Chapter 10
Cash Flows and Other Topics in Capital Budgeting

Guidelines for Capital Budgeting • An Overview of the Calculations of a Project’s Free Cash Flows • Options in Capital Budgeting • Risk and the Investment Decision • Incorporating Risk into Capital Budgeting • Examining a Project’s Risk Through Simulation • Finance and the Multinational Firm: Calculating Cash Flows and the International Dimension of Risk

Learning Objectives
After reading this chapter, you should be able to:

1. Identify guidelines by which we measure cash flows.
2. Explain how a project’s benefits and costs—that is, its free cash flows—are calculated.
3. Explain the importance of options or flexibility in capital budgeting.
4. Explain what the appropriate measure of risk is for capital-budgeting purposes.
5. Determine the acceptability of a new project using the risk-adjusted discount method of adjusting for risk.
6. Explain the use of simulation for imitating the performance of a project under evaluation.
7. Explain why a multinational firm faces a more difficult time estimating cash flows along with increased risks.

After 46 years, it was time for a change, and in 2001 that change came to Walt Disney Company’s Disneyland when it opened California Adventure. In Chapter 9, we noted the importance of this $1.4-billion investment by Walt Disney Co., its second park in Anaheim. Disney’s hope with this new park was to keep “first pick” on tourist dollars spent in southern California—in effect, to replicate the success that they have had in Orlando, Florida, with Disney World. Although the basic techniques used to evaluate this project, which were described in the previous chapter, were straightforward, coming up with the cash flow forecasts and adjusting for the risk associated with this project were very complicated, to say the least.

Not only would this new project directly compete with Disneyland, taking dollars away from Disney’s older park, but coming up with cash flow forecasts upon which to base a decision was further complicated by the fact that there was good deal of uncertainty about how individuals would spend their entertainment dollars in the future. The entertainment market had changed quite a bit since Disneyland first opened in 1955, with theme-park competition soaring and tourist dollars much harder to come by. Today, it is the “thrill ride” that brings patrons to theme parks—something that California Adventures lacks. In addition, there is a good deal of uncertainty surrounding other factors that affect how an entertainment dollar will be spent in the future. For the new Disney park, there is a good chance that the cash flow forecasts will not live up to expectations. Unfortunately, this park opened to a weakening economy and potential park patrons edgy about jobs and income. On top of this, the tragedy of September 11th dealt a further blow to park attendance, with attendance down about 25 percent in October 2001. The bottom line here is that it is extremely difficult to forecast either future cash flows or the level of uncertainty associated with those forecasts. How accurately Disney estimated the future cash flows and how they adjusted for risk will go a long way toward determining whether this $1.4-billion investment was money well spent.
OBJECTIVE 1

This chapter continues our discussion of decision-making rules for deciding when to invest in new projects. First, we examine what is a relevant cash flow and how to calculate the relevant cash flow. We then turn our attention to the problem of capital budgeting under uncertainty. In discussing capital-budgeting techniques in the preceding chapter, we implicitly assumed the level of risk associated with each investment proposal was the same. In this chapter we lift that assumption and examine various ways in which risk can be incorporated into the capital-budgeting decision.

In Chapter 9 we looked at decision criteria, assuming the cash flows were known with certainty. In this chapter, we see how difficult and complex estimating cash flows is. Not only will we develop an understanding of what a relevant cash flow is and how to measure it, but we will also try to understand the risks that Disney or any other company faces in making capital-budgeting decisions, not knowing exactly what future competition they will face. We will also learn how Disney or any other company can modify our capital-budgeting criterion to deal with risk.

Guidelines for Capital Budgeting

To evaluate investment proposals, we must first set guidelines by which we measure the value of each proposal. In effect, we are deciding what is and what isn’t a relevant cash flow.

Use Cash Flows Rather Than Accounting Profits

We use cash flows, not accounting profits, as our measurement tool. The firm receives and is able to reinvest cash flows, whereas accounting profits are shown when they are earned rather than when the money is actually in hand. Unfortunately, a firm’s accounting profits and cash flows may not be timed to occur together. For example, capital expenses, such as vehicles and plant and equipment, are depreciated over several years, with their annual depreciation subtracted from profits. Cash flows correctly reflect the timing of benefits and costs—that is, when the money is received, when it can be reinvested, and when it must be paid out.

Think Incrementally

Unfortunately, calculating cash flows from a project may not be enough. Decision makers must ask, What new cash flows will the company as a whole receive if the company takes on a given project? What if the company does not take on the project? Interestingly, we may find that not all cash flows a firm expects from an investment proposal are incremental in nature. In measuring cash flows, however, the trick is to think incrementally. In doing so, we will see that only incremental after-tax cash flows matter. As such, our guiding rule in deciding if a cash flow is incremental is to look at the company with, versus without, the new product. As you will see in the upcoming sections, this may be easier said than done.
In order to measure the true effects of our decisions, we analyze the benefits and costs of projects on an incremental basis, which relates directly to Principle 4: Incremental Cash Flows—It’s Only What Changes That Counts. In effect, we ask ourselves what the cash flows will be if the project is taken on versus what they will be if the project is not taken on.

**Beware of Cash Flows Diverted from Existing Products**

Assume for a moment that we are managers of a firm considering a new product line that might compete with one of our existing products and possibly reduce its sales. In determining the cash flows associated with the proposed project, we should consider only the incremental sales brought to the company as a whole. New-product sales achieved at the cost of losing sales of other products in our line are not considered a benefit of adopting the new product. For example, when Quaker Oats recently introduced Cap’n Crunch’s Cozmic Crunch, the product competed directly with the company’s Cap’n Crunch and Crunch Berries cereals. (In fact it was almost identical to Crunch Berries, with the shapes changed to stars and moons, along with a packet of orange space dust that turns milk green). Quaker meant to target the market niche held by Post Fruity Pebbles, but there was no question that sales recorded by Cozmic Crunch bit into—literally cannibalized—Quaker’s existing product line.

Remember that we are only interested in the sales dollars to the firm if the project is accepted, as opposed to what the sales dollars would be if the project were rejected. Just moving sales from one product line to a new product line does not bring anything new into the company, but if sales are captured from our competitors or if sales that would have been lost to new competing products are retained, then these are relevant incremental cash flows. In each case these are the incremental cash flows to the firm—looking at the firm as a whole, with the new product versus without the new product.

**Look for Incidental or Synergistic Effects**

Although in some cases a new project may take sales away from a firm’s current projects, in other cases a new effort may actually bring new sales to the existing line.

For example, in 2002, GM’s Pontiac division introduced the Vibe, an in-your-face-looking combination of a wagon and a sporty coupe. The idea was not only to sell lots of Vibes, but also to help lure back young customers to Pontiac’s other car lines. From 1994 until the introduction of the Vibe, the average age of Pontiac buyers had risen from 40 to 42. Thus, the hope was that the Vibe would bring younger customers into showrooms, who would in turn either buy a Vibe or lock on to another one of Pontiac’s products. Thus, in evaluating the Vibe, if managers were to look only at the revenue from new Vibe sales, they would miss the incremental cash flow to Pontiac as a whole that results from new customers who would not have otherwise purchased a Pontiac automobile but did so only after being lured into a Pontiac showroom to see a Vibe. This is called a synergistic effect. The cash flow comes from any Pontiac sale that would not have occurred if a customer had not visited a Pontiac showroom to see a Vibe.

**Work in Working-Capital Requirements**

Many times a new project involves additional investment in working capital. This may take the form of new inventory to stock a sales outlet, additional investment in accounts receivable resulting from additional credit sales, or increased investment in cash to operate cash registers, and more. Working-capital requirements are considered a cash flow even though they do not leave the company. How can investment in inventory be considered a cash outflow when the goods are still in the store?
Because the firm does not have access to the inventory’s cash value, the firm cannot use the money for other investments. Generally, working-capital requirements are tied up over the life of the project. When the project terminates, there is usually an offsetting cash inflow as the working capital is recovered, although this offset is not perfect because of the time value of money.

**Consider Incremental Expenses**

Just as cash inflows from a new project are measured on an incremental basis, expenses should also be measured on an incremental basis. For example, if introducing a new product line necessitates training the sales staff, the after-tax cash flow associated with the training program must be considered a cash outflow and charged against the project. If accepting a new project dictates that a production facility be reengineered, the cash flows associated with that capital investment should be charged against the project, and they will then be depreciated over the life of the project. Again, any incremental after-tax cash flow affecting the company as a whole is a relevant cash flow, whether it is flowing in or flowing out.

**Remember That Sunk Costs Are Not Incremental Cash Flows**

Only cash flows that are affected by the decision making at the moment are relevant in capital budgeting. The manager asks two questions: (1) Will this cash flow occur if the project is accepted? (2) Will this cash flow occur if the project is rejected? Yes to the first question and no to the second equals an incremental cash flow. For example, let’s assume you are considering introducing a new taste treat called Puddin’ in a Shoe. You would like to do some test-marketing before production. If you are considering the decision to test-market and have not yet done so, the costs associated with the test-marketing are relevant cash flows. Conversely, if you have already test-marketed, the cash flows involved in testing-marketing are no longer relevant in project evaluation. It’s a matter of timing. Regardless of what you might decide about future production, the cash flows allocated to marketing have already occurred. Cash flows that have already taken place are often referred to as “sunk costs” because they have been sunk into the project and cannot be undone. As a rule, any cash flows that are not affected by the accept/reject criterion should not be included in capital-budgeting analysis.

**Account for Opportunity Costs**

Now we will focus on the cash flows that are lost because a given project consumes scarce resources that would have produced cash flows if that project had been rejected. This is the opportunity cost of doing business. For example, a product may use valuable floor space in a production facility. Although the cash flow is not obvious, the real question remains: What else could be done with this space? The space could have been rented out, or another product could have been stored there. The key point is that opportunity-cost cash flows should reflect net cash flows that would have been received if the project under consideration were rejected. Again, we are analyzing the cash flows to the company as a whole, with or without the project.

**Decide If Overhead Costs Are Truly Incremental Cash Flows**

Although we certainly want to include any incremental cash flows resulting in changes from overhead expenses such as utilities and salaries, we also want to make sure that these are truly incremental cash flows. Many times, overhead expenses—heat, light, rent—would occur whether a given project were accepted or rejected. There is often not a single specific project to which these expenses can be allocated. Thus, the question is not whether the project benefits from overhead items but whether the overhead costs are incremental cash flows associated with the project and relevant to capital budgeting.
Ignore Interest Payments and Financing Flows

In evaluating new projects and determining cash flows, we must separate the investment decision from the financing decision. Interest payments and other financing cash flows that might result from raising funds to finance a project should not be considered incremental cash flows. If accepting a project means we have to raise new funds by issuing bonds, the interest charges associated with raising funds are not a relevant cash outflow. When we discount the incremental cash flows back to the present at the required rate of return, we are implicitly accounting for the cost of raising funds to finance the new project. In essence, the required rate of return reflects the cost of the funds needed to support the project. Managers first determine the desirability of the project and then determine how best to finance it.

