $51 million at the end of four years. Goodweek intends to sell the SuperTread to two distinct markets:

1. *The original equipment manufacturer (OEM) market*: The OEM market consists primarily of the large automobile companies (like General Motors) that buy tires for new cars. In the OEM market, the SuperTread is expected to sell for $36 per tire. The variable cost to produce each tire is $18.
2. *The replacement market*: The replacement market consists of all tires purchased after the automobile has left the factory. This market allows higher margins; Goodweek expects to sell the SuperTread for $59 per tire there. Variable costs are the same as in the OEM market.

Goodweek Tires intends to raise prices at 1 percent above the inflation rate; variable costs will also increase at 1 percent above the inflation rate. In addition, the SuperTread project will incur $25 million in marketing and general administration costs the first year. This cost is expected to increase at the inflation rate in the subsequent years.

Goodweek's corporate tax rate is 40 percent. Annual inflation is expected to remain constant at 3.25 percent. The company uses a 15.9 percent discount rate to evaluate new product decisions. Automotive industry analysts expect automobile manufacturers to produce 2 million new cars this year and production to grow at 2.5 percent per year thereafter. Each new car needs four tires (the spare tires are undersized and are in a different category). Goodweek Tires expects the SuperTread to capture 11 percent of the OEM market.

Industry analysts estimate that the replacement tire market size will be 14 million tires this year and that it will grow at 2 percent annually. Goodweek expects the SuperTread to capture an 8 percent market share.

The appropriate depreciation schedule for the equipment is the seven-year MACRS depreciation schedule. The immediate initial working capital requirement is $11 million. Thereafter, the net working capital requirements will be 15 percent of sales. What are the NPV, payback period, discounted payback period, AAR, IRR, and PI on this project?

CHAPTER

8

Risk Analysis, Real Options, and Capital Budgeting

In 1836, defenders of the Alamo in San Antonio, Texas, held out for 13 days against great odds, and "Remember the Alamo!" became a part of U.S. history. In contrast, Disney's 2004 movie *The Alamo*, starring Billy Bob Thornton as Davy Crockett, barely lasted a weekend at the box office, and the last thing Disney's management wants to do is remember that particular bomb. Disney spent close to $100 million making the movie, plus millions more for marketing and distribution, but the film pulled in only about $22.5 million. In fact, about 4 of 10 movies lose money at the box office, though DVD sales often help the final tally. Of course there are movies that do quite well. In 2005, the last of the Star Wars movies, *Revenge of the Sith*, pulled in about $849 million at a cost of $115 million.

Obviously, Disney didn't *plan* to lose $80 or so million on *The Alamo*, but it happened. As the short life and quick death of *The Alamo* show, projects don't always go as companies think they will. This chapter explores how this can happen, and what companies can do to analyze and possibly avoid these situations.

8.1 Sensitivity Analysis, Scenario Analysis, and Break-Even Analysis

One main point of this book is that NPV analysis is a superior capital budgeting technique. In fact, because the NPV approach uses cash flows rather than profits, uses all the cash flows, and discounts the cash flows properly, it is hard to find any theoretical fault with it. However, in our conversations with practical businesspeople, we hear the phrase "a false sense of security" frequently. These people point out that the documentation for capital budgeting proposals is often quite impressive. Cash flows are projected down to the last thousand dollars (or even the last dollar) for each year (or even each month). Opportunity costs and side effects are handled quite properly. Sunk costs are ignored—also quite properly. When a high net present value appears at the bottom, one's temptation is to say yes immediately. Nevertheless, the projected cash flow often goes unmet in practice, and the firm ends up with a money loser.

Sensitivity Analysis and Scenario Analysis

How can the firm get the net present value technique to live up to its potential? One approach is **sensitivity analysis**, which examines how sensitive a particular NPV calculation is to changes in underlying assumptions. Sensitivity analysis is also known as *what-if* analysis and *bop* (best, optimistic, and pessimistic) analysis.