Concept Check

1. What is an incremental cash flow? What is a sunk cost? What are opportunity costs?
2. If Ford introduces a new auto line, might some of the cash flows from that new car line be diverted from existing product lines? How should you deal with this?

An Overview of the Calculations of a Project’s Free Cash Flows

In measuring cash flows, we will be interested only in the incremental, or differential, after-tax cash flows that can be attributed to the proposal being evaluated. That is, we will focus our attention on the difference in the firm’s after-tax cash flows with versus
without the project—the project’s free cash flows. The worth of our decision depends on the accuracy of our cash flow estimates. For this reason, we first examined the question of what cash flows are relevant. Now we will see that, in general, a project’s free cash flows will fall into one of three categories: (1) the initial outlay, (2) the differential flows over the project’s life, and (3) the terminal cash flow. Once we have taken a look at these categories, we will take on the task of measuring these free cash flows.

**Initial Outlay**

The initial outlay involves the immediate cash outflow necessary to purchase the asset and put it in operating order. This amount includes the cost of installing the asset (the asset’s purchase price plus any expenses associated with shipping or installation) and any nonexpense cash outlays, such as increased working-capital requirements. If we are considering a new sales outlet, there might be additional cash flows associated with net investment in working capital in the form of increased inventory and cash necessary to operate the sales outlet. Although these cash flows are not included in the cost of the asset or even expensed on the books, they must be included in our analysis. The after-tax cost of expense items incurred as a result of new investment must also be included as cash outflows—for example, any training expenses that would not have been incurred otherwise.

Finally, if the investment decision is a replacement decision, the cash inflow associated with the selling price of the old asset, in addition to any tax effects resulting from its sale, must be included. It should be stressed that the incremental nature of the cash flow is of great importance. In many cases, if the project is not accepted, then status quo for the firm will simply not continue. In calculating incremental cash flows, we must be realistic in estimating what the cash flows to the company would be if the new project were not accepted.

**Tax Effects—Sale of Old Machine**

Potentially, one of the most confusing initial outlay calculations is for a replacement project involving the incremental tax payment associated with the sale of an old machine. There are three possible tax situations dealing with the sale of an old asset:

1. The old asset is sold for a price above the depreciated value. Here the difference between the old machine’s selling price and its depreciated value is considered a taxable gain and is taxed at the marginal corporate tax rate. If, for example, the old machine was originally purchased for $15,000, had a book value of $10,000, and was sold for $17,000, assuming the firm’s marginal corporate tax rate is 34 percent, the taxes due from the gain would be $(17,000 - 10,000) \times (.34)$, or $2,380.

2. The old asset is sold for its depreciated value. In this case, no taxes result, because there is neither a gain nor a loss in the asset’s sale.

3. The old asset is sold for less than its depreciated value. In this case, the difference between the depreciated book value and the salvage value of the asset is a taxable loss and may be used to offset capital gains and thus results in tax savings. For example, if the depreciated book value of the asset is $10,000 and it is sold for $7,000, we have a $3,000 loss. Assuming the firm’s marginal corporate tax rate is 34 percent, the cash inflow from tax savings is $(10,000 - 7,000) \times (.34)$, or $1,020.

**Differential Flows over a Project’s Life**

The differential cash flows over a project’s life involve the incremental after-tax cash flows resulting from the project being considered. In making the calculation, we will make sure that any increase in interest payments incurred as a result of issuing bonds to finance the project will not be included, because the costs of funds needed to support the project are implicitly accounted for by discounting the project back to the present using the required rate of return. Finally, an adjustment for the incremental change in taxes should be included. In addition, we must make sure our calculations reflect the fact that although depreciation is considered an expense from an accounting perspective, it does not involve any cash flows. We must also
take note of any changes in working capital or capital spending that take place. However, before we look at the actual calculation, we will briefly examine the calculation of depreciation and the net change in working capital.

Depreciation plays an important role in the calculation of cash flows. Although it is not a cash flow item, it lowers profits, which in turn lowers taxes. For students developing a foundation in corporate finance, it is the concept of depreciation, not the calculation of it, that is important. The reason the calculation of depreciation is deemphasized is that it is extremely complicated, and its calculation changes every few years as Congress enacts new tax laws. Through all this, bear in mind that although depreciation is not a cash flow item, it does affect cash flows by lowering the level of profits on which taxes are calculated.

**Depreciation**

The Revenue Reconciliation Act of 1993 largely left intact the modified version of the Accelerated Cost Recovery System introduced in the Tax Reform Act of 1986. Although this was examined earlier, a review is appropriate here. This modified version of the old accelerated cost recovery system (ACRS) is used for most tangible depreciable property placed in service beginning in 1987. Under this method, the life of the asset is determined according to the asset’s class life, which is assigned by the IRS; for example, most computer equipment has a 5-year asset life. It also allows for only a half-year’s deduction in the first year and a half-year’s deduction in the year after the recovery period. The asset is then depreciated using the 200-percent declining balance method or an optional straight-line method.

For our purposes, depreciation is calculated using a simplified straight-line method. This simplified process ignores the half-year convention that allows only a half-year’s deduction in the year the project is placed in service and a half-year’s deduction in the first year after the recovery period. By ignoring the half-year convention and assuming a zero salvage value, we are able to calculate annual depreciation by taking the project’s initial depreciable value and dividing by its depreciable life as follows:

\[
\text{annual depreciation using the simplified straight-line method} = \frac{\text{initial depreciable value}}{\text{depreciable life}}
\]

The initial depreciation value is equal to the cost of the asset plus any expenses necessary to get the new asset into operating order.

This is not how depreciation would actually be calculated. The reason we have simplified the calculation is to allow you to focus directly on what should and should not be included in the cash flow calculations. Moreover, because the tax laws change rather frequently, we are more interested in recognizing the tax implications of depreciation than in understanding the specific depreciation provisions of the current tax laws.

Our concern with depreciation is to highlight its importance in generating cash flow estimates and to indicate that the financial manager must be aware of the current tax provisions when evaluating capital-budgeting proposals.

**Net Working Capital**

While depreciation is an expense, but not a cash flow item, working capital is a cash-flow item, but not an expense. In fact, very few projects do not require some increased investment in working capital. It is only natural for inventory levels to increase as a firm begins production of a new product. Likewise, many of the sales of the new product may be on credit, resulting in an increase in accounts receivable. Offsetting some of this may be a corresponding increase in accounts payable, as the firm buys raw materials on credit.

The increased working capital minus any additional short-term liabilities that were generated is the change in net working capital. Thus, we need only look at the difference between the beginning and ending levels of investment in working capital less any additional short-term liabilities to calculate the change in net working capital. Complicating all of this are two things: the current portion of long-term debt and cash. Because the current portion of long-term debt is already counted as part of the financing for the project, including it as part of working capital would double-count it.
**Terminal Cash Flow**

The calculation of the terminal cash flow is in general quite a bit simpler than the preceding two calculations. Flows associated with the project’s termination may include the salvage value of the project plus or minus any taxable gains or losses associated with its sale.

Under the current tax laws, in most cases there will be tax payments associated with the salvage value at termination. This is because the current laws allow all projects to be depreciated to zero, and if a project has a book value of zero at termination and a positive salvage value, then that salvage value will be taxed. The tax effects associated with the salvage value of the project at termination are determined exactly like the tax effects on the sale of the old machine associated with the initial outlay. The salvage value proceeds are compared with the depreciated value, in this case zero, to determine the tax.

In addition to the salvage value, there may be a cash outlay associated with the project termination. For example, at the close of a strip-mining operation, the mine must be refilled in an ecologically acceptable manner.

**Measuring the Cash Flows**

Fortunately, the calculations for each cash flow category are very similar. In fact, the only reason we have divided our discussion into these three categories based upon timing is because there tend to be some unusual cash flows associated with the initial outlay and the terminal cash flow. For example, in addition to the cost of the fixed assets associated with the new project, there may be some other cash flows, perhaps training costs or marketing research expenses, that are associated with the start-up of the new project. Similarly, the terminal cash flow may involve some unusual cash flow, perhaps making the project site environmentally safe after the plant closes.

We are trying to measure the free cash flows to the company as a whole that accrue from the new project. To do this we will rely on pro forma financial statements. We can then divided our estimate of a project’s free cash flows into three types:

1. **The project’s change in operating cash flows.** These include any after-tax savings or earnings that result from the new project. It should take into account any new sales or cost savings offset by any increased expenses, all on an after-tax basis. It should also include any increases in overhead that are required. For example, if taking on the new project requires that the accounting staff must be increased by two, then that cash flow associated with the increased salaries from the additional staff should be included in the analysis. Likewise, if this project produces sales increases in other product lines, those cash flows will also be relevant.

   What we are trying to measure with the change in operating cash flows is simply the change in sales minus costs minus taxes:

   \[
   \text{operating cash flows} = \text{change in sales} - \text{change in costs} - \text{change in taxes}
   \]

   The easiest way to calculate this is to use a pro forma statement and simply convert the accounting information into cash flow information.¹

   The calculation of a project’s operating cash flow actually involves three steps. First, we determine the company’s *earnings before interest and taxes* (EBIT) with and without this project. Second, we subtract out the change in taxes. Keep in mind that in calculating the change in taxes, we will ignore any interest expenses. Third, we adjust this value for the fact that depreciation, a non–cash flow item, has been subtracted out in the calculation of EBIT. We do

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¹To do this, we take advantage of the fact that the difference between the change in sales and the change in costs should be equal to the change in EBIT plus depreciation.
this by adding back depreciation. Thus, operating cash flows are calculated as follows:

\[
\text{operating cash flows} = \text{change in earnings before interest and taxes} - \text{change in taxes} + \text{change in depreciation}
\]

2. Change in net working capital. As we mentioned earlier in this chapter, many times a new project will involve additional investment in working capital—perhaps new inventory to stock a new sales outlet or simply additional investment in accounts receivable. There also may be some spontaneous short-term financing—for example, increases in accounts receivable—that results from the new project. Thus, the change in net working capital is the additional investment in working capital minus any additional short-term liabilities that were generated.

3. Change in capital spending. Although there is generally a large cash outflow associated with a project’s initial outlay, there also may be additional capital spending requirements over the life of the project. For example, you may know ahead of time that the plant will need some minor retooling in the second year of the project in order to keep the project abreast of new technological changes that are expected to take place. In effect, we will look at the company with and without the new project. Any changes in capital spending that occur are relevant.

Thus, a project’s free cash flows are

\[
\text{project’s free cash flows} = \text{project’s change in operating cash flows} - \text{change in net working capital} - \text{change in capital spending}
\]

If we rewrite this, inserting our calculation for the project’s change in operating cash flows, we get

\[
\text{project’s free cash flows} = \text{change in earnings before interest and taxes} - \text{change in taxes} + \text{change in depreciation} - \text{change in net working capital} - \text{change in capital spending}
\]

How do we go about estimating the changes in EBIT, taxes, depreciation, net working capital, and capital spending? We start with estimates of how many units we expect to sell, what the costs—both fixed and variable—will be, what the selling price will be, and what the required capital investment will be. From there we can put together a pro forma statement that should provide us with the data we need to estimate the project’s free cash flows. However, you must keep in mind that our capital-budgeting decision will only be as good as our estimates of the costs and future demand. In fact, most capital-budgeting decisions that turn out to be bad decisions are not bad decisions because the decision maker used a bad decision rule, but because the estimates of future demand and costs were inaccurate.

Let’s look at a simple example. You are considering expanding your product line, which currently consists of Lee’s Press-on Nails, to take advantage of the fitness craze. The new product you are considering introducing is “Press-on Abs.” You feel you can sell 100,000 of these per year for 4 years (after which time this project is expected to shut down because forecasters predict healthy looks will no longer be in vogue, being replaced with a couch-potato look). The press-on abs will sell for $6 each, with variable costs of $3 for each one produced, while annual fixed costs associated with production will be $90,000. In addition, there will be a $200,000 initial expenditure associated with the purchase of new production equipment. It is assumed that this initial expenditure will be depreciated using the simplified straight-line method down to zero over 4 years. This project will also require a one-time initial investment of $30,000 in net working capital associated with inventory. Finally, assume that the firm’s marginal tax rate is 34 percent.
Let’s begin by estimating the initial outlay. In this example, the initial outlay will be the $200,000 initial expenditure plus the investment of $30,000 in net working capital, for a total of $230,000. Table 10-1 calculates the annual change in earnings before interest and taxes. This calculation begins with the change in sales ($\Delta Sales$) and subtracts the change in fixed and variable costs, in addition to the change in depreciation, to calculate the change in earnings before interest and taxes, or EBIT. Depreciation is calculated using the simplified straight-line method, which is simply the depreciable value of the asset ($200,000) divided by the asset’s expected life, which is 4 years. Taxes are then calculated assuming a 34 percent marginal tax rate. Once we have calculated EBIT and taxes, we don’t need to go any further, because these are the only two values from the pro forma income statement that we need. In addition, there is not any annual increase in working capital associated with the project under consideration in this example. Also notice that we have ignored any interest payments and financing flows that might have occurred. As mentioned earlier, when we discount the free cash flows back to present at the required rate of return, we are implicitly accounting for the cost of the funds needed to support the project.

The project’s annual change in operating cash flow, which is simply the change in earnings before interest and taxes minus the change in taxes plus the change in depreciation, is calculated in Table 10-2.

The project’s annual free cash flow is simply the change in operating cash flow less any change in net working capital and less any change in capital spending. In this example, there are no changes in net working capital and capital spending over the life of the project. This is not the case for all projects that you will consider. For example, on a project in which sales increase annually, it is likely that working capital will also increase each year to support a larger inventory and a higher level of accounts receivable. Similarly, on some projects the capital expenditures may be spread out over several years. The point here is that what we are trying to do is look at the firm with this project and without this project and measure the change in cash flows other than any interest payments and financing flows that might have occurred.

The terminal cash flow for this project is quite simple. The only unusual cash flow at the project’s termination is the recapture of the net working capital associated with the project. In effect, the investment in inventory of $30,000 is liquidated when the project is shut down in 4 years. Keep in mind that in calculating free cash flow, we subtract out the change in net working capital, but because the change in net working capital is negative (we are reducing our investment in inventory), we are subtracting a negative number, which has the effect of adding it back in. Thus, working capital was a negative cash flow when the project began and we invested in inventory. At termination it becomes a positive offsetting cash flow when the inventory is liquidated. The calculation of the terminal free cash flow is shown in Table 10-3.

<table>
<thead>
<tr>
<th>Table 10-1</th>
<th>Calculation of the Annual Change in Earnings Before Interest and Taxes for the Press-on Abs Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta$ Sales (100,000 units at $6/unit)</td>
<td>$600,000</td>
</tr>
<tr>
<td>Less: $\Delta$ Variable costs (variable cost $3.00/unit)</td>
<td>$-300,000</td>
</tr>
<tr>
<td>Less: $\Delta$ Fixed costs</td>
<td>$-90,000</td>
</tr>
<tr>
<td>Equals:</td>
<td>$210,000</td>
</tr>
<tr>
<td>Less: $\Delta$ Depreciation ($200,000/4 years)</td>
<td>$-50,000</td>
</tr>
<tr>
<td>Equals: $\Delta$ EBIT</td>
<td>$160,000</td>
</tr>
<tr>
<td>$\Delta$ Taxes: (taxed at 34%)</td>
<td>$54,400</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 10-2</th>
<th>Annual Change in Operating Cash Flow for the Press-on Abs Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta$ Earnings before interest and taxes (EBIT)</td>
<td>$160,000</td>
</tr>
<tr>
<td>Minus: $\Delta$ Taxes</td>
<td>$-54,400</td>
</tr>
<tr>
<td>Plus: $\Delta$ Depreciation</td>
<td>$+50,000</td>
</tr>
<tr>
<td>Equals: $\Delta$ Operating cash flow</td>
<td>$155,600</td>
</tr>
</tbody>
</table>
If we were to construct a free cash flow diagram from this example (Figure 10-1), it would have an initial outlay of $230,000, the free cash flows during years 1 through 3 would be $155,600, and the free cash flow in the terminal year would be $185,600. Free cash flow diagrams similar to that shown in Figure 10-1 will be used through the remainder of this chapter. Arrows above the time line indicate cash inflows, and arrows below the time line denote outflows.

A Comprehensive Example: Calculating Free Cash Flows

Now let’s put what we know about capital budgeting together and look at a capital-budgeting decision for a firm in the 34-percent marginal tax bracket with a 15-percent required rate of return or cost of capital. The project we are considering involves the introduction of a new electric scooter line by Raymobile. Our first task is that of estimating cash flows. This project is expected to last 5 years and then, because this is somewhat of a fad project, to be terminated. Thus, our first task becomes that of estimating the initial outlay, the annual free cash flows, and the terminal free cash flow. Given the information in Table 10-4, we want to determine the free cash flows associated with the project. Once we have that, we can easily calculate the project’s net present value, the profitability index, and the internal rate of return, and apply the appropriate decision criteria.

To determine the differential annual free cash flows, we first need to determine the annual change in operating cash flow. To do this we will take the change in EBIT, subtract out the change in taxes, and then add in the change in depreciation. This is shown in Section I of Table 10-5. We first determine what the change in sales revenue will be by multiplying the units sold times the sale price. From the change in sales revenue, we subtract out variable costs, which were given as a percentage of sales. Then, the change in fixed costs is subtracted out, and the result is earnings before depreciation, interest, and taxes (EBDIT). Subtracting the change in depreciation from EBDIT then leaves us with the change in earnings before interest and taxes (EBIT). From the change in EBIT, we can then calculate the change in taxes, which are assumed to be 34 percent of EBIT.

Using the calculations provided in Section I of Table 10-5, we then calculate the operating cash flow in Section II of Table 10-5. As you recall, the operating cash flow is simply EBIT minus taxes, plus depreciation.

To calculate the free cash flow from this project, we subtract the change in net working capital and the change in capital spending from operating cash flow. Thus, the first step becomes determining the change in net working capital, which is shown in Section III of Table 10-5. The change in net working capital generally includes both increases in inventory and increases in accounts receivable that naturally occur as sales increase from the introduction of the new product line. Some of the increase in accounts receivable may be offset by increases in accounts payable, but, in general,

![Figure 10-1](image-url)
Table 10-4
Raymobile Scooter Line
Capital-Budgeting Example

| Cost of new plant and equipment: $9,700,000 |
| Shipping and installation costs: $300,000 |

<table>
<thead>
<tr>
<th>Unit sales:</th>
<th>Year</th>
<th>Units Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>100,000</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>100,000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>70,000</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>50,000</td>
<td></td>
</tr>
</tbody>
</table>

Sales price per unit: $150/unit in years 1 through 4, $130/unit in year 5
Variable cost per unit: $80/unit
Annual fixed costs: $500,000
Working-capital requirements: There will be an initial working-capital requirement of $100,000 just to get production started. Then, for each year, the total investment in net working capital will be equal to 10 percent of the dollar value of sales for that year. Thus, the investment in working capital will increase during years 1 through 3, then decrease in year 4. Finally, all working capital is liquidated at the termination of the project at the end of year 5.
The depreciation method: We use the simplified straight-line method over 5 years. It is assumed that the plant and equipment will have no salvage value after 5 years. Thus, annual depreciation is $2,000,000/year for 5 years.

most new projects involve some type of increase in net working capital. In this example, there is an initial working capital requirement of $100,000. In addition, for each year the total investment in net working capital will be equal to 10 percent of sales for each year. Thus, the investment in working capital for year 1 is $750,000 (because sales are estimated to be $7,500,000). Working capital will already be at $100,000, so the change in net working capital will be $650,000. Net working capital will continue to increase during years 1 through 3, then decrease in year 4. Finally, all working capital is liquidated at the termination of the project at the end of year 5.

With the operating cash flow and the change in net working capital already calculated, the calculation of the project’s free cash flow becomes easy. All that is missing is the change in capital spending, which in this example will simply be the $9,700,000 for plant and equipment plus the $300,000 for shipping and installation. Thus, change in capital spending becomes $10,000,000. We then need merely to take operating cash flow and subtract from it both the change in net working capital and the change in capital spending. This is done in Section IV of Table 10-5. A free cash flow diagram for this project is provided in Figure 10-2.

Using the information provided in Section IV of Table 10-5 and Figure 10-2, we easily calculate the NPV, PI, and IRR for this project.

Concept Check

1. In general, a project’s cash flows will fall into one of three categories. What are these categories?
2. What is a free cash flow? How do we calculate it?
3. What is depreciation? Where does it come from?
4. Although depreciation is not a cash flow item, it plays an important role in the calculation of cash flows. How does depreciation affect a project’s cash flows?
### Table 10-5
Calculation of Free Cash Flow for Raymobile Scooters

#### SECTION I. CALCULATE THE CHANGE IN EBIT, TAXES, AND DEPRECIATION (THIS BECOMES AN INPUT IN THE CALCULATION OF OPERATING CASH FLOW IN SECTION II)

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units sold</td>
<td>50,000</td>
<td>100,000</td>
<td>100,000</td>
<td>70,000</td>
<td>50,000</td>
<td></td>
</tr>
<tr>
<td>Sales price</td>
<td>$150</td>
<td>$150</td>
<td>$150</td>
<td>$150</td>
<td>$130</td>
<td></td>
</tr>
<tr>
<td>Sales revenue</td>
<td>$7,500,000</td>
<td>$15,000,000</td>
<td>$15,000,000</td>
<td>$10,500,000</td>
<td>$6,500,000</td>
<td></td>
</tr>
<tr>
<td>Less: Variable costs</td>
<td>4,000,000</td>
<td>8,000,000</td>
<td>8,000,000</td>
<td>5,600,000</td>
<td>4,000,000</td>
<td></td>
</tr>
<tr>
<td>Less: Fixed costs</td>
<td>500,000</td>
<td>500,000</td>
<td>500,000</td>
<td>500,000</td>
<td>500,000</td>
<td></td>
</tr>
<tr>
<td>Equals: EBDIT</td>
<td>$3,000,000</td>
<td>$6,500,000</td>
<td>$6,500,000</td>
<td>$4,400,000</td>
<td>$2,000,000</td>
<td></td>
</tr>
<tr>
<td>Less: Depreciation</td>
<td>2,000,000</td>
<td>2,000,000</td>
<td>2,000,000</td>
<td>2,000,000</td>
<td>2,000,000</td>
<td></td>
</tr>
<tr>
<td>Equals: EBIT</td>
<td>$1,000,000</td>
<td>$4,500,000</td>
<td>$4,500,000</td>
<td>$2,400,000</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Taxes (@34%)</td>
<td>340,000</td>
<td>1,530,000</td>
<td>1,530,000</td>
<td>816,000</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

#### SECTION II. CALCULATE OPERATING CASH FLOW (THIS BECOMES AN INPUT IN THE CALCULATION OF FREE CASH FLOW IN SECTION IV)

<table>
<thead>
<tr>
<th>Operating cash flow:</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBIT</td>
</tr>
<tr>
<td>Minus: Taxes</td>
</tr>
<tr>
<td>Plus: Depreciation</td>
</tr>
<tr>
<td>Equals: Operating cash flows</td>
</tr>
</tbody>
</table>

#### SECTION III. CALCULATE THE NET WORKING CAPITAL (THIS BECOMES AN INPUT IN THE CALCULATION OF FREE CASH FLOWS IN SECTION IV)

<table>
<thead>
<tr>
<th>Change in Net Working Capital:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
</tr>
<tr>
<td>Initial working-capital requirement</td>
</tr>
<tr>
<td>Net working-capital needs</td>
</tr>
<tr>
<td>Liquidation of working capital</td>
</tr>
<tr>
<td>Change in working capital</td>
</tr>
</tbody>
</table>

#### SECTION IV. CALCULATE FREE CASH FLOW (USING INFORMATION CALCULATED IN SECTIONS II AND III, IN ADDITION TO THE CHANGE IN CAPITAL SPENDING)

<table>
<thead>
<tr>
<th>Free cash flow:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating cash flow</td>
</tr>
<tr>
<td>$2,660,000</td>
</tr>
<tr>
<td>Minus: Change in net working capital</td>
</tr>
<tr>
<td>Minus: Change in capital spending</td>
</tr>
<tr>
<td>Free cash flow</td>
</tr>
</tbody>
</table>

In this chapter, it is easy to get caught up in the calculations and forget that before the calculations can be made, someone has to come up with the idea for the project. In some of the example problems, you may see projects that appear to be extremely profitable. Unfortunately, as we learned in Principle 5: The Curse of Competitive Markets—Why It's Hard to Find Exceptionally Profitable Projects, it is unusual to find projects with dramatically high returns because of the very competitive nature of business. Thus, keep in mind that capital budgeting not only involves the estimation and evaluation of the project’s cash flows, but it also includes the process of coming up with the idea for the project in the first place.
Options in Capital Budgeting

The use of our discounted cash flow decision criteria, such as the NPV method, provides an excellent framework within which to evaluate projects. However, what happens if the project being analyzed has the potential to be modified after some future uncertainty has been resolved? For example, if a project that had an expected life of 10 years turns out to be better than anticipated, it may be expanded or continued past 10 years, perhaps going for 20 years. On the other hand, if its cash flows do not meet expectations, it may not last a full 10 years; it might be scaled back, abandoned, or sold. In addition, it might be delayed for a year or two. This flexibility is something that the NPV and our other decision criteria had a difficult time dealing with. In fact, the NPV may actually understate the value of the project because the future opportunities associated with the possibility of modifying the project may have a positive value. It is this value of flexibility that we will be examining using options.

Three of the most common option types that can add value to a capital-budgeting project are (1) the option to delay a project until the future cash flows are more favorable—this option is common when the firm has exclusive rights, perhaps a patent, to a product or technology; (2) the option to expand a project, perhaps in size or even to new products that would not have otherwise been feasible; and (3) the option to abandon a project if the future cash flows fall short of expectations.

The Option to Delay a Project

There is no question that the estimated cash flows associated with a project can change over time. In fact, as a result of changing expected cash flows, a project that currently has a negative net present value may have a positive net present value in the future. Let’s look at the example of an eco-car—a car with a hybrid gasoline engine and an electric motor. Perhaps you’ve developed a high-voltage nickel-metal hydride battery that you plan on using, coupled with a gasoline engine, to power an automobile. However, as you examine the costs of introducing an eco-car capable of producing 70 miles per gallon, you realize that it is still relatively expensive to manufacture the nickel-metal hydride battery and the market for such a car would be quite small. Thus, this project seems to have a negative net present value. Does that mean that the rights to the high-voltage nickel-metal hydride battery have no value? No, they have value because you may be able to improve on this technology in the future and make the battery more efficient and less expensive. They also have value because oil prices may rise, which would lead to a bigger market for fuel-efficient cars. In effect, the ability to delay this project with the hope that technological and market conditions will change, making this project profitable, lends value to this project.

Another example of the option to delay a project until the future cash flows are more favorable involves a firm that owns the oil rights to some oil-rich land and is considering an oil-drilling project. After all of the costs and the expected oil output are considered, this project may have a negative net present value. Does that mean the firm should give away its oil rights or that those oil rights have no value? Certainly not; there is a chance that in the future oil prices could rise to the point that this negative NPV project could become a positive NPV project. It is this ability to delay development that provides value. Thus, the value in this seemingly negative NPV project is provided by the option to delay the project until the future cash flows are more favorable.

The Option to Expand a Project

Just as we saw with the option to delay a project, the estimated cash flows associated with a project can change over time, making it valuable to expand a project. Again, this flexibility to adjust production to demand has value. For example, a firm may build a production plant with excess capacity so that if the product has more than anticipated demand, it can simply increase production. Alternatively, taking on this project may provide the firm with a foothold in a new industry and lead to other products that would not have otherwise been feasible. This reasoning has led many firms to expand into e-businesses, hoping to gain know-how and expertise that will lead to
other profitable projects down the line. It also provides some of the rationale for research and development expenditures in which the future project is not well defined.

Let’s go back to our example of the eco-car and examine the option to expand that project. One of the reasons that most of the major automobile firms are introducing eco-cars is that they feel that if gas prices surge beyond the $2 per gallon price, these hybrids may be the future of the industry, and the only way to gain the know-how and expertise to produce an eco-car is to do it. If the cost of technology declines and the demands increase—perhaps pushed on by increases in gas prices—then they will be ready to expand into full-fledged production. This point becomes clear when you look at the new Honda Insight, which was introduced in January 2000. This is a two-passenger, 3-cylinder car with a gas engine and electric motor. It provides 65 miles per gallon, and Honda expected to sell between 7,000 and 8,000 during 2000.

On every Insight that Honda sells, analysts estimate that Honda loses about $8,000. A Honda spokesman says that Honda expects to break even “in a couple of years.” Still, this project makes sense because only through it can Honda gain the technological and production expertise to produce an eco-car profitably. Moreover, the technology Honda develops with the Insight may have profitable applications for other cars or in other areas. In effect, it is the option of expanding production in the future that brings value to this project.

The Option to Abandon a Project

The option to abandon a project as the estimated cash flows associated with a project can change over time also has value. Again, it is this flexibility to adjust to new information that provides the value. For example, a project’s sales in the first year or two may not live up to expectations, with the project being barely profitable. The firm may then decide to liquidate the project and sell the plant and all of the equipment, and that liquidated value may be more than the value of keeping the project going.

Again, let’s go back to our example of the eco-car and, this time, examine the option to abandon that project. If after a few years the cost of gas falls dramatically while the cost of technology remains high, the eco-car may not become profitable. At that point Honda may decide to abandon the project and sell the technology, including all the patent rights it has developed. In effect, the original project, the eco-car, may not be of value, but the technology that has been developed may be. In effect, the value of abandoning the project and selling the technology may be more than the value of keeping the project running. Again, it is the value of flexibility associated with the possibility of modifying the project in the future—in this case abandoning the project—that can produce positive value.

Options in Capital Budgeting: The Bottom Line

Because of the potential to be modified in the future after some future uncertainty has been resolved, we may find that a project with a negative net present value based upon its expected free cash flows is a “good” project and should be accepted—this demonstrates the value of options. In addition, we may find that a project with a positive net present value may be of more value if its acceptance is delayed. Options also explain the logic that drives firms to take on negative NPV projects that allow them to enter new markets. The option to abandon a project explains why firms hire employees on a temporary basis rather than permanently, why they may lease rather than buy equipment, and why they may enter into contracts with suppliers on an annual basis rather than long term.

Concept Check

1. Give an example of an option to delay a project. Why might this be of value?
2. Give an example of an option to expand a project. Why might this be of value?
3. Give an example of an option to abandon a project. Why might this be of value?
Risk and the Investment Decision

Up to this point we have ignored risk in capital budgeting; that is, we have discounted expected cash flows back to the present and ignored any uncertainty that there might be surrounding that estimate. In reality the future cash flows associated with the introduction of a new sales outlet or a new product are estimates of what is expected to happen in the future, not necessarily what will happen in the future. For example, when Coca-Cola decided to replace Classic Coke with its “New Coke,” you can bet that the expected cash flows it based its decision on were nothing like the cash flows its realized. As a result, it didn’t take Coca-Cola long to reintroduce Classic Coke. The cash flows we have discounted back to the present have only been our best estimate of the expected future cash flows. A cash flow diagram based on the possible outcomes of an investment proposal rather than the expected values of these outcomes appears in Figure 10-3.

In this section, we assume that under conditions of risk we do not know beforehand what cash flows will actually result from a new project. However, we do have expectations concerning the possible outcomes and are able to assign probabilities to these outcomes. Stated another way, although we do not know what the cash flows resulting from the acceptance of a new project will be, we can formulate the probability distributions from which the flows will be drawn.

As we learned in Chapter 8, risk occurs when there is some question about the future outcome of an event.

In the remainder of this chapter, we assume that although future cash flows are not known with certainty, the probability distribution from which they come can be estimated. Also, because we have illustrated that the dispersion of possible outcomes reflects risk, we are prepared to use a measure of dispersion or variability later in the chapter when we quantify risk.

In the pages that follow, remember that there are only two basic issues that we address: (1) What is risk in terms of capital-budgeting decisions, and how should it be measured? (2) How should risk be incorporated into capital-budgeting analysis?

What Measure of Risk Is Relevant in Capital Budgeting?

Before we begin our discussion of how to adjust for risk, it is important to determine just what type of risk we are to adjust for. In capital budgeting, a project’s risk can be looked at on three levels. First, there is the project standing alone risk, which is a project’s risk ignoring the fact that much of this risk will be diversified away as the project is combined with the firm’s other projects and assets. Second, we have the project’s contribution-to-firm risk, which is the amount of risk that the project contributes to the firm as a whole; this measure considers the fact that some of the project’s risk will be diversified away as the project is combined with the firm’s other projects and assets, but ignores the effects of diversification of the firm’s shareholders. Finally, there is systematic risk, which is the risk of the project from the viewpoint of a well-diversified shareholder; this measure takes into account that some of a project’s risk will be diversified away as the project is combined with the firm’s other projects, and, in addition, some of the remaining risk will be diversified away.
Measures of Risk

<table>
<thead>
<tr>
<th>Perspective</th>
<th>Project standing alone: Ignores diversification within the firm and within the shareholder’s portfolio.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Project from the company’s perspective: Ignores diversification within the shareholder’s portfolio, but allows for diversification within the firm.</td>
</tr>
<tr>
<td></td>
<td>Project from the shareholder’s perspective: Allows for diversification within the firm and within the shareholder’s portfolio.</td>
</tr>
</tbody>
</table>

Risk That Is Diversified Away

<table>
<thead>
<tr>
<th>Project’s standing alone risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk diversified away within firm as this project is combined with firm’s other projects and assets</td>
</tr>
<tr>
<td>Risk diversified away by shareholders as securities are combined to form diversified portfolio; also called unsystematic risk</td>
</tr>
</tbody>
</table>

Should we be interested in the project standing alone risk? The answer is no. Perhaps the easiest way to understand why not is to look at an example. Let’s take the case of research and development projects at Johnson & Johnson. Each year Johnson & Johnson takes on hundreds of new R&D projects, knowing that they only have about a 10-percent probability of being successful. If they are successful, the profits can be enormous; if they fail, the investment is lost. If the company has only one project, and it is an R&D project, the company would have a 90 percent chance of failure. Thus, if we look at these R&D projects individually and measure their stand-alone risk, we would have to judge them to be enormously risky. However, if we consider the effect of the diversification that comes about from taking on several hundred independent R&D projects a year, all with a 10-percent chance of success, we can see that each R&D project does not add much risk to Johnson & Johnson. In short, because much of a project’s risk is diversified away within the firm, the project standing alone risk is an inappropriate measure of the meaningful level of risk of a capital-budgeting project.

Should we be interested in the project’s contribution-to-firm risk? Once again, at least in theory the answer is no, provided investors are well diversified and there is no chance of bankruptcy. From our earlier discussion of risk in Chapter 8, we saw that as shareholders, if we combined an individual security with other securities to form a diversified portfolio, much of the risk of the individual security would be diversified away. In short, all that affects the shareholders is the systematic risk of the project and, as such, is all that is theoretically relevant for capital budgeting.

Measuring Risk for Capital-Budgeting Purposes with a Dose of Reality—Is Systematic Risk All There Is?

According to the Capital Asset Pricing Model (CAPM) we discussed in Chapter 6, systematic risk is the only relevant risk for capital-budgeting purposes; however, reality complicates this somewhat. In many instances a firm will have undiversified shareholders, including owners of small corporations. Because they are not diversified, for those shareholders the relevant measure of risk is the project’s contribution-to-firm risk.

The possibility of bankruptcy also affects our view of what measure of risk is relevant. As you recall in developing the CAPM, we made the assumption that bankruptcy costs were zero. Because the project’s contribution-to-firm risk can affect the possibility of bankruptcy, this may be an appropriate measure of risk if
there are costs associated with bankruptcy. Quite obviously, in the real world there is a cost associated with bankruptcy. First, if a firm fails, its assets, in general, cannot be sold for their true economic value. Moreover, the amount of money actually available for distribution to stockholders is further reduced by liquidation and legal fees that must be paid. Finally, the opportunity cost associated with the delays related to the legal process further reduces the funds available to the shareholder. Therefore, because costs are associated with bankruptcy, reduction of the chance of bankruptcy has a very real value associated with it.

Indirect costs of bankruptcy also affect other areas of the firm, including production, sales, and the quality and efficiency of management. For example, firms with a higher probability of bankruptcy may have a more difficult time recruiting and retaining quality managers because jobs with that firm are viewed as being less secure. Suppliers also may be less willing to sell on credit. Finally, customers may lose confidence and fear that the firm may not be around to honor the warranty or to supply spare parts for the product in the future. As a result, as the probability of bankruptcy increases, the eventual bankruptcy may become self-fulfilling as potential customers and suppliers flee. The end result is that because the project’s contribution-to-firm risk affects the probability of bankruptcy for the firm, it is a relevant risk measure for capital budgeting.

Finally, problems in measuring a project’s systematic risk make its implementation extremely difficult. It is much easier talking about a project’s systematic risk than measuring it.

Given all this, what do we use? The answer is that we will give consideration to both measures. We know in theory systematic risk is correct. We also know that bankruptcy costs and undiversified shareholders violate the assumptions of the theory, which brings us back to the concept of a project’s contribution-to-firm risk. Still, the concept of systematic risk holds value for capital-budgeting decisions, because that is the risk that shareholders are compensated for assuming. Therefore, we will concern ourselves with both the project’s contribution-to-firm risk and the project’s systematic risk, and not try to make any specific allocation of importance between the two for capital-budgeting purposes.

**Incorporating Risk into Capital Budgeting**

In Chapter 9 we ignored any risk differences between projects. This approach is simple but not valid; different investment projects do in fact contain different levels of risk. We now look at the risk-adjusted discount rate, which is based on the notion that investors require higher rates of return on more-risky projects.

**Concept Check**

1. In capital budgeting, a project’s risk can be looked at on three levels, what are they and what are the measures of risk?
2. Is a project’s stand-alone risk the appropriate level of risk for capital budgeting? Why or why not?
3. What is systematic risk?
4. What problems are there associated with using systematic risk as the measure for risk in capital budgeting?

**Back to the Foundations**

All the methods used to compensate for risk in capital budgeting find their roots in **Principle 1: The Risk–Return Trade-off—We Won’t Take on Additional Risk Unless We Expect to Be Compensated with Additional Return**. In fact, the risk-adjusted discount method puts this concept directly into play.
Risk-Adjusted Discount Rates

The use of risk-adjusted discount rates is based on the concept that investors demand higher returns for more-risky projects. This is the basic principle behind Principle 1 and the CAPM, and this relationship between risk and return is illustrated graphically in Figure 10-5.

As we know from Principle 1, the expected rate of return on any investment should include compensation for delaying consumption equal to the risk-free rate of return, plus compensation for any risk taken on. Under the risk-adjusted discount rate approach, if the risk associated with the investment is greater than the risk involved in a typical endeavor, the discount rate is adjusted upward to compensate for this added risk. Once the firm determines the appropriate required rate of return for a project with a given level of risk, the cash flows are discounted back to the present at the risk-adjusted discount rate. Then the normal capital-budgeting criteria are applied, except in the case of the IRR. For the IRR, the hurdle rate with which the project’s IRR is compared now becomes the risk-adjusted discount rate. Expressed mathematically, the NPV using the risk-adjusted discount rate becomes

\[ NPV = \sum_{t=1}^{n} \frac{FCF_t}{(1 + k^*)^t} - IO \]  

where \( FCF_t \) = the annual free cash flow expected in time period \( t \)
\( IO \) = the initial cash outlay
\( k^* \) = the risk-adjusted discount rate
\( n \) = the project’s expected life

The logic behind the risk-adjusted discount rate stems from the idea that if the level of risk in a project is different from that of the typical firm project, then management must incorporate the shareholders’ probable reaction to this new endeavor into the decision-making process. If the project has more risk than a typical project, then a higher required rate of return should apply. Otherwise, marginal projects will lower the firm’s share price—that is, reduce shareholders’ wealth. This will occur as the market raises its required rate of return on the firm to reflect the addition of a more-risky project, whereas the incremental cash flows resulting from the acceptance of the new project are not large enough to offset this change fully. By the same logic, if the project has less than normal risk, a reduction in the required rate of return is appropriate. Thus, the risk-adjusted discount method attempts to apply more-stringent standards—that is, require a higher rate of return—to projects that will increase the firm’s risk level. This is because these projects will lead shareholders to demand a higher required rate of return to compensate them for the higher risk level of the firm. If this adjustment is not made, the marginal projects containing above-average risk could actually lower the firm’s share price.

**Example**

A toy manufacturer is considering the introduction of a line of fishing equipment with an expected life of 5 years. In the past, this firm has been quite conservative in its investment in new products, sticking primarily to standard
toys. In this context, the introduction of a line of fishing equipment is considered an abnormally risky project. Management thinks that the normal required rate of return for the firm of 10 percent is not sufficient. Instead, the minimum acceptable rate of return on this project should be 15 percent. The initial outlay would be $110,000, and the expected cash flows from this project are given in the following table:

<table>
<thead>
<tr>
<th>Year</th>
<th>Expected Free Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$30,000</td>
</tr>
<tr>
<td>2</td>
<td>30,000</td>
</tr>
<tr>
<td>3</td>
<td>30,000</td>
</tr>
<tr>
<td>4</td>
<td>30,000</td>
</tr>
<tr>
<td>5</td>
<td>30,000</td>
</tr>
</tbody>
</table>

Discounting this annuity back to the present at 15 percent yields a present value of the future free cash flows of $100,560. Because the initial outlay on this project is $110,000, the NPV becomes $-9,440, and the project should be rejected. If the normal required rate of return of 10 percent had been used as the discount rate, the project would have been accepted with a NPV of $3,730.

In practice, when the risk-adjusted discount rate is used, projects are generally grouped according to purpose, or risk class; then the discount rate preassigned to that purpose or risk class is used. For example, a firm with a required rate of return of 12 percent might use the following rate-of-return categorization:

<table>
<thead>
<tr>
<th>Project</th>
<th>Required Rate of Return (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement decision</td>
<td>12</td>
</tr>
<tr>
<td>Modification or expansion of existing product line</td>
<td>15</td>
</tr>
<tr>
<td>Project unrelated to current operations</td>
<td>18</td>
</tr>
<tr>
<td>Research and development operations</td>
<td>25</td>
</tr>
</tbody>
</table>

The purpose of this categorization of projects is to make their evaluation easier, but it also introduces a sense of the arbitrary into the calculations that makes the evaluation less meaningful. The trade-offs involved in the preceding classification are obvious; time and effort are minimized, but only at the cost of precision.

**Risk-Adjusted Discount Rate and Measurement of a Project's Systematic Risk**

When we initially talked about systematic risk or the beta, we were talking about measuring it for the entire firm. As you recall, although we could estimate a firm’s beta using historical data, we did not have complete confidence in our results. As we will see, estimating the appropriate level of systematic risk for a single project is even more fraught with difficulties. To truly understand what it is we are trying to do and the difficulties we will encounter, let us step back a bit and examine systematic risk and the risk adjustment for a project.

What we are trying to do is use the CAPM to determine the level of risk and the appropriate risk-return trade-offs for a particular project. We then take the expected return on this project and compare it to the required return suggested by the CAPM to determine whether the project should be accepted. If the project appears to be a typical one for the firm, using the CAPM to determine the appropriate risk-return trade-offs and then judging the project against them may be a warranted approach. But if the project is not a typical project, what do we do? Historical data generally do not exist for a new project. In fact, for some capital
Incorporating Risk into Capital Budgeting at Merck

The risks that pharmaceutical firms face in product development are great. It takes $359 million and 10 years, on average, to bring a new drug to market. Then, once the drug has reached the market, 70 percent of the time it is unprofitable. To allow for this risk, Merck uses a simulation approach and sensitivity analysis. In this way they are able to identify key variables that affect the project’s outcome.

Last year Merck and Co., Inc., invested well over $2 billion in R&D and capital expenditures combined. The company spent much of the money on risky, long-term projects that are notoriously difficult to evaluate. Indeed, the critics of modern finance would argue that such projects should not be subjected to rigorous financial analysis, because such analysis fails to reflect the strategic value of long-term investments. Yet at Merck, it is those projects with the longest time horizon that receive the most intense and financially sophisticated analyses. In fact, Merck’s financial function is active and influential with a highly quantitative, analytical orientation. The company is seldom, if ever, criticized for being shortsighted.

Why doesn’t all this analysis choke off long-term investing, as critics of modern finance theory say it should? In part because Merck is a leader in building financial models of scientific and commercial processes and in using those models to improve business decisions. Rather than relying on static, single-point forecasts, Merck’s models use probability distributions for numerous variables and come up with a range of possible outcomes that both stimulate discussion and facilitate decision making.

For example, Merck’s Research Planning Model, now ten years old, and its Revenue Hedging Model, now four years old, integrate economics, finance, statistics, and computer science to produce disciplined, quantitative analyses of specific elements of Merck’s business. These models do not make decisions. Instead, they provide Merck executives with cogent information both about risks and returns and about financial performance for specific projects and activities.


Beta Estimation Using Accounting Data

When we are dealing with a project that is identical to the firm’s other projects, we need only estimate the level of systematic risk for the firm and use that estimate as a proxy for the project’s risk. Unfortunately, when projects are not typical of the firm, this approach does not work. For example, when R. J. Reynolds introduces a new food through one of its food products divisions, this new product most likely carries with it a different level of systematic risk from what is typical for Reynolds as a whole.

To get a better approximation of the systematic risk level on this project, we estimate the level of systematic risk for the food division and use that as a proxy for the project’s systematic risk. Unfortunately, historical stock price data are available only for the company as a whole, and as you recall, historical stock return data are generally used to estimate a firm’s beta. Thus, we are forced to use accounting return data rather than historical stock return data for the division to estimate the division’s systematic risk. To estimate a project’s beta using accounting data we need only run a time-series regression of the division’s return on assets (net income/total assets) on the market investments—for example, a truck or a new building—historical data would not have much meaning. What we need to do is make the best of a bad situation. We either (1) fake it—that is, use historical accounting data, if available, to substitute for historical price data in estimating systematic risk—or (2) we attempt to find a substitute firm in the same industry as the capital-budgeting project and use the substitute firm’s estimated systematic risk as a proxy for the project’s systematic risk.
OBJECTIVE 6

The regression coefficient from this equation would be the project’s accounting beta and would serve as an approximation for the project’s true beta, or measure of systematic risk. Alternatively, a multiple regression model based on accounting data could be developed to explain betas. The results of this model could then be applied to firms that are not publicly traded to estimate their betas.

How good is the accounting beta technique? It certainly is not as good as a direct calculation of the beta. In fact, the correlation between the accounting beta and the beta calculated on historical stock return data is only about 0.6; however, better luck has been experienced with multiple regression models used to predict betas. Unfortunately, in many cases there may not be any realistic alternative to the calculation of the accounting beta. Owing to the importance of adjusting for a project’s risk, the accounting beta method is much preferred to doing nothing.

The Pure Play Method for Estimating a Project’s Beta

Whereas the accounting beta method attempts to directly estimate a project or division’s beta, the pure play method attempts to identify publicly traded firms that are engaged solely in the same business as the project or division. Once the proxy or pure play firm is identified, its systematic risk is determined and then used as a proxy for the project’s or division’s level of systematic risk. What we are doing is looking for a publicly traded firm on the outside that looks like our project and using that firm’s required rate of return to judge our project. In doing so we are presuming that the systematic risk and the capital structure of the proxy firm are identical to those of the project.

In using the pure play method it should be noted that a firm’s capital structure is reflected in its beta. When the capital structure of the proxy firm is different from that of the project’s firm, some adjustment must be made for this difference. Although not a perfect approach, it does provide some insights about the level of systematic risk a project might have.

1. What is the most commonly used method for incorporating risk into the capital budgeting decision? How is this technique related to Principle 1?
2. Describe two methods for estimating a project’s systematic risk?

Examining a Project’s Risk Through Simulation

Simulation: Explained and Illustrated

Another method for evaluating risk in the investment decision is through the use of simulation. The certainty equivalent and risk-adjusted discount rate approaches provided us with a single value for the risk-adjusted NPV, whereas a simulation approach gives us a probability distribution for the investment’s NPV or IRR. Simulation involves the process of imitating the performance of the project under evaluation. This is done by randomly selecting observations from each of the distributions that affect the outcome of the project, and continuing with this process until a representative record of the project’s probable outcome is assembled.

The easiest way to develop an understanding of the computer simulation process is to follow through an example simulation for an investment project evaluation. Suppose a chemical producer is considering an extension to its processing plant. The simulation process is portrayed in Figure 10-6. First, the probability distributions are determined for all the factors that affect the project’s returns; in this case, let us assume there are nine such variables:

1. Market size
2. Selling price
3. Market growth rate
4. Share of market (which results in physical sales volume)
Step 1: Develop probability distributions for key factors.

Step 2: Randomly select values from these distributions.

Step 3: Combine these factors and determine an internal rate of return.

Step 4: Continue to repeat this process until a clear portrait of the results is obtained.

Step 5: Evaluate the resultant probability distribution.

Then the computer randomly selects one observation from each of the probability distributions, according to its chance of actually occurring in the future. These nine observations are combined, and an NPV or IRR figure is calculated. This process is repeated as many times as desired, until a representative distribution of possible future outcomes is assembled. Thus, the inputs to a simulation include all
the principal factors affecting the project’s profitability, and the simulation output is a probability distribution of net present values or internal rates of return for the project. The decision maker bases the decision on the full range of possible outcomes. The project is accepted if the decision maker feels that enough of the distribution lies above the normal cutoff criteria (NPV ≥ 0, IRR ≥ required rate of return).

Suppose the output from the simulation of a chemical producer’s project is as shown in Figure 10-7. This output provides the decision maker with the probability of different outcomes occurring in addition to the range of possible outcomes. Sometimes called scenario analysis, this examination identifies the range of possible outcomes under the worst, best, and most likely case. The firm’s management examines the distribution to determine the project’s level of risk and then makes the appropriate adjustment.

You’ll notice that although the simulation approach helps us to determine the amount of total risk a project has, it does not differentiate between systematic and unsystematic risk. Because systematic risk cannot be diversified away for free, the simulation approach does not provide a complete method of risk assessment. However, it does provide important insights about the total risk level of a given investment project. Now we will look briefly at how the simulation approach can be used to perform sensitivity analysis.

**Sensitivity Analysis Through Simulation Approach**

Sensitivity analysis involves determining how the distribution of possible net present values or internal rates of return for a particular project is affected by a change in one particular input variable. This is done by changing the value of one input variable while holding all other input variables constant. The distribution of possible net present values or internal rates of return that is generated is then compared with the distribution of possible returns generated before the change was made to determine the effect of the change. For this reason sensitivity analysis is commonly called what-if analysis.

For example, the chemical producer that is considering a possible expansion to its plant may wish to determine the effect of a more-pessimistic forecast of the anticipated market growth rate. After the more-pessimistic forecast replaces the original forecast in the model, the simulation is rerun. The two outputs are then compared to determine how sensitive the results are to the revised estimate of the market growth rate.

**Concept Check**

1. Explain to yourself how simulations work.
2. What is scenario analysis? What is sensitivity analysis? When would you perform sensitivity analysis?
Chapter 10: Cash Flows and Other Topics in Capital Budgeting

Finance and the Multinational Firm: Calculating Cash Flows and the International Dimension of Risk

The process of measuring the incremental after-tax cash flows to the company as a whole gets a bit more complicated when we are dealing with competition from abroad. One area in which this is certainly true is in calculating the right base case—that is, what the firm’s incremental after-tax cash flows would be if the project is not taken on. In determining future cash flows we must always be aware of potential competition from abroad. We need only look to the auto industry to see that competition from abroad can be serious. During the 1970s, who would have thought that firms like Toyota, Honda, and Nissan could enter the U.S. markets and actually challenge the likes of Ford and GM? The end result of opening markets to international competition has led not only to increased opportunities, but also to increased risks.

There are also other intangible benefits from investing in countries such as Germany and Japan, where cutting-edge technology is making its way into the marketplace. Here investment abroad provides a chance to observe the introduction of new innovations on a first-hand basis, allowing firms such as IBM, GE, and 3Com to react more quickly to any technological advances and product innovations that might come out of Germany or Japan.

Along with all the benefits from going multinational come the risks. One of the major risks involves currency fluctuations. For example, in 1998, Boeing introduced the Boeing Business Jet, a new versatile business jet that combines fuel efficiency for short flights with globe-spanning range. Boeing produces these planes in the United States, paying workers and suppliers in U.S. dollars. Boeing then exports them all over the world, with payment received in many different currencies. What if between the time an order was placed and payment was received the value of the foreign currency fell? In fact, on April 1, 1998, the value of the Yugoslav dinar fell by 43% against the U.S. dollar. That means if Boeing had sold a Business Jet to a customer in Yugoslavia for Yugoslav dinars, Boeing would have received the same number of dinar stated in the contract, but they would have been worth 43% less. Risks from economic and currency problems abroad can be devastating.

1. In what ways does the process of measuring the incremental after-tax cash flows to the company as a whole get a bit more complicated when we are dealing with competition from abroad?

2. What new risks does a firm face when it enters the international markets?

Summary

In this chapter, we examine the measurement of incremental cash flows associated with a firm’s investment proposals and methods that are used to evaluate those proposals. Relying on Principle 3: Cash—Not Profits—Is King, and Principle 4: Incremental Cash Flows—It’s Only What Changes That Counts, we focus only on the incremental or differential after-tax cash flows attributed to the investment proposal. Care is taken to beware of cash flows diverted from existing products, look for incidental or synergistic effects, consider working-capital requirements, consider incremental expenses, ignore sunk costs, account for opportunity costs, examine overhead costs carefully, and ignore interest payments and financing flows.

To measure a project’s benefits, we use the project’s free cash flows. These free cash flows include

\[
\text{project’s free cash flows} = \text{project’s change in operating cash flows} - \text{change in net working capital} - \text{change in capital spending}
\]
If we can rewrite this, inserting our calculation for project's change in operating cash flows, we get:

\[
\text{project's free cash flows} = \text{change in earnings before interest and taxes} \\
- \text{change in taxes} \\
+ \text{change in depreciation} \\
- \text{change in net working capital} \\
- \text{change in capital spending}
\]

How do we deal with a project that has the potential to be modified in the future after some future uncertainty has been resolved? This flexibility to be modified is something that the NPV and our other decision criteria had a difficult time dealing with. It is this value of flexibility that we will be examining using options. Three of the most common types of options that can add value to a capital budgeting project are (1) the option to delay a project until the future cash flows are more favorable (this option is common when the firm has exclusive right, perhaps a patent, to a product or technology); (2) the option to expand a project, perhaps in size or even to new products that would not have otherwise been feasible; and (3) the option to abandon a project if future cash flows fall short of expectations.

We also cover the problem of incorporating risk into the capital-budgeting decision. First, we explore just what type of risk to adjust for: the project standing alone risk, the project's contribution-to-firm risk, or the project's systematic risk. In theory, systematic risk is the appropriate risk measure, but bankruptcy costs and the issue of undiversified shareholders also give weight to considering a project's contribution-to-firm risk as the appropriate risk measure. Both measures of risk are valid, and we avoid making any specific allocation of importance between the two in capital budgeting.

Two commonly used methods for incorporating risk into capital budgeting are (1) risk-adjusted discount rates and (2) simulation. The risk-adjusted discount rate involves an upward adjustment of the discount rate to compensate for risk. This method is based on the concept that investors demand higher returns for riskier projects. The simulation method is used to provide information about the location and shape of the distribution of possible outcomes. Decisions could be based directly on this method, or it could be used to determine input into either certainty equivalent or risk-adjusted discount rate method approaches.

The process of measuring the free cash flows to the company as a whole becomes more complicated when we are dealing with competition from abroad. One area in which this is certainly true is in calculating the right base case—that is, what the firm's free cash flows would be if the project is not taken on. Another complication involves the risks associated with currency fluctuations.

**Key Terms**

- contribution-to-firm risk, 294
- incremental after-tax cash flows, 280
- initial outlay, 284
- project standing alone risk, 294
- pure play method, 300
- risk-adjusted discount rate, 297
- scenario analysis, 302
- sensitivity analysis, 302
- simulation, 300
- systematic risk, 294

**Study Questions**

10-1. Why do we focus on cash flows rather than accounting profits in making our capital-budgeting decisions? Why are we interested only in incremental cash flows rather than total cash flows?

10-2. If depreciation is not a cash flow expense, does it affect the level of cash flows from a project in any way? Why?

10-3. If a project requires additional investment in working capital, how should this be treated in calculating cash flows?

10-4. How do sunk costs affect the determination of cash flows associated with an investment proposal?

10-5. In the preceding chapter we examined the payback period capital-budgeting criterion. Often this capital-budgeting criterion is used as a risk-screening device. Explain the rationale behind its use.

10-6. The use of the risk-adjusted discount rate assumes that risk increases over time. Justify this assumption.

10-7. Explain how simulation works. What is the value in using a simulation approach?
Self-Test Problem

ST-1. The Easterwood Corporation, a firm in the 34-percent marginal tax bracket with a 15-percent required rate of return or cost of capital, is considering a new project. This project involves the introduction of a new product. This project is expected to last 5 years and then, because this is somewhat of a fad project, to be terminated. Given the following information, determine the free cash flows associated with the project, the project’s net present value, the profitability index, and the internal rate of return. Apply the appropriate decision criteria.

Cost of new plant and equipment: $20,900,000
Shipping and installation costs: $300,000

<table>
<thead>
<tr>
<th>Unit sales</th>
<th>Year</th>
<th>Units Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>100,000</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>130,000</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>160,000</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>100,000</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>60,000</td>
</tr>
</tbody>
</table>

Sales price per unit: $500/unit in years 1 through 4, $380/unit in year 5
Variable cost per unit: $260/unit
Annual fixed costs: $300,000
Working-capital requirements: There will be an initial working-capital requirement of $500,000 just to get production started. For each year, the total investment in net working capital will be equal to 10 percent of the dollar value of sales for that year. Thus, the investment in working capital will increase during years 1 through 3, then decrease in year 4. Finally, all working capital is liquidated at the termination of the project at the end of year 5.

The depreciation method: Use the simplified straight-line method over 5 years. It is assumed that the plant and equipment will have no salvage value after 5 years.

Study Problems

10-1. (Capital Gains Tax) The J. Harris Corporation is considering selling one of its old assembly machines. The machine, purchased for $30,000 five years ago, had an expected life of 10 years and an expected salvage value of zero. Assume Harris uses simplified straight-line depreciation, creating depreciation of $3,000 per year, and could sell this old machine for $35,000. Also assume a 34-percent marginal tax rate.
   a. What would be the taxes associated with this sale?
   b. If the old machine were sold for $25,000, what would be the taxes associated with this sale?
   c. If the old machine were sold for $15,000, what would be the taxes associated with this sale?
   d. If the old machine were sold for $12,000, what would be the taxes associated with this sale?

10-2. (Relevant Cash Flows) Captins’ Cereal is considering introducing a variation of its current breakfast cereal, Crunch Stuff. This new cereal will be similar to the old with the exception that it will contain sugarcoated marshmallows shaped in the form of stars. The new cereal will be called Crunch Stuff n’ Stars. It is estimated that the sales for the new cereal will be $25 million; however, 20 percent of those sales will be former Crunch Stuff customers who have switched to Crunch Stuff n’ Stars who would not have switched if the new product had not been introduced. What is the relevant sales level to consider when deciding whether to introduce Crunch n’ Stars?

10-3. (Calculating Free Cash Flows) Racin’ Scooters is introducing a new product and has an expected change in EBIT of $475,000. Racin’ Scooters has a 34-percent marginal tax rate. This project will also produce $100,000 of depreciation per year. In addition, this project will also cause the following changes:

<table>
<thead>
<tr>
<th>Without the Project</th>
<th>With the Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounts receivable</td>
<td>$45,000</td>
</tr>
<tr>
<td>Inventory</td>
<td>65,000</td>
</tr>
<tr>
<td>Accounts payable</td>
<td>70,000</td>
</tr>
</tbody>
</table>

What is the project’s free cash flow?
10-4. *(Calculating Free Cash Flows)* Visible Fences is introducing a new product and has an expected change in EBIT of $900,000. Visible Fences has a 34-percent marginal tax rate. This project will also produce $300,000 of depreciation per year. In addition, this project will also cause the following changes:

<table>
<thead>
<tr>
<th>Without the Project</th>
<th>With the Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounts receivable</td>
<td>$55,000</td>
</tr>
<tr>
<td></td>
<td>$63,000</td>
</tr>
<tr>
<td>Inventory</td>
<td>55,000</td>
</tr>
<tr>
<td></td>
<td>70,000</td>
</tr>
<tr>
<td>Accounts payable</td>
<td>90,000</td>
</tr>
<tr>
<td></td>
<td>106,000</td>
</tr>
</tbody>
</table>

What is the project's free cash flow?

10-5. *(New Project Analysis)* The Chung Chemical Corporation is considering the purchase of a chemical analysis machine. Although the machine being considered will result in an increase in earnings before interest and taxes of $35,000 per year, it has a purchase price of $100,000, and it would cost an additional $5,000 to properly install this machine. In addition, to properly operate this machine, inventory must be increased by $5,000. This machine has an expected life of 10 years, after which it will have no salvage value. Also, assume simplified straight-line depreciation and that this machine is being depreciated down to zero, a 34-percent marginal tax rate, and a required rate of return of 15 percent.

a. What is the initial outlay associated with this project?
b. What are the annual after-tax cash flows associated with this project for years 1 through 9?
c. What is the terminal cash flow in year 10 (what is the annual after-tax cash flow in year 10 plus any additional cash flows associated with termination of the project)?
d. Should this machine be purchased?

10-6. *(New Project Analysis)* Raymobile Motors is considering the purchase of a new production machine for $500,000. The purchase of this machine will result in an increase in earnings before interest and taxes of $150,000 per year. To operate this machine properly, workers would have to go through a brief training session that would cost $25,000 after taxes. It would cost $5,000 to install this machine properly. Also, because this machine is extremely efficient, its purchase would necessitate an increase in inventory of $30,000. This machine has an expected life of 10 years, after which it will have no salvage value. Assume simplified straight-line depreciation and that this machine is being depreciated down to zero, a 34-percent marginal tax rate, and a required rate of return of 15 percent.

a. What is the initial outlay associated with this project?
b. What are the annual after-tax cash flows associated with this project for years 1 through 9?
c. What is the terminal cash flow in year 10 (what is the annual after-tax cash flow in year 10 plus any additional cash flows associated with termination of the project)?
d. Should this machine be purchased?

10-7. *(New Project Analysis)* Garcia's Truckin', Inc., is considering the purchase of a new production machine for $200,000. The purchase of this machine will result in an increase in earnings before interest and taxes of $50,000 per year. To operate this machine properly, workers would have to go through a brief training session that would cost $5,000 after taxes. It would cost $5,000 to install this machine properly. Also, because this machine is extremely efficient, its purchase would necessitate an increase in inventory of $20,000. This machine has an expected life of 10 years, after which it will have no salvage value. Finally, to purchase the new machine, it appears that the firm would have to borrow $100,000 at 8-percent interest from its local bank, resulting in additional interest payments of $8,000 per year. Assume simplified straight-line depreciation and that this machine is being depreciated down to zero, a 34-percent marginal tax rate, and a required rate of return of 10 percent.

a. What is the initial outlay associated with this project?
b. What are the annual after-tax cash flows associated with this project for years 1 through 9?
c. What is the terminal cash flow in year 10 (what is the annual after-tax cash flow in year 10 plus any additional cash flows associated with termination of the project)?
d. Should this machine be purchased?

10-8. *(Comprehensive Problem)* Traid Winds Corporation, a firm in the 34-percent marginal tax bracket with a 15-percent required rate of return or cost of capital, is considering a new project. This project involves the introduction of a new product. This project is expected to last 5 years and then, because this is somewhat of a fad project,
to be terminated. Given the following information, determine the free cash flows associated with the project, the project’s net present value, the profitability index, and the internal rate of return. Apply the appropriate decision criteria.

Cost of new plant and equipment: $14,800,000
Shipping and installation costs: $200,000

<table>
<thead>
<tr>
<th>Unit sales</th>
<th>Year</th>
<th>Units Sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>120,000</td>
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</tr>
<tr>
<td>3</td>
<td>120,000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>80,000</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>70,000</td>
<td></td>
</tr>
</tbody>
</table>

Sales price per unit: $300/unit in years 1 through 4, $250/unit in year 5
Variable cost per unit: $140/unit
Annual fixed costs: $700,000

Working-capital requirements: There will be an initial working-capital requirement of $200,000 just to get production started. For each year, the total investment in net working capital will be equal to 10 percent of the dollar value of sales for that year. Thus, the investment in working capital will increase during years 1 through 3, then decrease in year 4. Finally, all working capital is liquidated at the termination of the project at the end of year 5.

The depreciation method: Use the simplified straight-line method over 5 years. It is assumed that the plant and equipment will have no salvage value after 5 years.

10-9. (Comprehensive Problem) The Shome Corporation, a firm in the 34-percent marginal tax bracket with a 15-percent required rate of return or cost of capital, is considering a new project. This project involves the introduction of a new product. This project is expected to last 5 years and then, because this is somewhat of a fad project, to be terminated. Given the following information, determine the free cash flows associated with the project, the project’s net present value, the profitability index, and the internal rate of return. Apply the appropriate decision criteria.

Cost of new plant and equipment: $6,900,000
Shipping and installation costs: $100,000

<table>
<thead>
<tr>
<th>Unit Sales</th>
<th>Year</th>
<th>Units Sold</th>
</tr>
</thead>
<tbody>
<tr>
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<td>80,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>100,000</td>
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<tr>
<td>3</td>
<td>120,000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>70,000</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>70,000</td>
<td></td>
</tr>
</tbody>
</table>

Sales price per unit: $250/unit in years 1 through 4, $200/unit in year 5
Variable cost per unit: $130/unit
Annual fixed costs: $300,000

Working-capital requirements: There will be an initial working-capital requirement of $100,000 just to get production started. For each year, the total investment in net working capital will be equal to 10 percent of the dollar value of sales for that year. Thus, the investment in working capital will increase during years 1 through 3, then decrease in year 4. Finally, all working capital is liquidated at the termination of the project at the end of year 5.

The depreciation method: Use the simplified straight-line method over 5 years. It is assumed that the plant and equipment will have no salvage value after 5 years.

10-10. (Risk-Adjusted NPV) The Hokie Corporation is considering two mutually exclusive projects. Both require an initial outlay of $10,000 and will operate for 5 years. Project A will produce expected cash flows of $5,000 per year for years 1 through 5, whereas Project B will produce expected cash flows of $6,000 per year for years 1 through 5. Because project B is the riskier of the two projects, the management of Hokie Corporation has decided to apply a required rate of return of 15 percent to its evaluation but only a 12-percent required rate of return to project A. Determine each project’s risk-adjusted net present value.

10-11. (Risk-Adjusted Discount Rates and Risk Classes) The G. Wolfe Corporation is examining two capital-budgeting projects with 5-year lives. The first, project A, is a replacement project; the second, project B, is a project unrelated to current operations. The G. Wolfe Corporation uses the risk-adjusted discount rate method and groups projects according to purpose, and then uses a required rate of return or discount rate that has been preassigned to that purpose or risk class. The expected cash flows for these projects are given here:
The purpose/risk classes and preassigned required rates of return are as follows:

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Required Rate of Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement decision</td>
<td>12%</td>
</tr>
<tr>
<td>Modification or expansion of existing product line</td>
<td>15</td>
</tr>
<tr>
<td>Project unrelated to current operations</td>
<td>18</td>
</tr>
<tr>
<td>Research and development operations</td>
<td>20</td>
</tr>
</tbody>
</table>

Determine the project’s risk-adjusted net present value.

**Comprehensive Problem**

It’s been 2 months since you took a position as an assistant financial analyst at Caledonia Products. Although your boss has been pleased with your work, he is still a bit hesitant about unleashing you without supervision. Your next assignment involves both the calculation of the cash flows associated with a new investment under consideration and the evaluation of several mutually exclusive projects. Given your lack of tenure at Caledonia, you have been asked not only to provide a recommendation, but also to respond to a number of questions aimed at judging your understanding of the capital-budgeting process. The memorandum you received outlining your assignment follows:

TO:       The Assistant Financial Analyst  
FROM:     Mr. V. Morrison, CEO, Caledonia Products  
RE:       Cash Flow Analysis and Capital Rationing

We are considering the introduction of a new product. Currently we are in the 34-percent marginal tax bracket with a 15-percent required rate of return or cost of capital. This project is expected to last 5 years and then, because this is somewhat of a fad project, to be terminated. The following information describes the new project:

- **Cost of new plant and equipment:** $7,900,000
- **Shipping and installation costs:** $100,000
- **Unit sales:**
  - Year 1: 70,000 units
  - Year 2: 120,000 units
  - Year 3: 140,000 units
  - Year 4: 80,000 units
  - Year 5: 60,000 units
- **Sales price per unit:** $300/unit in years 1 through 4, $260/unit in year 5
- **Variable cost per unit:** $180/unit
- **Annual fixed costs:** $200,000

**Working-capital requirements:** There will be an initial working-capital requirement of $100,000 just to get production started. For each year, the total investment in net working capital will be equal to 10 percent of the dollar value of sales for that year. Thus, the investment in working capital will increase during years 1 through 3, then decrease in year 4. Finally, all working capital is liquidated at the termination of the project at the end of year 5.

**The depreciation method:** Use the simplified straight-line method over 5 years. It is assumed that the plant and equipment will have no salvage value after 5 years.

a. Should Caledonia focus on cash flows or accounting profits in making our capital-budgeting decisions? Should we be interested in incremental cash flows, incremental profits, total free cash flows, or total profits?
b. How does depreciation affect free cash flows?
c. How do sunk costs affect the determination of cash flows?
d. What is the project's initial outlay?
e. What are the differential cash flows over the project's life?
f. What is the terminal cash flow?
g. Draw a cash flow diagram for this project.
h. What is its net present value?
i. What is its internal rate of return?
j. Should the project be accepted? Why or why not?
k. In capital budgeting, risk can be measured from three perspectives. What are those three measures of a project's risk?
l. According to the CAPM, which measurement of a project's risk is relevant? What complications does reality introduce into the CAPM view of risk, and what does that mean for our view of the relevant measure of a project's risk?
m. Explain how simulation works. What is the value in using a simulation approach?
n. What is sensitivity analysis and what is its purpose?

Self-Test Solution

SS-1.

SECTION I. CALCULATE THE CHANGE IN EBIT, TAXES, AND DEPRECIATION
(THIS BECOMES AN INPUT IN THE CALCULATION OF OPERATING CASH FLOW IN SECTION II).

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units sold</td>
<td>100,000</td>
<td>130,000</td>
<td>160,000</td>
<td>100,000</td>
<td>60,000</td>
<td></td>
</tr>
<tr>
<td>Sales price</td>
<td>$500</td>
<td>$500</td>
<td>$500</td>
<td>$500</td>
<td>$380</td>
<td></td>
</tr>
<tr>
<td>Sales revenue</td>
<td>$50,000,000</td>
<td>$65,000,000</td>
<td>$80,000,000</td>
<td>$50,000,000</td>
<td>$22,800,000</td>
<td></td>
</tr>
<tr>
<td>Less: Variable costs</td>
<td>26,000,000</td>
<td>33,800,000</td>
<td>41,600,000</td>
<td>26,000,000</td>
<td>15,600,000</td>
<td></td>
</tr>
<tr>
<td>Less: Fixed costs</td>
<td>$300,000</td>
<td>$300,000</td>
<td>$300,000</td>
<td>$300,000</td>
<td>$300,000</td>
<td></td>
</tr>
<tr>
<td>Equals: EBDIT</td>
<td>$23,700,000</td>
<td>$30,900,000</td>
<td>$38,100,000</td>
<td>$23,700,000</td>
<td>$6,900,000</td>
<td></td>
</tr>
<tr>
<td>Less: Depreciation</td>
<td>$4,240,000</td>
<td>$4,240,000</td>
<td>$4,240,000</td>
<td>$4,240,000</td>
<td>$4,240,000</td>
<td></td>
</tr>
<tr>
<td>Equals: EBIT</td>
<td>$19,460,000</td>
<td>$26,660,000</td>
<td>$33,860,000</td>
<td>$19,460,000</td>
<td>$2,660,000</td>
<td></td>
</tr>
<tr>
<td>Taxes(@ 34%)</td>
<td>$6,616,400</td>
<td>$9,064,400</td>
<td>$11,512,400</td>
<td>$6,616,400</td>
<td>$904,400</td>
<td></td>
</tr>
</tbody>
</table>

SECTION II. CALCULATE OPERATING CASH FLOW
(THIS BECOMES AN INPUT IN THE CALCULATION OF FREE CASH FLOWS IN SECTION IV).

Operating cash flow:

| EBIT | $19,460,000 | $26,660,000 | $33,860,000 | $19,460,000 | $2,660,000 |
| Minus: Taxes | $6,616,400 | $9,064,400 | $11,512,400 | $6,616,400 | $904,400 |
| Plus: Depreciation | $4,240,000 | $4,240,000 | $4,240,000 | $4,240,000 | $4,240,000 |
| Equals: Operating cash flow | $17,083,600 | $21,835,600 | $26,587,600 | $17,083,600 | $5,995,600 |

SECTION III. CALCULATE THE NET WORKING CAPITAL
(THIS BECOMES AN INPUT IN THE CALCULATION OF FREE CASH FLOWS IN SECTION IV).

Change in Net Working Capital:

| Change in working capital | $500,000 | $4,500,000 | $1,500,000 | $1,500,000 | $(3,000,000) | $(5,000,000) |

SECTION IV. CALCULATE FREE CASH FLOW
(USING INFORMATION CALCULATED IN SECTIONS II AND III, IN ADDITION TO CHANGE IN CAPITAL SPENDING)

Free cash flow:

| Earnings before interest and taxes | $17,083,600 | $21,835,600 | $26,587,600 | $17,083,600 | $5,995,600 |
| Minus: Change in net working capital | $500,000 | $4,500,000 | $1,500,000 | $1,500,000 | $(3,000,000) | $(5,000,000) |
| Minus: Change in capital spending | $21,200,000 | $0 | $0 | $0 | $0 |
| Free cash flow | $(21,700,000) | $12,583,600 | $20,335,600 | $25,087,600 | $20,083,600 | $10,995,600 |
| NPV | $38,064,020 |